Cross-sectoral Validation of Indigenous Technical Knowledge in Agriculture

Document 4

Mission Unit
Division of Agricultural Extension
Indian Council of Agricultural Research
New Delhi 110 012

Cross-sectoral Validation of Indigenous Technical Knowledge in Agriculture

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Contents

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Contents

Cross-sectoral Validation of Indigenous Technical Knowledge in Agriculture

Contents

Preface

INDIGENOUS Technical Knowledge (ITK) in agriculture, animal husbandry, fisheries and other and-based activities has been in use since the human civilization by the farmers, animal owners and other practitioners. Inspite of advancement in scientific knowledge in agriculture, ITK-based practices still remain in use by the vast majority of the farming community particularly in resource-poor farming situations, without the knowledge of its scientific rationality.

The Mission Mode Project on 'Collection, Documentation and Validation of Indigenous Technical Knowledge (ITK)' has been a land mark effort not only in documenting 4880 inventories of ITKs in agriculture in three volumes but also in providing first hand results of validation on selected 111 ITKs experimented by the scientists of ICAR Institutions and State Agricultural/Animal Science Universities across the country.The results of the experiments indicated the rationality and efficacy of the ITKs in solving many of the problems faced by the farmers and other practitioners in sustaining their enterprises.

The promising 38 selected ITKs were further subjected to cross sectoral validation involving a few more research institutions for in-depth analysis and for identifying the active ingredients responsible for solving the problem. The present volume entitled *Cross-sectoral Validation of Indigenous Technical Knowledge in Agriculture* - Document 4 encompasses the results of cross-sectoral validation studies. It is firmly believed that the findings of,the experiments would provide a solid base for the future researchers, planners, policy makes as well as for the farmers and other practitioners to look back at the wisdom of the ITKs and incorporate the same in the research and development agenda.

The project team expresses its deep sense of gratitude to Dr Mangala Rai, Secretary (DARE) and Director-General (ICAR) for constant encouragement right from the inception of the project. The support received from National Agricultural Technology Project, particularly of Dr J. C. Katyal, National Director, Dr S. L. Mehta, former National Director, and Dr K. P. Agrawal, National Coordinator is highly acknowledged. The stupendous efforts made by the project personnel in implementing the programmes, collation and synthesis of the results, and bringing out this document deserve appreciation. The cooperation received from Directorate of Information and Publication in Agriculture (DIPA) is bringing out this document in a short time is highly appreciated.

The assistance received from Shri Sanjay Kushwaha, Technical Officer, ZC Unit, Jabalpur, Shri Vikas Jain and Ms Gigi Annee Abraham, both Research Associates and Ms Seema Naberia, Senior Research Fellow of the Lead Centre in compiling this Document is appreciated.

(PDAS)
Deputy Director-General (AE)
and Mission Leader

New Delhi
15 December 2004

Contents

Foreword

The concept of sustainability in Indian agricultural scenario has evoked interest on indigenous technical knowledge that has the element of use of natural products to solve problems pertaining to agriculture and allied activities through natural processes. The Indian Council of Agricultural Research (ICAR) launched a Mission Mode Project on "Collection, Documentation and Validation of Indigenous Technical Knowledge (ITK)" under National Agricultural Technology Project (NATP).

Initially, an effort was made to collect and compile indigenous knowledge-based practices in agriculture, animal husbandry and other land-based enterprises. The information have been compiled and published in the form of books in two volumes and two supplementary entitled *Inventory of Indigenous Technical Knowledge in Agriculture* - Document 1; Document 2 and; Supplement - 1 and 2 of Document 2. These four volumes contained an inventory of 4,880 ITKs covering 23 thematic areas *viz*,. Rain water management, Soil and water conservation, Wind erosion, Tillage practices, Crops and cropping systems, Soil fertility management, Pest and disease management, Farm implements, Post-harvest technology, Grain/seed storage, Horticultural crops, Veterinary science and animal husbandry, Fishery, Ethno botany and agro-biodiversity, Fuel management, Thermal efficiency, Weather forecasting, Waste water management, Garbage disposal and management, Food product development, Natural yarns, dyes and weaves, Low-cost housing materials and Ethnic food.

It is for the first time that a team of agricultural scientists drawn from ICAR institutes and State Agricultural/Veterinary Universities all over the country have made an effort under this project to take up validation studies on 111 selected ITKs. The initial results of the studies were published during 2003 in the form of a book entitled *Validation of Indigenous Technical Knowledge in Agriculture* - Document 3. From these, 37 important ITKs were further taken up for cross-sectoral validation through experimentation.

This publication entitled *Cross-sectoral validation of Indigenous Technical Knowledge in Agriculture* - Document 4 provides the results of experiments and its critical analysis on the efficacy of the ITKs. The results have been very interesting and extremely important that support scientific rationality of the ITKs for promoting their further application.

I hope this publication will open new chapter in agricultural research and provide the scientists a new direction for appropriate blending of ITKs with modern technologies. The voluminous and innovative efforts made by Dr P. Das, Deputy Director-General (Agril. Extn) and his dedicated team of scientists in bringing out this publication are commendable.

(MANGALA RAI)
Secretary
Department of Agricultural Research and Education
and
Director-General
Indian Council of Agricultural Research, New Delhi

New Delhi
15 December 2004

Contents

Introduction

INDIGENOUS Technical Knowledge (ITK) in agriculture, animal husbandry, fisheries and other and-based activities is being used since ages by the farmers, animal owners and other practitioners. Advancement in scientific knowledge in agriculture has questioned on rationality of ITKs and replaced these ITK-based practices. The problems of sustainability of modern scientific technologies and their impact on ecosystem and environment has evoked the interest on ITKs during the recent past.

The Indian Council of Agricultural Research (ICAR) implemented a Mission Mode Project on 'Collection, Documentation and Validation of Indigenous Technical Knowledge' under National Agricultural Technology Project (NATP) during 2000 to 2004. The project aimed at collecting and documenting the ITKs in agriculture and other land-based activities as well as studying their efficacy and validity through experimentation for establishing scientific rationality. The project activities were guided, monitored and supervised by an apex level committee (ITK Information Committee) with all DDGs of ICAR and eminent scientists as members.

Information on ITK were initially collected from the secondary sources like journals, reports, thesis, etc. and documented during 2002 in a 411-paged publication entitled 'Inventory of Indigenous Technical Knowledge in agriculture - Document 1'. Subsequently, information on indigenous knowledge-based practices were collected from primary sources through voluntary disclosures. These have been documented in three publications entitled 'Inventory of Indigenous Technical Knowledge in Agriculture - Document 2' and its supplements 1 and 2.

Experimental validation of 111 ITKs was carried out during 2002-2004 by the scientists of the ICAR Institutes and State Agricultural/Animal Science Universities all over the country under the technical supervision and monitoring of the respective Zonal Technical Coordination Committees (ZTCCs), and under overall supervision of the Mission Unit and the Lead Centre of the project.

Each Zonal Technical Co-ordination Committee identified the Co-operating Centres and the Co-operating Centre Principal Investigators (CCPI) for conducting experimental studies of their respective subject matter area. Scientists of related disciplines were associated in the experiments. The findings of the experiments were reviewed by the ZTCCs, and in the meetings convened by the Principal Investigators.

The initial results of 111 selected ITKs were published during 2003 in the fourth volume entitled, 'Validation of Indigenous Technical Knowledge in Agriculture - Document 3'. Some of the promising ITKs were subjected to cross-sectoral validation studies at additional research centres, while some of them required further studies as well as in-depth analysis, including identifying active ingredients contained in it.

The results of 38 ITKs have been included in this volume entitled, 'Cross-sectoral Validation of Indigenous Technical Knowledge in Agriculture - Document 4', out of 38 ITKs, 23 were validated cross sectoral, i.e. at more than one location in different zones and 15 were single center experiments. The list of the ITKs and the experimenting organizations for validation are as follows:

Contents

SI. No.	Code No.	Title	Experimenting organization
Rain water management			
1.	105	Rain water management for teak *(Tectona grandis* Linn. F.), mango *{Mangifera indica* Linn.) and neem *(Azadirachta* indica A. Juss.) in arid and semi-arid regions	1. Tamil Nadu Agricultural University, Coimbatore 2. Central Research Institute for Dryland Agriculture, Hyderabad
2.	2024	Rain water measurement using *rolu* (indigenous rain gauge)	Central Research Institute for Dryland Agriculture, Hyderabad
3.	599	Method of rainwater management in mountainous landscape under apple orchard	Ch. Sarwan Kumar Krishi Vishwa Vidyalaya, Palampur
Soil and water conservation			
4.	615	Cultivation of apple in Himalayan region	Ch. Sarwan Kumar Krishi VishwaVidyalaya, Palampur
Pest and disease management			
5.	344	Management of yellow stem borer in paddy by use of parasi *{Cleistanthus collinus)* leaf	Central Rice Research Institute, Cuttack
6.	357	Control of insect-pest in lowland rice using parasi *(Cleistanthus collinus)*	Central Rice Research Institute, Cuttack
7.	365	Planting of wild *Saccharum spontaneum* in paddy field for controlling leaf folder	Central Rice Research Institute, Cuttack
8.	1418	Control of caseworm *(Nymphula depunctalis)* in rice by leaves of *parsa* and sali	1. Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia 2. Birsa Agricultural University, Ranchi
	1422	Control of gall fly *(Pachydiplosis oryzae)* in rice	1. Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia 2. Birsa Agricultural University, Ranchi
10.	368	Management of *gundhi* (harmfull green algae) in paddy field by karada *(Cleistanthus collinus)* leaves	Central Rice Research Institute, Cuttack

SI. No.	Code No.	Title	Experimenting organization
Horticultural crops			
11.	170	Pest management in tomato *(Lycopersicon* esculentum) by using leaf extract of *Cynodon dactylon*	Tamil Nadu Agricultural University, Coimbatore
12.	366	Use of kochila *(Strichnos nuˣvomica)* mixed cowdung compost in brinjal for controlling fruit and shoot borer	1. Orissa University of Agriculture and Technology 2. Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia Vidyalaya, Nadia
13.	1415	Control of insects in cucurbits, cowpea and lady's finger by spraying urine of domestic animals mixed with tobacco soaked water	1. Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia 2. Birsa Agricultural University, Ranchi
14.	1416	Control of insect-pests by spraying of starch, animal urine and dusting of cowdung ash in vegetables	1. Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia 2. Birsa Agricultural University, Ranchi
15.	1417	Control of shoot and fruit borers by tobacco-soaked water with soap	1. Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia 2. 'Birsa Agricultural University, Ranchi
16.	701	Protection of cabbage from pests	Indian Institute of Horticultural Research, Bangalore
17.	141	Control of rhinocerous beetle in coconut by using cowdung slurry	Tamil Nadu Agricultural University, Coimbatore
18.	370	Sprouting in yam by cowdung slurry	Regional Centre, Central Tuber Crops Research Institute, Bhubaneswar
19.	403	Off-season flowering in guava	Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia
Farm Implements			
20.	2039	*Pingali dhanti* for intercultural operation in tomato	Central Research Institute for Dryland Agriculture, Hyderabad
21.	2132	*Guddeli* to uproot ginger	Central Research Institute for Dryland Agriculture, Hyderabad

Sl. No.	Code No.	Title	Experimenting organization
Fishery			
22.	424	Use of banana pseudostem in fish pond to enhance productivity of fish	West Bengal University of Animal and Fishery Sciences, Kolkata
		Veterinary science and animal husbandry	
23.	416	Treatment of foot-and-mouth disease in cattle by using harida *(Terminalia chebula]* and behada *{Terminalia bellirica)*	1. West Bengal University of Animal and Fishery Sciences, Kolkata 2. Indian Veterinary Research Institute, Izatnagar 3. Birsa Agricultural University, Ranchi 4. Maharashtra Animal Science and Fishery Sciences University, Nagpur
24.	1279	Evaluation of peach *(Prunus* persica) leaves with fresh milk in the treatment of FMD lesion/wounds	1. West Bengal University of Animal and Fishery Sciences, Kolkata 2. Indian Veterinary Research Institute, Izatnagar 3. Birsa Agricultural University, Ranchi 4. Maharashtra Animal Science and Fishery Sciences University, Nagpur
25.	1288	Use of babool *(Acacia* nilotica) and jamun *(Syzygiune* cumini) bark extract to cure foot-and-mouth disease in animals	1. West Bengal University of Animal and Fishery Sciences, Kolkata 2. Indian Veterinary Research Institute, Izatnagar 3. Birsa Agricultural University, Ranchi 4. Maharashtra Animal Science and Fishery Sciences University, Nagpur
26.	1588	Control of FMD in cattle with camphor	1. West Bengal University of Animal and Fishery Sciences, Kolkata 2. Indian Veterinary Research Institute, Izatnagar

SI. No.	Code No.	Title	Experimenting organization
			3. B irsa Agricultural University, Ranchi 4. Maharashtra Animal Science and Fishery Sciences University, Nagpur
27.	1595	Use of bantulsi *(Ocimum* gratessimum) leaf paste for treatment of *khurha* (FMD) in cattle and buffalo	1. West Bengal University of Animal and Fishery Sciences, Kolkata 2. Indian Veterinary Research Institute, Izatnagar 3. Birsa Agricultural University, Ranchi 4. Maharashtra Animal Science and Fishery Sciences University, Nagpur
28.	1280	Use of stone fruit (bael) to check diarrhoea in animals	1. Indian Veterinary Research Institute, Izatnagar 2. Birsa Agricultural University, Ranchi 3. Maharashtra Animal Science and Fishery Sciences University, Nagpur 4. Orissa University of Agriculture and Technology, Bhubaneswar
29.	1287	Control of diarrhoea in cattle and buffalo a paste made from leaves of shisham *(Dalbergia sissoo)*	1. Indian Veterinary Research Institute, Izatnagar 2. Birsa Agricultural University, Ranchi 3. Maharashtra Animal Science and Fishery Sciences University, Nagpur 4. Orissa University of Agriculture and Technology, Bhubaneswar
30.	1585	Treatment of diarrhoea by juice of urhul *(Hibiscus rosasinensis)* flower in goats	1. Indian Veterinary Research Institute, Izatnagar 2. Birsa Agricultural University, Ranchi 3. Maharashtra Animal Science and Fishery Sciences University, Nagpur 4. Orissa University of Agriculture and Technology, Bhubaneswar

SI. No.	Code No.	Title	Experimenting organization
31.	1589	Treatment of diarrhoea in animals (goat and sheep) by *pojo*	1. Indian Veterinary Research Institute, Izatnagar 2. Birsa Agricultural University, Ranchi 3. Maharashtra Animal Science and Fishery Sciences University, Nagpur 4. Orissa University of Agriculture and Technology, Bhubaneswar
32.	1967	Curing of diarrhoea in goats by using takala *{Cassia tora)* flower juice	1. Indian Veterinary Research Institute, Izatnagar 2. Birsa Agricultural University, Ranchi 3. Maharashtra Animal Science and Fishery Sciences University, Nagpur 4. Orissa University of Agriculture and Technology, Bhubaneswar
33.	1968	Wound management in animal by use of leaf extract of ridge gourd *(Luffa accutangula)/ekdandi (Tridax procumbents)*	1. Ch. Sarwan Kumar Krishi VishwaVidyalaya, Palampur 2. Maharashtra Animal Science and Fishery Sciences University, Nagpur
34.	1966	Use of bhangariya *(Eclipta* alba) to cure blain in animals	1. Tamil Nadu Veterinary and Animal Sciences University, Chennai 2. Maharashtra Animal Science and Fishery Sciences University, Nagpur
35.	1284	Determination of efficacy of pigeon waste in showing estrus symptoms in heifers	Indian Veterinary Research Institute, Izatnagar
36.	1272	Treatment of swelling of shoulders in bullocks/bull	1. Indian Veterinary Research Institute, Izatnagar 2. Maharashtra Animal Science and Fishery Sciences University, Nagpur
37.	1285	Treatment of haemorrhagic septicaemia by *kala jeera*	Central Institute for Research on Goat, Makhdoom

SI. No.	Code No.	Title	Experimenting organization
38	1590	Technique of curing bone fracture in animals	1. Ch. Sarwan Kumar Krishi VishwaVidyalaya, Palampur 2. Birsa Agricultural University, Ranchi

The results of the experir ntation including identification of active ingredients are included in this document.

Contents

RAIN WATER MANAGEMENT

Code	**105**
Title of the ITK	**Rain-water management for teak *(Teetona grandis* Linn, f.), mango *(Mangifera indica* Linn.) and** neem ***(Azadirachta indica* A. Juss) in arid and semi-arid regions**
Description of the ITK	This practice is to retain rain water in the soil and to grow trees, particularly mango, neem and teak, which are best suited for arid and semi-arid regions. The practice is appropriate for a garden or estate where teak, mango or neem trees are grown. A circle in the soil is made around 1-year-old teak trees within a distance of 30 cm. Along the line of the circle, a hole of 7.5 cm depth is made. During the first year, at the time of rainy season, rain water gets collected in these holes. This technique may be adopted in areas where there is less water available. When the tree is 2 years old, a circle can be made at a distance of 1.2 m alongwifh 1.8 m deep holes on the circle. Similar circle at a distance of 1.8 m can be made when the tree is 3 years old alongwith 2.7 m deep holes on the circle to retain water in the successive year. This has been in practice for the last 2 years. There is no practical risk and it is easy to handle, less labour intensive and best suited for such trees. This is in practice in Periakovilankullam village of Tirunelveli district in Tamil Nadu.
Name and address of the discloser :	Thiru S. Murugesan, Periakovilankulam, Sankararkovil, Tirunelveli district, Tamil Nadu 627 953.
Location of use of the ITK	Periakovilankulam, Sankararkovil (P.O.), Tirunelveli district (Tamil Nadu) 627 953
Experimenters	Dr S.V.K Hiswaran, Associate Professor, Forest College and Research Institute, Mettupalayam, Coimbatore 641 301 (Tamil Nadu) Dr G. Subba Reddy, Head, Division of Crop Sciences, Dr N.N Reddy, Senior Scientist (Horticulture), Central Research Institute for Dryland Agriculture, Hyderabad 500 059 (Andhra Pradesh)

METHODOLOGY

An unstructured interview was conducted to obtain the details of the ITK prior to conducting the experiment. The experiment was laid out at Forest Research College, Mettupalayam (Tamil Nadu) for 3 years (2002-2004) for trees of teak, mango and neem to assess the effect of soil

moisture-conservation practices by making micro-depressions around the basin of the plant (ITK method). This was compared with the conventional basin method for the first and second years. Mulching with pebbles was introduced to the above mentioned two treatments during the third year. As a part of cross validation, the experiments were conducted at Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad with grass mulch in 3 years old trees of mango and teak during third year 2004. The same experiment with grass mulching was taken up for experimentation at Central Research Institute for Dryland Agriculture, Hyderabad.

Experiment

Mettupalayam

Teak and Neem: The experimental plot was of 0.25 acres and land had a slope of about 4.2%. Seedlings were planted during the rainy season. Six micro-depressions (ITK), of 15-20 cm depth, were made as a circle 30 cm away from the plant stem in the first year, in the second year six more micro-depressions were made 30 cm away from the first circle, falling in the middle of two micro-depressions of the first circle.

Mango: The ITK practice was implemented for the planted mango trees and six micro-depressions were made 1 m away from the tree, in a circle, and a second circle was also made similarly.

Soils of the study area are clay loam with pH 7.9 and EC 0.166 dS/m, with organic carbon content 0.51%.

Treatments

There were four treatments, T_1, micro-depressions (Fig. 1); T_2, basin method; T_3, micro-depression with pebble mulch and T_4, basin method with pebble mulch.

Moisture content in the soil was determined using a neutron probe at three places (S_1 , S_2, S_3) up to four depths (15 cm, 30 cm, 45 cm, 60 cm). Soil moisture (% by volume) was recorded at near the plant stem (S_1), 30 cm away from the micro-depression (S_2) and again 30 cm away from the S_2 (S_3) at 3 spots for each depth and up to 60 cm soil depth for six trees (replications).

Soil analysis

Soil samples were collected at the top and bottom of the experimental fields (0-30 cm depth) in different years and the samples were analysed for pH, EC and plant nutrients like nitrogen, phosphorus, potassium and organic carbon.

Run-off studies

To evaluate the quantum of run-off water collected from the experimental plot under different treatments as micro depression (T_1) and control (T_2), the SCS curve number method was adopted.

The equation for quantifying run-off is as follows:

$$Q = \frac{(I - 0.3S)^2}{(I + 0.7S)}$$

Where,

Q = Run-off volume (mm)
I = Rainfall (mm)
S = Retention parameter

The retention parameter is defined in terms of curve number (CN):

$$S = \frac{1000}{CN} - 10$$

Curve number (CN) is defined as the approximate percentage of incident rainfall that becomes run-off. The curve number depends upon the land use, soil type and hydrologic condition. It was arrived at by working out the proportion of land area that offers interception to the run-off water. For the estimation of run-off, rainfall of 6 mm and above was taken for calculation.

Biometric observations like height of the plant (cm) and collar diameter (cm) were recorded.

Hyderabad

The experiment was conducted at CRIDA, Hyderabad during 2004 with teak and mango trees.

Teak: The experimental plot was of 0.1 ha and on a land having 4.2% slope. Seedlings were planted during the rainy season. Six micro depressions which are of 15-20 cm in depth were made as a circle at 30 cm away from the plant stem.

Mango: The practice of micro depressions was carried out for the mango trees planted and six micro depressions were made at lm away from the tree Soils of the experimental area are sandy loam with a slope of 1-2%.

Treatments

There were four treatments: T_1, micro-depressions; T_2, basin method; T_3, micro-depression with grass mulch and T_4, basin method with grass mulch (Fig. 2).

Moisture content in the soil was determined using a neutron probe at three places (S_1 S_2, S_3) at four depths (15 cm, 30 cm, 45 cm, 60 cm). Soil moisture (% by volume) was recorded at near the plant stem (S_1), 30 cm away from the micro-depression (S_2) and again 30 cm away from the S_2 (S_3) at 3 spots for each depth and up to 60 cm soil depth for six trees (replications).

Biometric observations like height of the plant (cm) and collar diameter (cm) were recorded for the trees.

RESULTS

Moisture content in soil

More moisture was retained in the treatments under teak and neem compared with the

Table 1. Height (cm) of the plants as affected by moisture-conservation measures at Mettupalayam

Period	Teak				Neem				Mango			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
October 02	25.1	21.2			113.6	115.4						
November 02	29.0	26.3			132.9	131.3						
December 02	31.9	28.1			142.0	139.4			72.5	71.8		
January 03	32.6	29.3			157.3	156.7			76.9	75.4		
February 03	33.1	30.9			165.0	162.6			82.3	80.1		
April 03	36.6	33.7			179.2	177.0			93.4	89.2		
May 03	39.4	36.6			192.6	191.5			100.2	96.4		
June 03	42.9	40.3			197.9	195.6			105.4	102.5		
July 03	56.5	54.3			210.4	212.4			114.6	111.3		
August 03	64.4	61.9			221.6	212.2			124.8	119.8		
September 03	69.9	66.1			229.3	227.6			132.5	129.3		
October 03	74.5	69.9			243.2	239.1			144.6	139.5		
November 03	77.5	74.7			261.1	251.8			150.5	140.4		
December 03	84.6	78.4			262.5	253.4			152.4	142.5		
January 04	90.4	85.4	89.4	86.2	264.6	256.9	263.4	259.6	153.6	143.4	152.2	145.4
February 04	95.4	89.6	92.6	91.5	271.9	266.2	272.5	271.4	158.4	149.6	157.8	151.3
March 04	108.8	104.5	110.6	105.3	283.2	273.4	285.1	280.5	161.9	158.3	163.4	155.8
April 04	122.4	117.3	126.4	118.9	301.0	286.1	299.6	297.4	165.2	161.2	168.9	159.1
May 04	139.6	131.4	140.1	132.2	312.6	301.2	310.4	306.5	170.6	164.6	172.6	164.2
June 04	148.6	141.3	151.6	144.9	315.6	306.1	315.4	309.7	177.3	168.4	175.3	169.4
July 04	153.3	146.2	155.4	151.7	321.8	310.4	319.5	314.8	181.4	173.2	182.6	175.6
August 04	159.6	151.5	161.5	158.3	326.9	316.5	324.6	322.5	186.7	178.9	187.4	181.3
September 04	163.8	155.2	164.4	162.0	328.4	319.1	329.1	326.5	191.8	182.6	192.1	187.4

T_1: Micro-depressions (ITK); T_2: basin method; T_3: micro-depressions with pebble mulch; T_4: basin method with pebble mulch

Table 2. Collar diameter (cm) of plants as affected by moisture-conservation treatments

Period	Teak				Neem				Mango			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
October 02	0.44	0.43			1.5	1.6						
November 02	0.7	0.6			1.6	1.6						
December 02	0.8	0.8			1.7	1.7			1.6	1.6		
January 03	0.8	0.8			1.9	1.9			1.8	1.7		
February 03	0.9	0.9			2.1	2.0			2.1	2.0		
April 03	1.3	1.2			2.3	2.2			2.3	2.2		
May 03	1.4	1.3			2.4	2.4			2.4	2.3		
June 03	1.4	1.3			2.5	2.5			2.5	2.4		
July 03	1.6	1.6			2.6	2.3			2.5	2.5		
August 03	1.8	1.7			2.7	2.7			2.6	2.5		
September 03	2.1	2.0			2.8	2.8			2.7	2.6		
October 03	2.2	2.1			2.9	2.8			2.9	2.8		
November 03	2.2	2.1			3.0	2.9			3.0	2.9		
December 03	2.3	2.2			3.1	3.0			3.1	3.0		
January 04	15.4	14.3	15.2	14.5	3.1	3.0	3.1	3.0	3.1	3.1	3.2	3.0
February 04	15.8	14.9	15.8	15.1	3.2	3.1	3.2	3.1	3.2	3.1	3.2	3.1
March 04	16.2	15.8	16.3	15.6	3.3	3.2	3.3	3.2	3.3	3.2	3.3	3.3
April 04	16.5	16.1	16.9	15.9	3.4	3.3	3.3	3.3	3.4	3.3	3.4	3.4
May 04	17.1	16.5	17.3	16.4	3.4	3.3	3.4	3.3	3.5	3.4	3.5	3.5
June 04	17.5	16.7	17.5	16.9	3.4	3.3	3.4	3.4	3.6	3.5	3.6	3.5
July 04	17.8	17.4	17.8	17.3	3.4	3.4	3.5	3.4	3.6	3.5	3.6	3.6
August 04	18.0	17.5	18.2	17.6	3.5	3.4	3.5	3.4	3.7	3.6	3.7	3.6
September 04	18.3	17.7	18.4	18.0	3.5	3.4	3.5	3.4	3.8	3.6	3.7	3.7

T_1: Micro-depressions; T_2: basin method; T_3: micro-depressions with pebble mulch; T_4: basin method with pebble mulch

Table 3. Height (cm) and collar diameter (cm) of teak as affected by soil-moisture-conservation measures at Mettupalayam and Hyderabad

	Mettupalayam (2004)						Hyderabad (2004)					
	Tree height			Collar diameter			Tree height			Collar diameter		
	Jun	Sep	Increment (%)	Jun	Sep	Increment (%)	Jun	Sep	Increment (%)	Jun	Sep	Increment (%)
T_1	148.6	163.8	10.2	17.5	18.3	4.6	380	392	3.2	4.2	4.3	2.4
T_2	141.3	155.2	9.8	16.7	17.7	6.0	385	390	1.3	4.3	4.3	-
T_3	151.6	164.4	8.4	17.5	18.4	5.1	385	402	4.4	4.3	4.4	2.4
T_4	144.9	162.0	11.8	16.9	18.0	6.5	390	396	1.5	4.2	4.3	2.4

Mettupalayam: T_1: Micro-depressions; T_2: basin method; T_3: micro-depressions with pebble mulch; T_4: basin method with pebble mulch.

Hyderabad: T_1: Micro-depressions; T_2: basin method; T_3: micro-depressions with grass mulch; T_4: basin method with grass mulch.

Contents

Table 4. Height (cm) and collar diameter (cm) of mango as affected by soil-moisture-conservation measures at Mettupalayam and Hyderabad

	Mettupalayam (2004)						Hyderabad (2004)					
	Tree height			Collar diameter			Tree height			Collar diameter		
	Jun	Sep	Increment (%)	Jun	Sep	Increment (%)	Jun	Sep	Increment (%)	Jun	Sep	Increment (%)
T_1	177.3	191.8	8.2	3.6	3.8	5.6	350	362	3.4	17.3	17.4	0.6
T_2	168.4	182.6	8.4	3.5	3.6	2.9	358	364	1.7	17.2	17.3	0.6
T_3	175.3	192.1	9.6	3.6	3.7	2.8	355	365	2.7	17.3	17.5	1.2
T_4	169.4	187.4	10.6	3.5	3.7	5.7	366	375	2.5	17.2	17.4	1.2

Mettupalayam: T_1: Micro-depressions; T_2: basin method; T_3: micro-depressions with pebble mulch; T_4: basin method with pebble mulch.

Hyderabad: T_1: Micro-depressions; T_2: basin method; T_3: micro-depressions with grass mulch; T_4: basin method with grass mulch.

Table 5. Available nitrogen, phosphorus and potassium (kg/ha) as recorded under different soil-moisture conservation treatments

Increment	Micro-depression			Basin			
	2003	2004	Mean	2003	2004	Mean	
Available N (kg/ha)	251	238	245	248	219	234	4.5
Available P (kg/ha)	24.2	16.4	20.3	16.0	15.4	15.7	22.6
Available K (kg/ha)	207	189.4	198	201	215.3	208	5.1

treatments in mango. No conspicuous difference was observed between the treatments of micro-depressions and basins during high-rainfall period. However, the difference was significant during low-rainfall period (summers of all the years). During the period of low rainfall, the

Fig. 1. Micro-depressions

Fig. 2. Basin with grass mulch

Fig. 3. Water retention in micro-depressions after rain

Fig. 4. Water retention in basin after rain

Table 6. Run-off volume under different treatments

Month	Rainfall (mm)	Run-off volume (m^3) Micro-depression	Basin
Jan 04	46.0	19.801	20.931
	33.0	13.615	14.705
	6.3	1.401	2.066
Mar 04	17.0	6.100	7.069
Apr 04	30.0	12.194	13.270
	17.3	6.239	7.211
	7.5	1.882	2.610
May 04	30.6	12.478	13.557
	17.7	6.424	7.401
	28.0	11.248	12.313
	28.2	11.343	12.409
	10.0	2.943	3.767
	23.0	8.89	9.926
	15.0	5.182	6.121
	9.4	2.683	3.488
	13.5	4.500	5.411
Jun04	7.2	1.756	2.474
Jul 04	6.3	1.401	2.065
Aug 04	14.8	5.091	6.026
	6.0	1.285	1.931
	6.0	1.285	1.931
Sep 04	24.9	9.787	10.832
	12.0	3.825	4.704
	16.0	5.640	6.594
Total	425.7	157.002	178.813

plants under the micro-depression were able to draw moisture from the soil. The moisture content was maximum at 60 cm depth in both the treatments throughout the period. Moisture content was higher near the plants in micro-depressions and in basins with mulch compared with the plants in basins (Figs 3, 4). Mulching with pebbles did not express much difference. Among the sites (S_1, S_2, S_3), maximum moisture was recorded in the sites nearer the plant stem (S_1) and micro-depressions (S_2) as both were ai par, but it was low with S_3 (60 cm away from the micro-depressions). With increase in soil depth from 15 to 60 cm, soil-moisture retention increased.

Biometric observations

Data on the biometric observations on height of the trees (cm) and collar diameter (cm) taken at Mettupalayam for 3 years are presented in Tables 1 and 2. It is evident that the growth of trees was faster in the method of micro-depressions over the other treatments and the difference was still obvious with pebble mulch during summer.

Soil analysis

Available nitrogen and potassium content in soil was not influenced by the treatments. However, available phosphorus content (20.3 kg/ ha) was higher in the treatment of micro-depression than in the basins (15.7 kg/ha) (Table 5). Micro-depression had intercepted more run-off that led to lesser run-off (157.0 m^3) compared with basin (178.8 m^3) during 2004 (Table 6).

However, results obtained in Tables 3 and 4 on the growth of teak and mango at Mettupalayam and Hyderabad indicate that while micro-depression favoured growth of the trees at Mettupalayam, it had no impact on tree growth at Hyderabad.

DISCUSSION

Treatments in mango recorded lower percentage of soil-moisture retention, which might be due to the variation in the distance of micro-depressions made. High rainfall intensities lead to filling of the micro-depressions with soil and all the treatments would be at par with each other at this condition, whereas micro-depressions (ITK) were helpful in retaining more moisture during low-intensity rain-fall periods and helped avoid death of trees due to continuous droughts.

CONCLUSION

The micro-depressions were useful for light showers with less intensity as in Mettupalayam because the depressions were able to hold more moisture compared with basin method. More moisture can be conserved with micro-depressions especially on mulching. The main disadvantage of pebble mulch is that the soil temperature tends to be higher in the summer months compared with other treatments. This may have its impact on the roots at the top. In slopy lands, the method of micro-depressions has its' limitations, because soil fills the micro-depressions regularly during each rain. The advantage of the micro-depressions method is that it can retain the soil transported by erosion in the run-off water, by collecting in the micro-depressions. The micro-depression-method has been found to intercept more run-off water compared with basin method. This method has been found to be useful where trees are grown under rainfed conditions. The growth of the trees is faster, as evident from the observations on collar diameter and height of the plants, due to more moisture availability in clay loam soils at Mettupalayam. The effect of micro-depressions was not visible in the light soils of Hyderabad because the splash of rain caused filling of the micro depressions with sand, leaving it ineffective compared with basin method. Soil fertility tends to improve in plots where micro-depressions were made at Mettupalayam.

□

Code	:	2024
Title of the ITK		**Rain-water measurement using *rolu* (indigenous rain-gauge)**
Description of the ITK		*Rolu* (7.4" depth, 9" diameter hole on a 3'x3'xl.5' granite stone block) is useful in knowing the quantity of rainfall for sowing. Seeds in the field are sown when the *rolu* is filled with rain-water. This technique helps the farmers in estimating the rainfall that is sufficient to go for seeding. This method is adopted for sowing dryland crops like sorghum, castor etc. in Alfisols.
Name and address of the discloser :		Shri Narasimha Reddy, Nallavelli, Yacharam mandal, Ranga Reddy dist., Andhra Pradesh
Location of use of the ITK		Nallavelli village, Yacharam mandal, Ranga Reddy dist, Andhra Pradesh
Experimenters		Dr V.Maruthi, Senior Scientist (Agronomy), Dr G.Subba Reddy, Head, Division of Crop Sciences and Shri N.N.Srivastava, Principal Scientist (Agrometeorology), Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh 500 059

METHODOLOGY

Discussion with the discloser and other farmers of the area: Interacted with the discloser (farmer) to consider the finer details of the use of the indigenous rain-gauge for validation. This practice was further confirmed by the other farmers in the surrounding villages.

Fabrication of indigenous rain-gauges: Rain-guages were fabricated with the help of a local mason with the specifications recorded as claimed by the discloser (Fig. 1).

Validation: Experimental validation was done under both on-station (CRIDA Research Farms at Gunegal and Hayathnagar) and on-farm situations in the villages of Nallavelli, Nasdik Singaram of Ranga Reddy district and Gollapalli village of Nalgonda district during rainy *(kharif)* season from 2002 to 2004. Indigenous rain-gauges were installed nearby standard rain-gauge at all the study sites to compare their efficiency in terms of validation, refinement and correlation of the various agricultural operations with rainfall in commonly cultivated rainfed crops such as sorghum + pigeonpea, castor etc.

Fig. 1. Indigenous rain-gauge *(rolu)*

Contents

At each site, circumference area of ½ km was taken as a unit for the study. The area of the study under each site was marked into four directions of north, east, south and west. The fields covering the study area were given the code numbers in the form of F_1 ... series and mentioning the crops. The monitoring on various agricultural operations for each crop were monitored and the field area belonging to different farmers in the study area were documented. Area falling under different farmers in the study area were documented. The operations performed by different farmers in the study area under different crops were documented in relation to the rainfall received in the standard and indigenous rain-gauges mounted side by side. Further, the quantity of rainfall received in both indigenous and standard raingauges on different dates from June to September was correlated by taking the parameters of the volume of water stored in both types of rain-gauges, considering the surface area collecting rainfall in each rain-gauge. Based on these parameters, a correction factor was determined to correlate the quantity of rainfall received in indigenous rain-gauge with the rainfall of standard rain-gauge. Operations performed for raising the crops with relation to rain water received in the rain-gauges were recorded. The loss of rain water in the form of overflow, splash and human interference was recorded for refinement of the indigenous rain-gauge.

RESULTS AND DISCUSSION

The rainfall from both indigenous and standard rain-gauges established at different experimental sites was recorded during rain events during July-October 2002-04 (Fig. 2). Simultaneously, the various agricultural operations done by the farmers were related with the rainfall received during growing season of crops such as sorghum + pigeonpea, castor etc. A correlation was developed between the rainfall received through indigenous and standard rain-gauges for all the years. During the process, a correction factor was developed to quantify the rainfall of indigenous rain-gauge (IR) to test the validity of rainfall with standard rain-gauge (SR). The parameters included to derive the correction factor are surface area and volume.

Correlation

To correlate the rainfall of indigenous rain-gauge with standard rain-gauge, derivation of Surface area ratio is required. It was arrived at by:

Surface area ratio = Area of standard rain-gauge/area of indigenous rain-gauge

$= 200 \text{ cm}^2 / 398 \text{ cm}^2 = 0.50$

The results were validated over the study area by developing a correction factor for its wider applicability with the similar specifications of the rain-gauges used in the present study.

To develop a correction factor, the rainfall data obtained from both the rain-gauges were fitted with the linear relationships, as:

I. $R_S = C_F \times R_I$

where

R_S = Rainfall measured by standard rain-gauge (mm)
C_F = Correction factor
R_I = Rainfall measured by indigenous rain-gauge (mm)

In the first year of experimentation, the pooled correction factor observed was 0.32. With a little

Fig. 2. Measurement of rain water collected in *rolu*

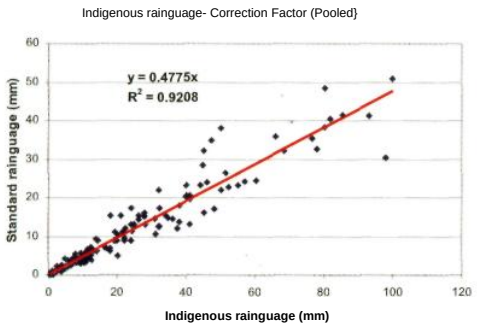


Fig. 3. Relationship between rainfall of indigenous rain-gauge and rainfall of standard rain-gauge under on-station and on-farm situations (pooled)

improvement through slope manipulation a correction factor of 0.42 was achieved in the second year of experimentation. However, in the third year, CF achieved is 0.477 when the linear model was validated with the rainfall data measured from the experimental sites, which is very nearer to the theoretical correction factor. A positive correlation was observed with the rainfall measured by both indigenous and standard rain-gauges, with high coefficient of determination, R^2= 0.92 (Fig. 3). The quantity of rainfall received from indigenous rain-gauge and the operations carried out by the farmers of the surrounding fields were recorded.

Operations performed in relation to depth of rain water received in indigenous rain-gauge

On-station trial

Sorghum+pigeonpea

Sorghum + pigeonpea were sown by 50-100% farmers in 3 days when the indigenous rain-gauge was filled to >3/4 capacity or more in the research station as the fields were kept ready by ploughing

Table 1. Sowing operation done for sorghum + pigeonpea and the rainfall received in the indigenous and standard rain-gauges

Experimental site	Date	Rainfall received in standard rain-gauge (mm)	Rainfall received in indigenous rain-gauge (mm)	Corrected rainfall (indigenous rain-gauge rainfall x 0.478)	Depth (cm)	Duration of sorghum + pigeonpea sowing (No. days)	Fields sown (%)/ Farmers adopted **(%)**
Gunegal Research Farm	24/7/02	27	77.8	37.2	>3/4	3	50
Hayathnagar Research Farm	4/6/04	35.2	76.8	36.7	>3/4	3	100
	6/6/04	23.2	44.2	21.1	>l/2	5	100
	15/6/03	33.3	78	37.3	>3/4	2	75
Nallavelli	13/7/02	8.3	20	9.6	<l/2	4	100
	12/6/03	32.8	95.4	45.6	Full	3	100
	3/6/04	12.2	20.5	9.8	<l/2	2	100
Nasdik Singaram							
	21/6/02	25.2	50	23.9	>l/2	7	60
	10/6/03	8.0	36	17.2	<l/2	3	100
	4/6/04	19.5	41.2	19.7	>l/2	3	100

with the onset of monsoon, besides sowing operation being mechanized when the standard rain-gauge recorded 19.5 mm to 35.2 mm (Table 1). Of all the 3 years, the rainfall received in indigenous rain-gauge during 2004 when multiplied with the correction factor of 0.48 came nearer to the rainfall recorded from standard rain-gauge emphasizing the improvement in indigenous rain-gauge as well as its nearness to the water requirement for sowing operation, which is about 12 mm when the fields are ploughed and 20 mm for both tillage and sowing.

Castor

Castor was sown mostly at the same time of the sowing of sorghum+pigeonpea as the fields were kept ready with primary tillage and mechanization made it possible to complete the sowing at a single stretch. Castor was sown for 1-3 days when the indigenous rain-gauge was up to >3/4 capacity, leading to 100% sowings (Table 2).

On-farm trials

Sorghum +pigeonpea

Sorghum+ pigeonpea were sown in 2-7 days by the farmers, leading to 100% sowings with rain-water filling to $^{1}/_{2}$—>3/4th capacity of the indigenous rain-gauge. This might have happened due to the fear of losing the season for sorghum

Table 2. Sowing operation carried out for castor and the rainfall received in the indigenous and standard rain-gauges

Experimental site	Date	Rainfall received in standard rain-gauge (mm)	Rainfall received in indigenous rain-gauge (mm)	Corrected rainfall (indigenous rain-gauge rainfall x 0.478)	Depth (cm)	Duration of castor sowing (No. of days)	Fields sown Farmers adopted (%)
Gunegal	23/8/02	8.4	63.6	30.4	>3/4	1	100
Research Farm	24/8/02	16.4	50	23.9	***Vi***	2	100
	24/6/03	7.2	12.4	5.9	>l/4	3	100
	30/6/04	6.3	13.5	6.5	>l/2	3	100
Hayathnagar	30/6/04	11.3	24.4	11.7			
Research Farm							
Nallavelli	13/7/02	8.3	20	9.6	<l/2	1	20
	12/6/03	23.2	73	34.9	>3/4	2	100
	2/7/04	23.1	46	22	>l/2	3	100
	2/8/02	15.7	50	23.9	>l/2	2	35
Nasdik singaram	10/6/03 28/6/04	8	36	17.2	<l/2	5	100
	30/6/04 2/7/04	20.3	50	23.9	>l/2	3	100
Gollapally	16/7/02						
	18/7/02	7	23	11	<l/2	2	50
	24/6/03 25/6/03 8/6/04	18	38	18.2	>l/2	3	100
	10/6/04	7	19.5	9.3	<l/2	2	100

(after June 15th farmers do not prefer to sow sorghum due to the fear of attack of the shoot fly), which forms a major chunk of the fodder required by the farmer and sorghum grain is the bonus for them. Further, if the farmer does not keep the field ready also, he loses the prime rainy days for tillage, which does not happen in research stations. However, if there is delay in receiving rainfall, even with small rainfall like <l/2 capacity also all the farmers sow the sorghum+ pigeonpea crop.

In Nallavelli of Yacharam mandal of Ranga Reddy district of Andhra Pradesh, it was recorded that when the rainfall received in indigenous rain-gauge ranged from 1/2 to full, which was about 8-33 mm in standard rain-gauge, it resulted in 100% sowing of sorghum+ pigeonpea crops in the farmers' fields. It was observed that the rainfall received in indigenous rain-gauge when corrected was nearer to the recorded rainfall of standard rain-gauge. The variation decreased from 30% to 18%, which shows the improved precision towards the optimum requirement of water for sowing operation.

When the indigenous rain-gauge was full, sorghum+ pigeonpea were sown by all the farmers within 3 days. Therefore it fulfills the claim made by the discloser. However, under some conditions as mentioned above, when the rainfall is low in quantity and late in the season, the claim is vitiated.

Castor

In castor crop, 1/2 to 3/4th filling of the indigenous rain-gauge with the rain water led to sowing of castor by all the farmers from 1-5 days, as this is a commercial crop of this Telangana region and is suitable for late sowing or for delayed rainfall conditions.

Overflow events

Data presented in Table 3 indicate the probability of receiving the overflowing rainfall events over 33 years (1971-2003) for each month. The overflowing rainfall events depend on the amount received and their distribution in the respective months. The probability of receiving the overflowing rain events ranged from 10 to 28%.

Table 3. Probability (%) of receiving overflowing rain events for indigenous rain-gauge (> 40 mm)

Month	Total rainy days/ 33 years	Overflow events (> 40 mm)	Probability (%)
January	15	3	20.0
February	18	4	22.2
March	21	5	23.8
April	52		9.6
May	86	15	17.4
June	213	43	20.2
July	300	64	21.3
August	295	70	23.7
September	247	65	26.3
October	189	52	27.5
November	66	13	19.7
December	14	3	21.4
Total	1,516	337	22.2

• for 1971-2003 = 33 years

CONCLUSION

When the indigenous rain-gauge was full, sorghum + pigeonpea were sown by all the framers within 3 days, which technically amounts to 50 mm in the standard rain-gauge. Sowings can be continued for 2 more days. With this, it fulfils the claim made by the discloser. But the claim gets vitiated under delayed monsoon conditions, because the season to sow sorghum + pigeonpea would be lost for the fear of sorghum shootfly attack, and the farmer will prefer to sow castor instead of sorghum + pigeonpea.

Low price of the indigenous rain-gauge made of granite ranging from Rs 250 to 300, which can be made by the local mason, and its less proneness to theft over the standard rain-gauge are the major advantages.

□

Code : **599**

Title of the ITK **Method of rain-water management in mountainous land scape under apple orchard**

Description of the ITK : In several parts of the Himalayas, villages are located at the foot-hills or valleys. Villagers often harvest rain water by building small water-storage "ponds (locally called chaal).The number of such ponds varies from 30 to 40 depending upon the valleys and villages. Each water pond is 9 m long, 9 m wide and 0.9 m deep. During rainy season water gets stored in these ponds, which not only act as water reservoir for the villagers but also control the floods in the low hill areas during rainy season. The water collected in the ponds is not used for human drinking purpose, but provides drinking water for cattle and for irrigation purposes. This is in practice for the past several years.

Name and address of the discloser : Shri Prem Singh Verma, Gawahi village, Sandhu P.O., Theog tehsil, Shimla (Himachal Pradesh) 171 222

Location of use of the ITK : Different villages in the foot-hills or valleys of the Himalayas were considered. The experimental site is an apple orchard, located at village Gawahi, which is 45 km from Shimla city on national highway 22 (commonly called Hindustan-Tibet Road) and 8 km from Theog town, which is a gateway to apple belt of Shimla district. The orchard is of about 3 ha area, at 2,400 m above MSL, which was established 10 years ago.

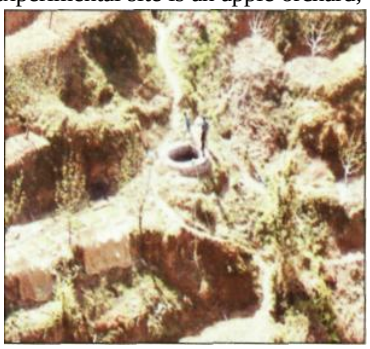


Fig. 1. *Chaals* used traditionally in the village

Experimenters : Dr Pradeep K. Sharma, Chief Scientist (WM), Dr O.C. Kapur, Senior Scientist (Soils), and Dr S. S. Masand, Senior Scientist (Soils), Department of Soil Science, Ch. Sarwan Kumar Krishi Viswa Vidyalaya, Palampur (Himachal Pradesh) 176 062

Contents

METHODOLOGY

The landscape is very steep, with a slope of 70-75% (Fig. 1). About 500 apple trees were planted along the visually-observed contours at a spacing of 3-6 m. The trees are being fertilized regularly with chemical fertilizers and farmyard manure. The orchard is completely rainfed. There is no source of water for irrigation. The rainfall is inadequate and highly variable in distribution. The apple trees therefore often experience moisture stress. Consequently, these are weak and do not show full vigour.

This experiment was conducted during 2002-2004. Two sets of treatments were imposed in this study.

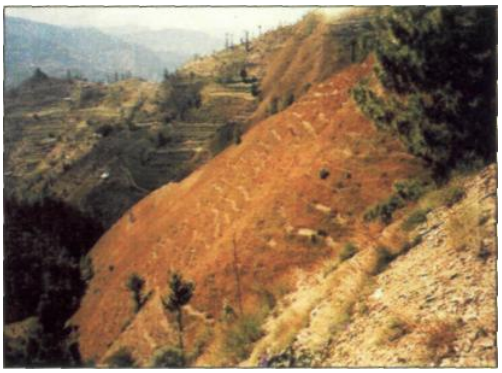
1. For *in-situ* rain-water harvesting and profile moisture conservation, the following three sets of treatments, in addition to control, were tested: mulching, terracing + mulching, and terracing + trenching + mulching.
2. For testing *chaal*, five types of dug-out tanks were constructed at appropriate locations in the experimental area, viz. (i) polyethelene-lined tank, (ii) bitumen (tarcoal)-lined tank, (iii) cement+concrete-lined tank (RCC), (iv) mud-plastered tank, and (v) unlined tank (control).

The whole experimental site was divided into three blocks for imposing the following treatments:

(i) *Terracing:* Land shaping between two apple trees along the contours in such a way that rain water flows towards the tree basins,
(ii) *Trenching:* Small trenches of appropriate sizes were dug above the tree basins to harvest rain water *in situ.*
(iii) *Mulching:* The tree basins were mulched with FYM, pine needles, pebbles and cocopit, in addition to unmulched control.

Terracing

Terracing was done in two blocks of the experimental area, covering 20 plant rows, with a total length of 2,040 m (Fig. 2). The average width of these terraces was 1.5 m. It involved an earth-work of about 1,530 m^3. A gentle side-wise slope was given on each terrace to direct the run-off during rain storms, if any, towards the tree basins.



ig. 2. Terraced block

Trenching

Trenches (0.3-0.4 m deep and 0.3-0.4 m wide) were made along the hill-side wall, above the apple tree basins (Fig. 3). The total length of trenching, covering 11 plant rows, was 1,122 m. The average breadth and depth of these trenches was 0.304 m each. Trenching involved an earth-work of 103.6 m^3.

Mulching

The tree basins were mulched with farmyard manure (10-15 cm thick layer), pine needles, cocopit (prepared from coconut fibre) and pebbles (single layer) (Figs 4-7). The cocopit was either mixed with soil or spread over soil surface in the tree basin. Five trees with each type of mulch, including the control without mulch were tagged for taking observations on the effect of water harvesting or conservation on the growth and vigour of apple trees.

Before spreading the polyethelene sheet in the dug-out tank, the walls of the tank were

Fig. 3. Trenching along the hill-side wall

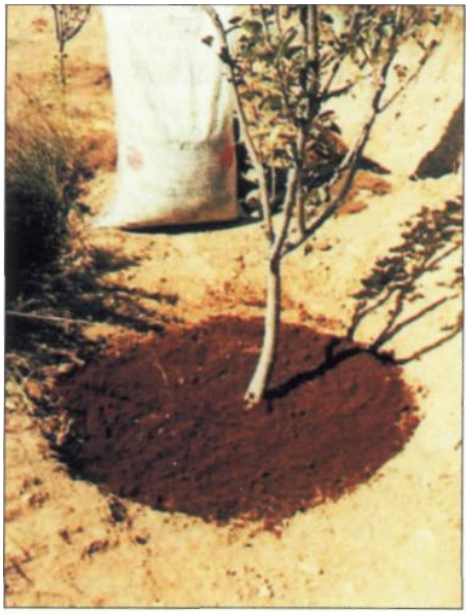
Fig. 4. Pine-needle mulch

smoothened to avoid puncturing of sheet. Molten bitumen was sprayed on the walls of the tank with the help of a metal container having numerous small holes in the side wall. For mud plastering, dry, chopped grass was mixed with dry soil in the ratio of 1:10. The mixture was saturated with water, and kneaded thoroughly to convert it into a soft plastic mud.

Observations were recorded on general features of the area, initial characterization of the soil for texture, water retention, particle density, bulk density, infiltration rate, pH, organic C and available NPK, soil moisture (0-60 cm depth) in tree basins under different mulch treatments, water storage and seepage losses in different dug-out tanks, rainfall and potential evaporation of the area.

The soil moisture was determined gravimetrically at periodic intervals under different treatments. Growth parameters like plant height, canopy circumference and the stem girth of apple trees and relative leaf-water content were monitored for 2004.

Soil samples were collected at six locations in the orchard up to a depth of 60 cm at 15 cm depth increment. The six soil samples for each depth were thoroughly mixed and a composite sample was prepared. The composite soil samples were



Cocopit mulch

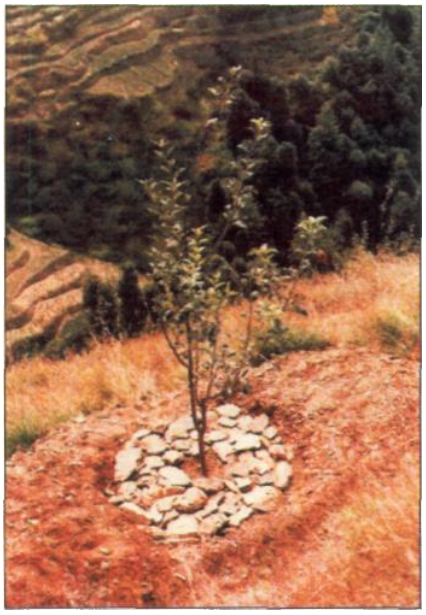


Fig. 6. Pebble mulch

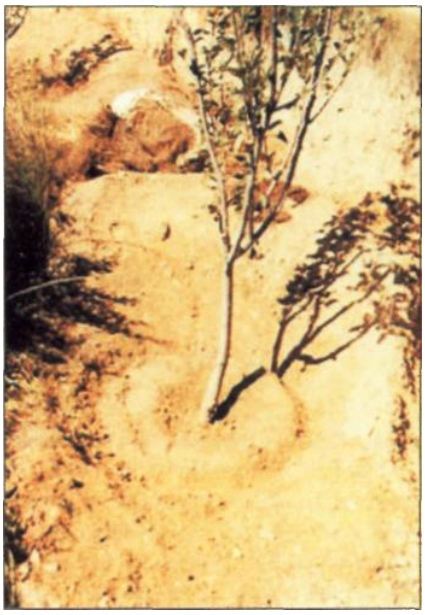


Fig. 7. Control (no mulch)

analysed in duplicate for texture (International Pipette method), organic carbon (Dichromate oxidation method of Walkley and Black), available N (Alkaline permanganate method), Olsen's P, exchangeable K (Ammonium acetate method), pH (1:2.5 soil.water suspension) and particle density (Pycnometer method). Soil-moisture retention of disturbed soil samples (soil passed through 2 mm sieve) was determined at saturation, -30 and -1500 kPa water potential, using Pressure plate apparatus. Bulk density was determined using 3 cm long and 5.6 cm diameter metal cores, by taking soil core from the middle portion of each soil layer.

Soil properties

Chemical and physical properties of experimental soil as observed at the initiation and termination of the experiment are given in Tables 1 and 2.

The experimental soil was acidic in reaction (Table 1). The organic carbon was medium in the top 45 cm depth, but low in 45-60 cm depth. The nutrient status was medium for available N, high for Olsen's P, and medium (0-15 cm depth) to low (15-60 cm depth) for exchangeable K. It requires applications of recommended doses of N and K; the dose of P may be reduced by 25% of the recommended one.

The soil was gravelly and medium in texture. The bulk-density values indicated progressive increase in soil strength with depth, especially below 30 cm (Table 2). The average particle

Table 1. Chemical properties of the experimental soil

Soil depth (cm)	pH	Organic carbon	Available nutrients (kg/ha)		
		(%)	N	P	K
0-15	5.8	0.84	492.2	44.1	167.9
15-30	5.9	0.68	477.2	39.3	112.0
30-45	5.9	0.55	460.5	30.7	89.6
45-60	5.9	0.44	314.3	28.3	78.6

Table 2. Physical properties of the experimental soil

Soil depth (cm)	Soil separates (%)			Textural class (ISSS)	Soil-moisture retention (%) at			Particle density (Mg/m^3)	Bulk density (Mg/m^3)	Total porosity (%)
	Clay	Silt	Sand		Saturation	-30kPa	-1500 kPa			
0-15	9.7	27.0	63.3	Sil	49.1	24.9	14.3	2.61	1.14	56.0
15-30	12.8	25.0	62.2	1	49.8	24.1	14.8	2.61	1.25	52.1
30-45	11.8	25.4	62.8	1	50.5	26.1	15.1	2.60	1.47	43.5
45-60	14.0	22.0	64.0	1	51.4	26.6	15.2	2.60	1.45	44.0

Sil, Silty loam; 1, loam

density of soil was 2.61 Mg/m^3. The porosity of soil was thus high, especially in the top 30 cm soil layer. Consequently, the soil is highly permeable for water, and hence well drained. The infiltration rate of soil (after 6 hr of initiation of infiltration process) varied between 5,379 and 7,005 mm/day. The water-retention capacity of soil is relatively poor due to high sand content.

RESULTS

Stability of terraces and trenches

Land shaping (trenching and terracing) was done in October-November 2002. Due to fragile nature of landscape and heavy snowfall during winters, the terracing was severely damaged, and had to be reconstructed after 11/2 years. The width of the terraces was significantly reduced from 1.5 m to 0.5 m.

The depth of trenches on an average decreased from 0.4 m to 0.15-0.21 m. The average depth of trenches under different land-shaping treatments after 17 and 22 months of their construction is shown in Table 3. The depth was reduced to the extent that it needed repair. Therefore trenches need to be frequently repaired in fragile and erosion-prone soils.

Table 3. The average depth of trenches under different treatments after 18 months of their construction

Treatment	Depth of trenches (m)		
	15 Nov 2002	10 Apr 2004	16 Sep 2004
Control	0.40	0.25	0.18
Basin	0.40	0.27	0.21
Basin+terrace	0.40	0.28	0.15
Basin+terrace+trench	0.40	0.27	0.18

In spite of the damage done to the terraces and trenches due to rainfall and snow, the moisture conservation due to these land-shaping treatments encouraged the growth of natural vegetation. After the rainy season, the terraces provided with trenches showed profuse growth of grasses and leguminous vines due to profile water conservation. It would help in soil conservation and add organic matter to the soil upon its decay.

Soil-moisture conservation

An amount of 1,500-1,600 mm rainfall was received during 2003 (January-December), and 1,100-1,200 mm during 2004 (January September). The potential evaporation for the same period was 850-1,000 mm and 600-700 mm, respectively.

Effect of land-shaping

The effect of land-shaping treatments on soil-moisture conservation is shown in Table 4. Land shaping had significant effect on soil-moisture conservation. Soil moisture in all soil layers and at all dates was significantly higher in plant basins

Table 4. Effect of land shaping on soil-moisture conservation

Soil depth (cm)	Soil moisture (mm)			
	Basin (control)	Basin+terracing	Basin+terracing+trenching	CD (0.05)
3 January 2003				
0–15	3.7	7.2	22.2	3.1
15–30	3.1	9.0	12.5	3.3
30–45	3.1	10.4	15.2	4.1
45–60	4.0	9.4	15.2	3.7
Total (0–6)	13.9	36.0	65.1	-
13 April 2003				
0–15	7.0	5.1	32.5	4.4
15–30	7.1	6.9	36.4	3.6
30–45	22.1	20.3	44.1	3.1
45–60	20.2	18.9	30.4	3.7
Total (0–60)	56.4	51.2	143.4	-
21 April 2003				
0–15	14.2	15.2	19.5	2.9
15–30	15.2	15.2	22.9	2.8
30–45	20.3	20.5	24.5	2.6
45–60	21.3	19.6	28.7	3.1
Total (0–60)	71.0	70.5	95.6	-
19 April 2004				
0–15	16.1	15.6	15.9	4.1
15–30	20.8	26.7	27.9	3.3
30–45	20.0	31.5	30.7	3.1
45–60	23.4	33.4	33.4	3.0
Total (0–60)	80.3	107.2	107.9	-
7 May 2004				
0–15	30.9	24.1	24.9	2.2
15–30	23.2	46.5	49.5	3.1
30–45	37.7	35.0	45.2	2.7
45–60	49.0	48.5	58.5	2.9
Total (0–60)	140.8	154.1	178.1	-
6 August 2004				
0–15	53.4	65.1	63.3	2.9
15–30	53.6	88.4	99.6	3.0
30–45	90.2	90.2	93.7	3.0
45–60	81.0	85.6	96.2	3.3
Total (0–60)	278.2	329.3	352.8	-
16 September 2004				
0–15	34.9	48.4	62.0	3.1
15–30	49.8	62.4	77.8	3.0
30–45	57.5	65.4	84.7	2.9
45–60	63.4	71.8	92.9	3.1
Total (0–60)	205.6	248.0	317.4	-

Table 5. Effect of different mulch materials on soil-moisture conservation

Soil depth (cm)	Soil moisture (mm)					
	No mulch	FYM mulch	Cocopit mulch	Pine-needle mulch	Pebbles mulch	CD (0.05)
3 January 2003						
0-15	22.2	25.4	25.7	27.0	25.7	2.2
15-30	12.5	16.2	14.6	13.2	14.8	1.9
30-45	15.2	18.0	16.6	16.3	18.5	NS
45-60	15.2	19.4	15.3	15.0	19.3	NS
Total (0-60)	65.1	79.0	72.2	71.5	78.3	-
13 April 2003						
0-15	6.2	19.5	18.0	22.6	19.5	2.4
15-30	6.9	23.4	22.3	24.8	22.9	1.8
30-45	17.9	28.4	24.9	28.0	26.2	1.9
45-60	16.1	31.8	28.9	31.5	28.7	2.7
Total (0-60)	47.1	103.1	94.1	106.9	97.3	-
21 April 2003						
0-15	13.3	30.8	30.3	32.5	29.7	1.8
15-30	14.0	29.9	30.8	31.8	30.5	1.8
30-45	17.5	27.1	25.5	28.6	27.7	2.0
45-60	17.0	30.5	26.6	27.1	28.0	2.2
Total (0-60)	61.8	118.3	113.2	120.0	115.9	-
19 April 2004						
0-15	15.9	15.8 .	17.1	15.0	15.9	NS
15-30	27.9	25.9	28.4	44.1	31.2	1.9
30-45	27.7	30.2	32.6	38.5	40.1	2.2
45-60	30.4	30.3	29.0	31.6	31.6	NS
Total (0-60)	101.9	102.2	107.1	115.2	117.7	-
7 May 2004						
0-15	21.1	30.6	28.2	38.5	27.9	3.3
15-30	25.6	33.3	30.0	43.0	33.3	3.4
30-45	57.2	59.1	60.4	64.9	57.8	2.9
45-60	61.0	66.1	63.3	69.2	62.2	2.2
Total (0-60)	164.9	189.1	181.9	225.6	181.2	-
6 August 2004						
0-15	53.4	64.3	79.8	87.8	77.7	3.5
15-30	69.6	77.5	86.4	96.4	87.1	2.8
30-5	73.7	79.7	96.0	99.0	94.9	2.8
45-60	86.2	96.3	102.5	99.9	97.5	3.1
Total	282.9	317.8	364.7	383.1	357.2	-
16 September						
0-15	39.9	48.1	47.0	59.0	46.0	2.8
15-30	53.8	61.6	63.0	75.5	60.9	2.8
30-45	57.9	68.0	70.1	81.1	68.0	2.8
45-60	68.4	79.8	81.1	90.0	83.3	3.5
Total (0-60)	220.0	257.5	261.2	305.6	258.2	-

NS, Non-significant; FYM, farmyard manure

Contents

Table 6. Effect of land shaping on plant height, canopy circumference and stem diameter of apple trees

Treatment	Plant height (m)		Canopy circumference (m)		Stem diameter* (cm)	
	8 May 04	16 Sep 04	8 May 04	16 Sep 04	8 May 04	16 Sep 04
Control	2.34	3.08	2.91	4.11	9.9	10.5
Basin	2.64	3.15	3.24	4.26	9.9	10.9
Basin+ terrace	2.73	3.38	3.30	4.38	11.4	12.4
Basin+terrace+trench	2.76	3.59	3.48	4.53	12.2	14.2
LSD (0.05)	0.16	0.19	0.12	0.10	0.4	0.4

*Diameter of the stem was measured at 10 cm above the ground surface

Table 7. Effect of mulching on plant height, canopy circumference and stem diameter of apple trees

Treatment	Plant height (m)		Canopy circumference (m)		Stem diameter* (cm)	
	8 May 04	16 Sep 04	8 May 04	16 Sep 04	8 May 04	16 Sep 04
Control	2.52	3.04	3.15	3.73	10.5	10.9
FYM	2.76	3.36	3.27	4.02	11.4	11.9
Cocopit	2.79	3.16	3.30	3.88	11.6	11.7
Pebble	2.64	3.09	3.19	3.63	10.9	11.1
Pine needles	2.91	3.25	3.28	3.95	11.7	11.9
LSD (0.05)	0.21	0.18	0.09	0.08	0.5	0.06

*Diameter of the stem was measured at about 10 cm above the ground surface

Table 8. Effect of mulching on relative leaf-water content of apple trees

Treatments	Relative leaf-water content* (%)	
	6 Aug 2004	16 Sep 2004
Control	66.8	62.5
FYM	81.6	76.4
Cocopit	77.0	75.4
Pebble	71.9	71.5
Pine needles	82.0	80.9
LSD (0.05)	8.8	10.2

*Relative leaf-water content = ((fresh wt-dry wt)/ (turgid wt-dry wt)) x 100

Fig. 8. Water stored in polythelene-lined tank

terracing and trenching. Trenching enhanced water conservation through harvesting the run-off water and the water directly from the rains and snow. Terracing alone was also effective in conserving moisture by directing the flow of run-off towards plant basins. Terracing and trenching

thus should be practised in rainfed orchards for harvesting and conserving rain water *in situ*.

Effect of mulching

The effect of mulching on soil-moisture conservation is shown in Table 5. Mulching retained more soil moisture than no-mulch. Differences in moisture conservation due to different types of mulches, however, were small, but in many cases significant. Pine-needle mulch had an edge over other mulch materials. The choice of mulch material will depend on its availability, cost effectiveness and moisture conservation in the long run. Pine needles are easily available locally. Pebbles also appear as a potential mulch material, as they are also locally available in plenty. However, they may interfere with cultural practices like fertilizer application etc.

The land shaping as well as mulching used for soil-moisture conservation significantly improved the growth parameters of apple trees, viz. plant height, canopy circumference and stem diameter. The making of tree basins significantly improved all the three growth parameters (Table 6). However, composition of terracing and trenching further improved the plant growth whereas all the three parameters were highest under the treatment of basin+terrace+trenching.

Likewise, growth of apple trees was better with mulch than without mulch (Table 7). All the three parameters of plant growth were significantly low under control without mulch. Highest plant growth was observed with pine-needle mulch, although differences due to other mulch materials were nonsignificant.

Effect of mulching on water status of apple trees

The effect of mulching on plant water status was determined in terms of relative leaf-water content of apple trees, and the data are shown in Table 8.

The relative leaf water content (RLWC) increased significantly with the application of mulch. Highest RLWC was observed with pine-needle mulch, and the lowest in control. The differences in RLWC among different mulch materials were nonsignificant. According to Table 8 mulching improved the water status of apple trees under rainfed situations.

Water harvesting

Five dug-out tanks were constructed in the experimental area. Four of them were lined each with polythelene sheet (Fig. 8), bitumen (Fig. 9), mud (mixed with dry grass in the ratio of 10:1), and cement+concrete layer (RCC) (Fig. 10), and the fifth was kept as unlined control (Fig. 11).

The capacity of polythelene sheet tank was 17.6 m^3, of bitumen tank 10.0 m^3, of RCC tank was 8.2 m^3, mud-plastered tank was 9.8 m^3, and control was 12.7 m^3.

The RCC and polylined tanks were effective in storing rain water *in situ/v/ater* from springs brought to the site through rubber pipes. No seepage was observed in RCC and polylined tanks even after 2 years of their construction. The bitumen-lined tank did not perform well at this site, because the soil at the experimental site was loose and gravelly. Consequently, the soils caved in along with the bitumen layer as the temperature rose and the soil became dry. The mud-lining also did not prove effective, as it developed numerous cracks upon drying. It was also not possible to store water at all in the un-lined control tank due to very high seepage. Hence in this type of soil, the *chaal* concept does not seem to work. The *chaal* has to be lined with some effective sealant, like RCC or polyethylene (UV resistant material).

The cost of construction of dug-out tanks is given in Table 9. Cost of construction was highest in RCC tank, followed by polylining and bitumen lining. Although the cost involved in the construction of mud-plastered and un-lined tanks was minimum, their utility would depend on the seepage losses and hence the effective water storage. Data are being collected on water storage

Fig. 9. Bitumen-lined tank

Fig. 10. Water stored in RCC tank

Fig. 11. Unlined tank (control)

natural sources, such as rains, springs and snow, for use in agriculture and domestic purposes. However, *chaals* without lining are not effective at all locations because of excessive seepage losses. To increase their efficiency in storing the harvested rain water, either the *chaals* have to be lined with suitable lining materials, or locations have to be identified for constructing *chaals*, that are low lying and naturally have very low permeability to water. Polythelene and RCC were two very effective lining materials for checking seepage losses in *chaals*. Since RCC is very expensive, polythelene is recommended as a lining material. Bitumen, being hydrophobic in nature, is also effective in reducing seepage losses from farm ponds, but its mode of application needs to be standardized in loose and gravelly soils.

Table 9. Cost of construction of dug-out tanks with different lining materials

Lining material	Volume (m^3)	Cost (Rs)			
		Excavation	Lining	Total cost	Cost/m^3 water harvested
Polythelene	17.6	2,335	1,750	4,085	232
Bitumen	10.0	1327	810	2,137	214
RCC (1:6:12)	8.2*	1,088	7,460	8,548	2,849
Mud	9.8	1,300	240	1,540	157
Unlined control	12.7	1,685	-	1,685	133

*Effective volume was 3.0 m^3 Excavation cost was Rs 132.67/m^3 soil

and seepage losses from each tank.

CONCLUSION

These studies have shown that *chaal* is an effective structure for harvesting water from

Land shaping (terracing and trenching) was very effective in conserving soil moisture in tree basins by directing the run-off water towards tree basins and harvesting the rain water. The moisture conservation effect was further enhanced when land shaping was coupled with mulching. Pine-needle mulch was comparatively more effective in moisture conservation. The pebble mulch was also effective, and may be easy to apply at on-farm level because of its easy availability locally. However, due to fragile nature of the land scape, the terracing and trenches were damaged due to snowfall and rains, and had to be repaired even after 1 year of construction.

The effect of soil moisture conservation through land shaping and mulching was significantly observed on the growth of apple trees. □

SOIL AND WATER MANAGEMENT

Code	**615**
Title of the ITK	**Cultivation of apple in Himalayan region**
Description of the ITK	Traditional apple-orchard farming involves the use of contour ditches, water-control canal, soil traps, bench terraces and hedge rows of fast-growing leguminous plants, which have been adopted by the farmers of Himlayan region. Soil and water erosion is a serious problem in hilly regions. Since earlier times farmers used to practice this technology in an integrated way to improve soil and water conservation and manage nutrients in apple orchard. This technology helps in stabilizing the fragile eco-system dominated by apple-farming system. Use of such technologies lays focus on soil and water conservation as well as fertility management, resulting in a paradigm shift towards maximization of productivity, profitability and sustainability of hill eco-system. This is in practice for several years.
Name and address of the discloser	Shri Prem Singh, village Gawahi, P.O. Sandhu, tehsil Theog, Shimla (Himachal Pradesh) 171 222.
Location of use of the ITK	Farmers in Himalayan region
Experimenters	Dr Pradeep K. Sharma, Chief Scientist (WM);Dr Atul, Head, Department of Agroforestry and Environment, COA;Dr O. C. Kapur, Senior Scientist (Soils), Dr S.S. Masand, Senior Scientist (Soils); Department of Soil science, CSKHPKV, Palampur, Himachal Pradesh.

METHODOLOGY

The ITK-based technology has variously been termed Sloping Agriculture Land Technology (SALT). SALT is a package technology on soil conservation and food production, integrating different soil-conservation measures in just one setting. Basically, SALT is a method of growing field and permanent crops in 3-5 m wide bands between contoured rows of nitrogen-fixing trees. The nitrogen-fixing trees are thickly planted in double rows to make hedge-rows. When a hedge is 1.5 to 2 m tall, it is cut down to 75 cm and the cuttings (tops) are placed in alley-ways to serve as organic manures.

Experiment

Experiments were conducted for characterization of the site and evaluation of experimental soil, evaluation of the prevalent practice of the hedge-row cultivation of the apple plants and others on the sloping lands, field mapping of the discloser's area, preparation of the stratified diagrams of the plantation, contour testing, important value index (IVI) exercise of the area to know the present ecological status of the land, productivity estimation of the area, secondary data collection of the biomass and the economic yield of the SALT practised area of the discloser, terracing and plantation of grass on

terraced land.

The experimental site was an apple orchard in village Gawahi, located at 45 km from Shimla city on National Highway 22 (commonly called Hindustan-Tibet Road) and 8 km from Theog town, which is a gateway to apple belt of Shimla district. The orchard was of about 3 ha area, at 2,400 m above msl, which was established 10 years ago. The landscape is very steep, with a slope of 70-75%. About 500 apple trees were planted along the visually-observed contours at a spacing of 3-6 m. The trees are being fertilized regularly with chemical fertilizers and FYM. The orchard is completely rainfed.

Soil characterization

Soil samples were collected at eight locations, i.e. six in the SALT (orchard) area up to a depth of 60 cm at 15 cm depth increment, and two in non-SALT (non-orchard) area at two depths at 30 cm depth interval. The soil samples for each depth were thoroughly mixed and a composite sample was prepared. The composite soil samples were analysed in duplicate for texture (International Pipette method), organic carbon (Dichromate oxidation method of Walkley and Black), available N (Alkaline permanganate method), Olsen's P, exchangeable K (Ammonium acetate method), pH (1:2.5 soil:water suspension) and particle density (Pycnometer method). Soil-moisture retention of disturbed soil samples (soil passed through 2 mm sieve) was determined at saturation, -30 and -1500 kPa water potential, using Pressure plate apparatus. Bulk density was determined using 3 cm long and 5.6 cm diameter metal cores, by taking soil core from the middle portion of each soil layer.

The soil was gravelly and medium in texture. The bulk density of soil varied from 1.14 to 1.47 mg/m^3. The average particle density of soil was 2.61 mg/m^3. The porosity of soil was thus high, especially in the top 30 cm soil layer. Consequently, the soil was highly permeable for water. The infiltration rate of soil (after 6 hr of initiation) varied from 5379 and 7005 mm/day (Table 1).

The soil was acidic in reaction irrespective of the SALT (orchard) and non-SALT (non-orchard) area. In the SALT area the organic carbon was in the medium range in the top 45 cm depth, but low in 45-60 cm depth. In the non-SALT area, the organic carbon was low. The nutrient status was medium for available N, high for Olsen's P and low to medium for exchangeable K at both the locations (Table 2).

Field mapping

The contour lines were drawn and the marking of each tree was done to prepare the actual location of the trees. The line-transect method was used to calculate and mark the trees and with the help of a frame the actual contour lines were

Table 1. Soil physical properties of the study area

	Soil separates (%)				Soil moisture retention (%) at					
Soil depth (cm)	Clay	Silt	Sand	Textural class (ISSS)	Saturation	-30 kPa	-1500 kPa	Particle density (mg/m^3)	Bulk density (mg/m^3)	Total porosity (%)
Non-SALT area										
0-30	8.0	25.0	67.0	Silt loam	43.0	21.0	10.0	2.64	1.21	54.2
30-60	10.0	19.0	71.0	Loam	44.0	23.0	11.0	2.43	1.46	39.9
SALT area										
0-15	9.7	27.0	63.3	Silt loam	49.1	24.9	14.3	2.61	1.14	56.0
15-30	12.8	25.0	62.2	Loam	49.8	24.1	14.8	2.61	1.25	52.1
30-45	11.8	25.4	62.8	Loam	50.5	26.1	15.1	2.60	1.47	43.5
45-60	14.0	22.0	64.0	Loam	51.4	26.6	15.2	2.60	1.45	44.0

Table 2. Soil-chemical properties of the study area

Soil depth (cm)	pH	Organic carbon (%)	Available nutrients (kg/ha)		
			N	P	K
Non-SALT area					
0–30	5.9	0.48	502	30.3	157
30–60	5.9	0.42	346	22.4	134
SALT area					
0–15	5.8	0.84	492	44.1	168
15–30	5.9	0.68	477	39.3	112
30–45	5.9	0.55	460	30.7	90
45–60	5.9	0.44	314	28.3	79

also developed .

In the high slope area, terraces were prepared on the contour lines, but these deviated from it with the decrease in slope. The triangular pattern of the plantation was done to accommodate maxium number of plants.

Observations were recorded on physical parameters, viz. topography, slope, soil type, soil and water conservation, fertility management, land preparation, irrigation, seed and fertilizer placement, chemical parameters, viz. nutrients and fertilizers, biological parameters, viz. planting method, improved cultivars and pest control.

At the end of planted row dug out of 4-5 feet of soil away from the last plant was made to develop a mud wall of the terrace. Line quadrant method was used to evaluate the lay-out plan. The observations were recorded with respect to the existing plantation survival, plant-to-plant distance, plant height and the plant spread.

RESULTS AND DISCUSSION

Contour testing

The planting of trees did not follow exactly the contour lines. A deviation, as high as 7.8 m, was observed between the actual contour lines and the planting of trees (Table 3). Likewise, deviations in plant to plant distance, plant height and plant spread were also observed.

Important Value Index exercise

To study the diversity of species and heterogeneity between SALT and non-S ALT areas under investigation, phyto-sociological studies were carried out for different plant species occurring in those areas.

In the non-SALT area, there was much diversity in plant species. In addition to many grasses (12 species), shrubs like *Rumex*, *Rubus*, *Rosa* and *Berberis* spp. were also found. The ecological success of a species in the area appeared to be a function of its cumulative dispersion, numerical strength and relative dominance values. Minor variations in dispersion or relative dominance failed to affect the order. Higher numerical strength of *Rosa* spp. in non SALT areas compared with that of *Rumex* spp. failed to generate a variation in IVI order (Table 4). Species diversity was greatly reduced in SALT

managed areas. Ecological success of a species was dependent upon the nature of species associated in the area. It was interesting to note that grass *Agropyron canaliculatus* was ecologically more successful when grown in association with different grasses and shrubs in non-SALT areas compared with when it was existing in association with apple trees in SALT areas (Table 5).

Performance and productivity estimation of the area

More than 92% of the trees planted survived. No replanting was done to fill the gaps. Consequently, the plant-to-plant distance varied from 5 to 33 m. The mean plant height of the apple orchard on the slope is 6.57 feet with the range of 3 to 12 feet (Table 3). This indicates that this is a unique attempt and the plantation stock is young.

Table 3. Performance of apple trees in the sloping agriculture land technology area (orchard)

Statistical parameter	Deviation from contour (m)	Plant to plant distance (m)	Plant height (ft)	Plant spread (ft)
Mean	3.18	16.69	6.57	4.93
Standard Error	0.33	1.03	0.40	0.48
Standard Deviation	1.98	6.17	2.39	2.91
Sample Variance	3.92	38.11	5.72	8.45
Kurtosis	-0.35	0.03	-0.27	2.05
Skewness	0.21	-0.05	0.40	1.23
Minimum	0.00	5.00	3.00	0.15
Maximum	7.80	33.00	12.00	14.00

The spread of the plant is an indicator of its health and establishment state. Table 3 shows that the mean spread was 5feet, which can be classified as the satisfactory growth. The maximum value of the spread of the plants was 14feet, with an exception to very thin growth of plants.

The data were analysed using the two sets of degrees of slopes as treatment, i.e., very high (>50 degrees) and moderate (30-40 degrees), along with the combination of the terraced and non-terraced areas in the SALT area. T_1 represents the plantation on high slope with terraced land, T_2 the plantation on moderate slope with terraced land, T_3 the plantation on high slope on non-terraced land; and T_4 the plantation on moderate slope with non terraced land. The transects were laid out at different slopes. The analysis of variance indicated the significant effect of slope on the spread and height of apple trees. It can be inferred that at high slopes the farmer's intervention of developing small terraces is useful in getting better performance.

The plant height as well as the spread of the apple trees was generally more in the terraced and high slopes, followed by the terracing at the moderate slope. In addition, the contouring at moderate slopes also proved beneficial, but not at higher slopes. It happened so probably because the construction of small terraces provided a medium to hold the tree roots at the initial stage, which gave boost in the establishment of plants.

The pH did not differ in the different systems, because the studied site is being treated by the farmer under the SALT for the last 5 years only. However, organic carbon, available nitrogen, phosphorus, potassium, bulk density and porosity decreased with increase in the soil depth. The soil-moisture retention was more in the top layer of the soil, which supplemented the adoption concept of the SALT farmers of the area.

There was reduction in the species diversity

Table 4. Dominance and ecological success of different plant species in non-SALT areas

Species	Relative frequency (%)	Relative density (%)	Relative dominance (%)	Importance Value Index (IVI)
Chrysopogon fulvus	12.1	28.7	20.0	60.7
Agropyron canaliculatum	13.3	27.1	12.8	53.1
Poa pratensis	13.3	24.6	10.0	47.9
Berberis spp.	9.6	15.0	22.0	46.6
Trifolium repens	17.1	17.2	11.8	46.1
Lolium spp.	12.3	20.5	10.3	43.0
Rumex spp.	9.3	10.2	19.1	38.6
Rubus spp.	8.9	11.4	18.2	38.4
Rosa brumoni	4.5	12.9	17.8	35.2
Agwstis spp.	9.6	5.4	7.7	22.7
Trifolium pratense	8.4	5.2	6.0	19.2
Bromus spp.	6.0	4.4	4.8	15.1
Lotus corniculatus	6.0	2.1	6.8	15.0
Phleum alpinum	4.8	0.5	7.5	12.9

with the introduction of the orchard species. The land management and uprooting of unwanted vegetation by the farmer for establishing orchard reduced the species diversity. This improved the under-storey grass cover and gave additional income through the fruit plants. The ecological succession of the species brought out change in the carrying capacity of the vegetation, as only the dominant species survived, and with the removal of the shrubs component the associated species automatically vanished.

Through this indigenous technology of intervention of the horticulture crops in the area and maintaining the indigenous species on the same piece of land, the farmer developed a sustainable land-management system in terms of ecological bio-diversity, soil health, less soil erosion and economical improvement.

Species	Relative frequency (%)	Relative density (%)	Relative dominance (%)	Importance Value Index (IVI)
Pyrus malus	45.3	75.0	45.2	165.5
Chrysopogon fulvus	12.0	24.5	21.8	58.3
Agropyron canaliculatus	15.2	15.2	10.2	40.6
Trifolium repens	10.6	11.5	4.70	26.7
Cynodon dactylon	9.1	8.2	7.9	25.2
Bromus spp.	7.4	5.6	6.2	19.2
Lolium spp.	6.5	5.0	2.4	13.8
Poa pratensis	7.5	4.3	0.95	12.7

Establishment of grasses on terraced SALT and non-SALT areas

Being a fragile and sloping landscape, the terraces were damaged by rains and snowfall even after 1 year of their construction. That means,

either the terraces are to be repaired every year, which is rather a costly affair, or stabilize the terraces so that they are not washed away by water. To stabilize the terraces, attempt was made to establish grass on the terraces (Fig 2). The fescue and orchard grasses were planted at 20x20 cm plant and 40x40 cm row spacings on the terraces during August 2004, which is a rainy season.

The results of this investigation are summarized in Tables 6 and 7. These results revealed that there was increase in root proliferation, number of leaves and plant height in SALT area than in non-SALT area. Also grasses planted in lower part of terrace and trenches showed increased growth pattern than in the central part of the terrace (Table 6) Similar results were also obtained for two other productivity parameters viz. percentage increase in root and shoot biomass and number of leaves (Table 7).

CONCLUSION

Contour orchard farming and terracing are the pre-requisites of the steep-slope orchard raising, as has been tried by the discloser. To mitigate the water stress and soil-erosion condition due to steep slopes, management of the slopes through vegetative structures was found essential. This intervention helped in developing the ecological and economically sustainable land-management system.

Table 6. Effect of different land-shaping treatments (SALT and non-SALT areas) on grass (fescue: *Festuca* spp.) proliferation after 30 days interval

Treatment	Increase (%) in root length	Increase (%) in no. of leaves	Increase (%) in shoot height
Control (non-SALT)	82	78	70
Trench	203	94	76
Lower part of terrace	197	158	133
Central part of terrace	106	95	68

Table 7. Effect of different land-shaping treatments (SALT and non-SALT areas) on root and shoots of fescue *(Festuca* spp.) proliferation after 30 days interval

Treatment	Increase (%) in dry root biomass	Increase (%) in no. of leaves	Increase (%) in dry-shoot biomass
Control (non SALT)	100	100	100
Trench	166	128	130
Lower part of terrace	152	118	113
Central part of terrace	155	111	120
Terrace	156	116	103

Code	344
Title of ITK	**Management of yellow stem-borer in paddy by use *of parasi (Cleistanthus collinus)* leaf**
Description of the ITK	Application of 75-150 kg *parasi (Cleistanthus collinus)* leaves by broadcasting once in the rice field at 3 days after transplanting controls yellow stem-borer during *kharif.* All the rice growers in Aralkocha village of Purulia district in West Bengal follow this practice for the last 50 years. Yellow stem-borer of paddy (attacking in all the growth stages, except flowering and onward stages) is the most important and major pest problem in lowland paddy. The larva enters the stem and feeds upon the internal plant material, thereby disrupting the vascular passage to the terminal portion (which may be leaf or panicle). It results into drying of the portion causing the symptoms (dead-heart at the vegetative stage and white earhead in the mature stage).
Name and address of the discloser	Secretary, Aralkocha Kansabati Club, village Aralkocha, P.O. Konnapara, Block-Hura, Purulia (West Bengal) 723 128, through Kalyan Krishi Vigyan Kendra, Vivekanandanagar, Purulia (West Bengal) 723 147.
Location of use of the ITK	Villages Aralkocha, Rahemda, Siju, Arujnjora, Chirumarcha, Hura, Piruzia,West Bengal 723 147
Experimenters	Dr (Ms) Mayabini Jena, Senior Scientist, Department of Entomology and Dr T.K. Dangar, Scientist (Senior Scale), Department of Soil Microbiology, Central Rice Research Institute, Cuttack (Orissa) 753 006 and Training Organiser, Kalyan KVK, Purulia (West Bengal)

METHODOLOGY

Experiment

Experiments were conducted during rainy season *(kharif)* of 2002,2003 and 2004 and during winter season *(rabi)* 2004 at Central Rice Research Institute, Cuttack and during *kharif 2002* and 2003 in farmers' fields of Aralcocha village, Purulia district to validate the efficacy of *parasi* leaf against yellow stem-borer (YSB) in rice. The treatments taken during the experiment of CRRI farm were: (i) use of *parasi* (75 kg/ha) at 30 days after transplanting (DAT), (ii) use of *parasi* (75 kg/ha) each at 30,60 and 90 DAT, (iii) use of *parasi* (100 kg/ha) at 30 DAT, (iv) use of *parasi* (100 kg/ha) each at 30, 60 and 90 DAT, (v) use of *parasi* (150 kg/ha) at 30 DAT, (vi) use of *parasi* (150 kg/ha) each at 30, 60 and 90 DAT, (vii) use of carbofuran (1 kg/ha) at 60 and 90 DAT, and (viii) untreated control. Seedlings of Savitri variety at 30 days were transplanted during third week of July in randomized block design by using 4 replications. Observations on dead-heart (DH) and white ear formation (WEH) were taken after

Table 2. Effect of *parasi* leaf application on soil microbes in rice (2003)

Bacterial colonies ($\times 10^5$)	1st application of *parasi* leaf (kg/ha) 30 DAT			Control (30 DAT)	2nd application of *parasi* leaf 60 DAT			Control (60 DAT)
	75	100	150		75	100	150	
Heterotrophic	8.19	7.88	150	4.81	1.52	1.69	0.97	3.97
Spore-former	1.73	1.60	8.01	2.35	0.56	0.70	0.64	2.91
Gm (–) ve	1.63	1.21	1.82	1.50	0.92	0.94	0.85	0.95
Free N_2 fixing	0.81	0.72	1.44	0.49	0.62	0.50	0.48	0.55
Nitrifying	0.62	0.60	0.74	0.26	0.58	0.66	0.58	0.21
De-nitrifying	0.10	0.11	0.64	0.11	0.20	0.18	0.17	0.16
Phosphate solubilizing	0.05	0.04	0.15	0.08	0.02	0.03	0.03	0.04
Actinomycetes	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
Fungi	0.37	0.21	0.01	0.46	0.40	0.32	0.73	0.62

Table 3. Effect of *parasi* leaf against yellow stem borer in *rabi* rice (2004)

Treatment	DH(%)/m^2	WEH(%)/m^2	No. of EBT/m^2	Yield (q/ha)
Parasi leaf @ 150 kg/ha at 10 DAT	6.5	3.3	341.0	35.3
Parasi leaf @ 150 kg/ha at 10 and 20 DAT	5.5	2.9	351.2	38.5
Parasi leaf @ 150 kg/ha at 10, 20 and 30 DAT	4.2	1.7	359.7	41.4
Parasi leaf @ 250 kg/ha at 30 DAT	6.8	3.3	336.7	37.0
Carbofuran	3.7	2.3	368.5	42.3
Untreated control	10.4	6.7	285.2	30.9

DAT, Days after transplanting; DH, dead-heart; WEH, white earhead; EBT, ear-bearing tiller

Data obtained from the experiment in farmers' fields (Aralkocha) showed considerably less population of the insect in both the years, 2002 and 2003, ranging from 0 to 1/m^2 with an average of 0.4/replication.White earhead formation was also meagre, ranging from 0 to 0.5. Reduction in population was related to the drought and heavy rain situation by the farmers. Yield varied from 5.63 to 6.03 tonnes/ha in comparison to 4.93 tonnes/ha in untreated control. Though the insect did not contribute to significant yield loss due to its less or no infestation, there was an increase in yield with *parasi* treatment in comparison to that with untreated control.

Experiment conducted during *rabi* showed that among different treatments *parasi* leaf application (150 kg/ha) at 10 and 20 DAT and at 10,20 and 30 DAT were on par with the efficacy of carbofuran. Single application of *parasi* leaf at 150 kg/ha or 250 kg/ha were next in the order of efficacy, though all the treatments were superior to the untreated control. The same trend of efficacy was also obtained in white ear-head formation and grain yield. In addition to the reduction of YSB infestation, there was an increase in the number of ear-bearing tillers in all the treatments in comparison to the control. But it was more in repeated application *of parasi* treatments than in single application, which may also increase the grain yield (Table 3).

CONCLUSION

Parasi leaf was found effective in controlling yellow stem-borer and thereby increasing the yield of rice when it was applied thrice in rice fields. It has also been found effective in increasing the population of earthworms and soil bacteria. □

Codeno	**357**
Title of the ITK	**Control of insect-pests in lowland rice using parasi (Cleistanthus collinus)**
Description of the ITK	Approximately 0.4 to 0.5 kg fresh, tender branches of *Cleistanthus collinus* are planted erect or spread in the standing water after establishment of summer rice with the anticipation of pest outbreak. This practice is being followed by a good number of farmers belonging to Kapgari village under Jhargram subdivision in Midnapur district of West Bengal. This practice has been in vogue over generations without any modification and is being followed in patches vulnerable to insect-pest incidence. Rice *gundhi* bug infests paddy at the milk stage. It sucks the milk, leaving the grain chaffy or partially chaffy, depending upon the extent of infestation. It generally appears in damaging level during rainy *(kharif)* season in the early maturing varieties that mature during 1st or 2nd week of October.
Name and address of the discloser	Dr G. B. Manna, former Principal Scientist, 85 H, Hijli Co-operative, Prembazar, Kharagpur (West Bengal) 721306 Berakunda, Bhamganagar, Ganjam (Orissa) 761 126
Location of use of the ITK	Dr (Ms) Mayabini Jena, Senior Scientist, Department of Entomology and Dr T.K. Dangar, Scientist, Department of Soil Microbiology, Central Rice Research Institute, Cuttack (Orissa) 753 006
Experimenters	

METHODOLOGY

Experiment

Experiments were conducted during the rainy *(kharif)* seasons 2002, 2003 and 2004 at Central Rice Research Institute (CRRI), Cuttack and during *kharif 2002* and 2003 in farmers' fields of

Fig. 1. Implantation of *parasi* twig in farmer's field (Balasore)

Fig. 2. Healthy grains *(left)* and *gundhi* bug-infested grains *(right)*

Contents

Ajodhya village, Balasore (Orissa). In the research station, 30-day-old seedlings were transplanted in randomized block design for 6 treatments each with 4 replications. Fertilizer was applied @ 60:30:30 kg NPK/ha. Twigs of *parasi* were implanted @ 5/plot (25 m^2) and leaves were applied @ 100 kg/ha. Malathion dust was applied @ 25kg/ ha. Observations were taken on population of *gundhi* bug (after 5 and 10 days of treatment by sweeping net method) and yield of rice. In farmers' fields, only 3 treatments each with 10 replications were taken, i.e. implanting *parasi* twigs, applying insecticides and untreated control.

RESULTS AND DISCUSSION

Results obtained from the experiments conducted at CRRI, Cuttack and in farmers' fields during 2002 revealed that *gundhi* bug infested the paddy in spite of *parasi* application. But there was decrease in population for the treatment where it was applied after infestation and applied as fresh twigs or leaves. Accordingly, the yield was also highest in the treatment. But a significant increase in yield was not obtained in *parasi* treatment than in untreated control. Experiments conducted during 2003 showed that insect incidence was less and irregular in farmers' fields. *Parasi* twigs were implanted when the insect population was 1/m^2 But it did not increase subsequently, as is clear from the data on 10 DAT. However, insect population was found to decrease in *parasi* treatment in comparison to untreated control (Table 1). Yield was also more though not significant. Yield data during 2003 were much influenced by rain and subsequent flood. Hence these have not been presented.

Table 1. Population of *gundhi* bug in *parasi* treatment (2003)

Treatment	Insect no./sweep net			
	CRR1		Farmers' fields*	
	5 DAT	10 DAT	5 DAT	10 DAT
Twig implantation + leaf (at flowering)	4	3		
Twig implantation (at flowering)	5	4	-	-
Twig implantation + leaf (after insect infestation)	4	2	-	-
Twig implantation (after infestation)	4	2	9	2
Malathion dust	1	1	3	1
Control	7	4	18	9
CD at 5%	0.07		0.58	

DAT, Days after treatment

CONCLUSION

Gundhi bug population was reduced by both fresh leaves and planting of twigs of *parasi* at the time after *gundhi* bug infestation.

Code : **365**

Title of the ITK **Planting of wild *Saccharum spontaneum* in paddy field for controlling leaf-folder**

Description of the ITK : Wild sugarcane *(Saccharum spontaneum)* twigs of height 4 to 5 feet and 4 to 5 cm diameter are planted after 15 days of transplanting in rice field for control of leaf-roller. These erected branches harbour the predators at the time of occurrence of leaf-roller, thereby suppressing the incidence of pest. About 90% farmers in the Benakunda village of Ganjam district in Orissa adopt this practice. Rice case worm, *Nimphula depunctalis* Guenee (Lepidoptera: pyralidae) is an insect pest of rice in low lying area and waterlogged conditions. Larvae make their cases by cutting top portion of the leaf and rolling the leaf section around their body with the help of silky threads produced by their saliva. The head end remains open. Larvae remain within the case while floating on water surface. They crawl up rice plants to feed remaining in their cases. The larvae feed by scrapping patches of green tissue from young tender leaves, leaving only the white epidermis. The pattern of damage is not uniform because the larvae floating in their cases are often carried to one side of the paddy field by wind or water currents. Damaged plants become stunted and produce fewer tillers. Wild sugarcane, *Saccharum spontaneum* grows near river banks on marshy lands. The plant is used by the farmers of Bhanjanagar area (Ganjam district) to control case worm in rice.

Name and address of the discloser Shri Birendra Nayak, village Bhanjanagar, district Ganjam (Orissa) 761 126

Location of use of the ITK : Village Benakunda, block Bhanjanagar, district Ganjam (Orissa) 761126

Experimenters : Dr (Ms) Mayabini Jena, Senior Scientist and Shri K.S. Behera Senior Scientist, Department of Entomology, Central Rice Research Institute, Cuttack (Orissa) 753 006

METHODOLOGY

Experiment

Field experiments were carried out during the rainy *(kharif)* season of 2002, 2003 and 2004 at two locations, i.e. at (i) CRRI, Cuttack and (ii) farmers' fields in the villages. At CRRI, Cuttack the treatments taken were: planting *Saccharum spontaneum* at 7 days after transplanting (DAT), 14 DAT, and after infestation, foliar spray of insecticide (imidacloprid) @ 0.05 kg ai/ha and untreated control. Seeds were sown on 25-28

Fig. 1. Implantation of S. *spontaneum* in farmers' field

Fig. 2. Spider on stem of S. *spontaneum*

June. Seedlings were raised in the nursery with all the recommended agronomic practices to obtain healthy seedlings. Thirty-day old seedlings were transplanted on 25-28 July in randomized block design (RBD), each treatment in 4 replications with 40 m^2area for each microplot (replication). Fertilizer application was made @ 60 N:30 P:30 K kg/ha. Half the dose was applied basal, whereas the rest was applied in two split doses, one at the tillering and the other at panicle-initiation stage. First and second treatments of wild sugarcane were made at the scheduled period. Source of availability of wild sugarcane was found out within 60 km periphery of CRRI. Observations on percentage of hill infestation and yield of rice were taken. The variety used was Moti.

In farmers' fields three treatments were used: planting of *S. spontaneum* at insect infestation, insecticide treatment, and untreated control. Each farmer represented one replication with three plots as three treatments. Each plot size was within the range of 600-800 m^2 with 10 replications.

RESULTS AND DISCUSSION

Results of the experiments conducted during 2002 at CRRI research station showed that planting of wild sugarcane at 5 DAT was more effective than the other treatments. Incidence of caseworm was not observed on 20 DAT due to planting of wild sugarcane at 7 DAT and 14 DAT, and with application of imidacloprid. Planting of wild sugarcane before infestation by caseworm helped obtain rice yield of 63.2 to 64 q/ha, which was 68 q/ha when insecticide was applied. Untreated plot gave the lowest yield (51.7 q/ha). Substantial reduction in incidence of case-worm was noticed in the experiments conducted at farmers' fields. Observations at farmers' fields further showed reduction of pest population towards 10th day of botanical treatment, and total control was observed after 20th and 30th day of treatment (Tables 1 and 2). No hills were lost by insect infestation in wild sugarcane treatment, whereas there was complete damage of 30 to 45% hills in untreated control plots. In addition, delayed flowering was observed with reduced

Table 1. Percentage of hill infestation and grain yield in farmers' fields at Bhanjanagar (2003)

Treatment	Hill infestation (%) at different DAT*		
	10	20	Yield (q/ha)
S. spontaneum	26.0	0.0	30.3
Insecticide (Monocrotophos)	2.4	0.0	32.2
Untreated control	29.6	0.0	29.1
CD at 5%	4.1	-	3.3

*DAT, Days after treatment

Table 2. Effect of wild sugarcane on caseworm population and leaf area damage in farmers' fields of Kasiadihi (2003)

Treatments	No.of insects/m²			Leaf damage/hill (%)			
	10 DAT	20 DAT	30 DAT	10 DAT	20 DAT	30 DAT	Yield (q/ha)
Wild sugarcane	88.0	19.0	3.0	11.5	7.8	1.8	59.0
Imidacloprid	38.0	1.9	2.0	4.8	1.25	0.0	62.0
Untreated control	130.5	167.3	124.4	33.9	71.4	84.8	23.0
CD at 5%	0.09	0.16	0.26	2.65	4.58	4.43	1.70

DAT: Days after treatment

panicle size.

Substantial reduction in incidence of caseworm as determined by infestation of hill was obtained in the experiments conducted at farmers' fields.

Mode of action of *S. spontaneum:* Observations taken on the micro-ecosystem after planting of *Saccharam spontaneum* revealed the following facts:

1. Almost all the leaves of *S. spontaneum* provided habitation for spiders.
2. Spider eggs were available in 65% of *S. spontaneum* implanted in both leaf surfaces and at the leaf-sheath portion.
3. Spider population was 2-3/m^2 after 5 days of planting of *S. spontaneum,* which gradually increased to 6-8 after 15 days, with small spider nymphs all over the field.
4. Spiders collected from CRRI, Vogra, Bhanjanagar and Kasiadihi belonged to 6 types, which were: *Neoscona* sp., *Araneus* sp., *Oxyopes* sp., *Tetragnatha* sp., Clubirna sp. and *Argeiops* sp.
5. Two types of spiders *Araneus* sp. and *Oxyopes* sp. were observed to kill and devour the larvae of caseworm.
6. Web formation was perhaps another mode of action for controlling the caseworm by trapping it at moth stage.
7. High rate of egg laying of some of the spiders was observed on the broad leaf surface of *S.spontaneum,* which perhaps helped in spreading the population less time. 8. The egg masses collected from leaf showed 200-250 spiders hatching from one egg mass. This may be another contribution of *S. spontaneum* to its efficacy against rice caseworm.

Fig. 3. A species of spider

CONCLUSION

Planting of wild sugarcane *(Saccharum spontaneum)* is effective in controlling the infestation of rice caseworm both before and after infestation. It is due to the fact that wild sugarcane plants help in multiplication of different types of spiders that control the caseworm.

□

Code	**:**	**1418**
Title of the ITK		**Control of caseworm *(Nymphula depunctatis)* in rice by leaves ofparasi and sali**
Description of the ITK	:	Caseworms are very common in the area of Khaspokharia village West Singhbhum district, Jharkhand. Fresh leaves of *parasi {Cleistanthus collinus)* and *sali (Boswellia serrata)* are spread on the insect-infested field @ 5 kg leaves per 100 m^2. A majority of insects (70-80%) are controlled with this practice.
Name and address of the discloser	:	Shri Sanat Kumar Sawaiyan, Dumbisai, Chaibasa, West Singhbhum (Jharkhand)
Location of use of the ITK	:	Village Khaspokharia, block Tantnagar, West Singhbhum (Jharkhand) 834 006
Experimenters	:	Birsa Agricultural University, Ranchi (Jharkhand) 834 006 Dr N. Kudada, Assistant Professor-cum-Junior Scientist (Senior Scale), Department of Plant Pathology; Dr Rabindra Prasad, Junior Scientist-cum- Assistant Professor (Senior Scale), Department of Entomology; Shri K.K. Sinha, Assistant Professor- cum- Junior Scientist (Selection Grade), Entomology and Dr R.P. Singh 'Ratan', Head Department of Extension Education. Bidhan Chandra Krishi Vishva-vidyalaya, Mohanpur, Nadia (West Bengal) 741252 Dr S. K. Mandal, Professor, Department of Agricultural Entomology.

METHODOLOGY

Initially the experiment was conducted in farmers' fields at Khaspokharia village, Tantanagar block in West Singhbhum district of Jharkhand during 2003-04 and also in 2004-05 cropping seasons. The experiment was also conducted at Central Research Farm, BCKVV, Gayeshpur, Nadia (West Bengal) during 2004-05 for cross-validation of the results obtained at Khaspokharia village.

Field experiments

At Khaspokharia village the experiment was carried out in randomized block design (RBD) with four treatments in 15 replications for validation of ITK. The treatments were: T_1, control; T_2, application of *parsa* leaves @ 100 kg/ha; T_3, application of *sali* leaves @ 100 kg/ha; and T_4, application of chlorpyriphos @ 1.0 litre/ha. Each farmer represented one replication with four plots four treatments. Each plot size was within the range of 500-1000 m^2. Observations were taken on number of total leaves, damaged leaves and number of caseworm leaves/hill after 30 and 60 days of treatment (DAT). Rice seeds of local varieties were used. About 30-35-day-old seedlings were transplanted in the field.

Contents

At Central Research Farm, BCKV also, the experiment was conducted following RBD with 4 treatments each, being replicated 7 times for the control of rice caseworm. The treatments were: T_1, *parasi* leaves @ 100 kg/ha; T_2, *sali* leaves @ 100 kg/ha; T_3, chlorpyriphos at 0.05% a. i., and T_4, control.

Thirty-day-old seedlings of rice variety IET 4786 (Shatabdi) were transplanted on 27 July 2004 in plots measuring 5 x 3 m at a spacing of 20 x 15 cm. The crop was manured with N: P: K @ 80: 50: 50. Irrigation was given as and when required to maintain standing water in the field. Fresh *parasi* and *sali* leaves were spread over the standing water in plots at 7 DAT (days after transplanting). Chlorpyriphos was sprayed twice, at 7 and 22 DAT.

Observations were taken from all the hills of 0.5 m^2 area at two locations in each plot at 15 days interval starting from 15 days after treatment. Counts were taken on total number of leaves in each hill and those showing infestation by case-worm. The number of leaf cases bearing larvae was also counted.

RESULTS AND DISCUSSION

Results obtained from the experiment conducted on 15 farmers' fields during 2003-04 and 2004-05 cropping seasons are presented in Table 1. At 30 DAT minimum mean caseworm infestation (30.9%) was recorded in T_4, i.e. application of chlorpyriphos @ 1.0 litre/ha compared with 81.3% in control during two cropping seasons (2003-04 and 2004-05). Treatment T_4 was followed by application of *parasi* leaves @ 100 kg/ha (T_2,), which recorded 58.1% caseworm infestation. Data revealed that all the treatments were significantly superior to control.

At 60 DAT also data showed that treatment T_4 recorded minimum mean caseworm infestation (9.4%), which was statistically superior to control. All the treatments were significantly superior to control.

Maximum extent of control of caseworm infestation (61.53%) was recorded by application of chemical insecticide (T_4). This treatment (T_4) was followed by T_2 (28.64%) and T_3 (18.84%) at 30 DAT. Similar results were recorded at 60 DAT (Table 2).

Use *of parasi* leaves was effective in reducing caseworm population at 30 and 60 DAT during 2003-04 and 2004-05 cropping seasons (Table 3).

Maximum extent of caseworm population control (91%) and (97.5%) was recorded by application of chemical insecticide (T_4) at 30 DAT and 60 DAT. This treatment (T_4) was followed by T_2 (application of *parasi* leaves @ 100 kg/ha), which recorded 83.0 and 88.1% caseworm population control at 30 and 60 DAT respectively (Table 4).

At Central research Farm, BCKV, Gayashpur, the caseworm infestation was low during the

Table 1. Effect of application of *parasi* and *sali* leaves and application of chlorpyriphos on caseworm infestation at Khaspokharia (mean of 2003 and 2004)

Treatment	Mean caseworm infestation (%)	
	30 DAT	60 DAT
T_1, Control	81.3	87.7
T_2, Application of *parasi* leaves @ 100 kg/ha	58.1	24.2
T_3, Application of *sali* leaves @ 100 kg/ha	65.9	30.1
T_4, Application of chlorophyriphos @ 1.0 liter/ha	30.9	9.4
CD at 5%	3.99	2.4

DAT, Days after transplanting

Contents

Table 2. Extent of control of caseworm infestation at Khaspokharia (mean of 2003 and 2004)

Treatment	Mean extent of control of caseworm infestation (%)	
	30 DAT	60 DAT
T_1, Control	-	-
T_2, Application of *parasi* leaves @ 100 kg/ha	28.7	72.5
T_3, Application of *sali* leaves @ 100 kg/ha	18.9	65.7
T_4, Application of chlorphyriphos @ 1.0 liter/ha	61.5	89.3

DAT, Days after transplanting

Table 3.Effect of application of *parsa* and *sali* leaves and chlorpyriphos on population of caseworm infestation at Khaspokfiaria (mean of 2003 and 2004)

Treatment	Mean population of caseworm/hill	
	30 DAT	60 DAT
T_1, Control	6.24	6.79
T_2, Application of *parasi* leaves @ 100 kg/ha	1.01	0.78
T_3, Application of *sali* leaves @ 100 kg/ha	2.64	1.32
T_4, Application of chlorphyriphos @ 1.0 litre/ha	0.55	0.17

DAT, Days after transplanting

Table 4. Extent of control of caseworm population at Khaspokharia (mean of 2003 and 2004)

Treatment	Mean extent of caseworm population/hill (%)	
	30 DAT	60 DAT
T_1, Control	-	-
T_2, Application of *parsa* leaves @ 100 kg/ha	83.0	88.1
T_3, Application of *sali* leaves @ 100 kg/ha	57.8	80.5
T_4, Application of chlorpyriphos @ 1.0 liter/ha	91.0	97.5

DAT, Days after transplanting

season. Infestation started about 10 days after transplanting of the crop, and relatively higher level of infestation was recorded at 3 weeks after transplanting. Low level of infestation continued till 5 weeks after transplanting, after which the infestation was totally seized.

Only a few scattered leaf cases containing larvae, were recorded on the plots during different observations. The percentage of leaves that showed caseworm damage as recorded after 3 weeks of transplanting was 3.16% in chlorpyriphos, 4.69% *mparasi*, 5.76% in *sali* and 7.52% in untreated control. Amongst different treatments, chlorpyriphos (0.05%) was superior to all other treatments. *Parasi* and *sali* were at par but only the former *(parasa)* differed significantly from the control.

Effect on yield and benefit: cost ratio

Chloropyriphos (0.05% a.i.) gave highest grain

yield (40.77 q/ha) followed by *parasi* (39.54 q/ha) and *sali* (39.04 q/ha). However, none of the treatments differed significantly from control (37.79 q/ha) in respect of grain yield. The chemical treatment, chlorpyriphos (0.05% a. i.) gave highest additional yield (2.98 q/ha) and additional return (Rs 1,788.0/ha) followed by *parsa* (1.75 q/ha and Rs 1,050.0/ha respectively) and *sali* leaves (1.25 q/ha and Rs 750/ha, respectively). However, this treatment ranked 2nd and 3rd in respect of net additional return and benefit: cost ratio respectively. *Parasi* leaves ranked first in both the parameters. *Sali* leaves, though ranked second in benefit: cost ratio, ranked 3rd in net additional return.

CONCLUSION

The study revealed that spreading of *parasi* leaves once 5-10 days after transplanting @ 100 kg/ha helped in reducing both the rice caseworm infestation and larvae population. Application of *parasi* leaves showed significantly lower infestation of caseworm than control.

□

Code	**:**	**1422**
Title of the ITK		**Control of gallfly** *(Pachydiplosis oryzae)* in rice
Description of the ITK	:	Gallfly *{Pachydiplosis oryzae)* is very harmful to rice crop. It damages whole crop of rice. Farmers of Tamar block of Ranchi district in Jharkhand use *parso* or *persu {Cleistanthus collinus)* leaves for controlling gallfly. In this practice, fresh leaves of *parsu* or *persu* are collected and spread in the infested field without processing. About 10 kg leaves are required for 100 m^2 area. These leaves are spread at the initial stage of infestation. This practice controls 70-80% insects. All farmers of the village use this age-old practice.
Name and address of the discloser	:	Shri R.S. Prasad, Department of Extension Education, Birsa Agricultural University, Kanke, Ranchi (Jharkhand) 834006
Location of use of the ITK	:	Village Deori, block Tamar, Ranchi (Jharkhand)
Experimenters	:	1. Birsa Agricultural University, Ranchi (Jharkhand) 834 006: Shri K. K. Sinha, Assistant Professor-cum-Junior Scientist, Department of Entomology and Dr R. P. Singh 'Ratan', Head, Department of Extension Education. 2. Bidhan Chandra Krishi Vishvavidyalaya, Mohanpur, Nadia (West Bengal) 741252: Dr S. K. Mandal, Professor, Department of Agricultural Entomology.

METHODOLOGY

Location: Initially the experiment was conducted village Deori, block Tamar, Ranchi (Jharkhand) during *kharif* 2003-2004, where results have been published in *Validation of Indigenous Technical Knowledge in Agriculture Document 3* (2004). The experiment was repeated during *kharif* 2004-2005 at the same location. It was also conducted for cross validation during *kharif 2004* at Central Research Farm of BCKV, Gayeshpur, Nadia, West Bengal.

Experiment: The field experiment was

Fig. 1. Farmers spreading leaves of *Cleistanthus collinus* in rice field

Contents

conducted in rainy *(kharif)* season of 2003-04 at Deori village in randomized block design with three treatments, viz., T_1, control; T_2, *parso* leaf @ 25 kg/ha; and T_3, application of carbofuran 3 G @ 15 kg/ha (two doses), having 10 replications. Each treatment covered 2,000 m^2. Observations were taken on number of tillers/m^2, affected tillers/m^2, infestation (%), and extent of control. During *kharif* 2004-05, 10 replications were made with four treatments, viz. control, application of *parso* leaf @ 50 kg/ha, application of *parso* leaf @ 100 kg/ha and application of carbofuran @ 30 kg/ha. The changes in treatment were made to identify effective dose for control of gallfly.

The experiment conducted at Central Research Farm, BCKV had seven replications with three treatments, viz., control, application of *parso* leaf @ 100 kg/ha and application of carbofuran @ 0.75 kg a.i./ha. About 30-day-old seedlings of rice variety IET 4786 (Shatabdi) were transplanted on 27 July 2004 in plots measuring 5 x 3 m at a spacing of 20 x 15 cm. The crop was manured with N: P: K @ 80:50:50. Gallfly infestation was first recorded on the crop at 35 days after transplanting and only single application of the treatments was done at 40 days after transplanting of seedlings.

The number of gallfly-infested tillers (silver shoots) was recorded from all the hills of 0.5 m^2 area from two locations per plot. The number of tillers were also recorded. The plots were observed regularly at 10 days interval starting from 15 days after transplanting (DAT) for the presence of silver shoots. The infestation was first observed on 35 DAT and treatments were given on 40 DAT. Then the last observation was taken on 60 DAT.

RESULTS AND DISCUSSION

Results obtained during 2003-2004 showed that when the crop was not given any treatment, i.e. in the control plot, the infestation of gall-midge (% of the silver shoot) increased from 6% at 30 days after transplanting (DAT) to 9.8% at 60 DAT. In *parso* leaf application, the intensity of infestation was reduced from 3.2% at 30 DAT to 2.1 % at 45 DAT and finally to 2.0% at 60 DAT. In carbofuran application, the infestation was reduced from 4% at 30 DAT to 2.0% at 60 DAT.

Mean data of the results obtained during *kharif* 2003-04 and 2004-05 at village Deori (Ranchi) are presented in Table 1.

The pre-treatment data (at 25 DAT) show that all the treatment plots had more or less equal extent of infestation, ranging from 10.1 to 10.9%. At

Table 1. Effect of different treatments on infestation of gallfly-Ranchi

DAT Treatment	Pre-treatment (25 DAT)	30 DAT	45 DAT
T_1: Control	10.1	11.9	14.8
T_2: *Parso* leaves @ 50 kg/ha	10.9	9.0	4.2
T_3: *Parso* leaves @ 100 kg/ha	10.7	8.1	3.5
T4: Carbofuran 3G @ 30 kg/ha	10.8	6.1	3.1

DAT, Days After Transplanting

successive dates of observation, the control plot (T_1) showed a regular increase in infestation percentage, i.e. from 10.1 at 25 DAT to 14.8 at 45 DAT with a mean value of 12.3 during this period. The treatment T_2 showed a decline in infestation from 10.9 at 25 DAT to 4.2 at 45 DAT. Application of *parso* leaves @ 100 kg/ha, showed greater decline in infestation from 10.8 at 25 DAT to 3.6 at 45 DAT and thus proving to be superior to T_2, i.e. when *parso* leaves were applied @ 50 kg/ha. The greatest decline in pest infestation was recorded in carbofuran application (T_4), where the infestation decreased from 10.6% at 25 DAT to 3.1% at 45 DAT.

Data presented in Table 2 show the decrease in infestation percentage at 45 DAT over the respective values at 25 DAT. $T_($ shows an increase of 116.6%. All other treatments showed decrease in infestation percentage, with the lowest (84.9%) in T_2 and the highest (92.0%) in T_4.

Table 2. Decrease/increase in infestation over 25 DAT at Ranchi (mean of 2003 and 2004)

DAT Treatment	Infestation (%) at 25 DAT	Infestation (%) at 45 DAT	Increase/(decrease) (%) over pretreatment (25 DAT)
T_1: Control	3.0	6.5	116.6
T_2: *Parso* leaves @ 50 kg/ha	3.5	0.53	(84.9)
T_3: *Parso* leaves @ 100 kg/ha	3.8	0.38	(90.0)
T4: Carbofuran 3G @ 30 kg/ha	3.5	0.28	(92.0)

DAT = Days After Transplanting

Data presented on Table 3 show the extent of control of gall-midge infestation compared with the control (T_1). At 30 DAT, treatment T_2 shows 42.9% control followed by T_3 (52.4%) and the highest in T_4 (71.4%). The same trend was observed at 45 DAT. The extent of control in T_2 was 91.8% followed by 94.2% in T_3 and the highest of 95.7% in T_4, which indicates that T_4 gave the best control measure. However, T_3, i.e. application *of parso* leaves @ 100 kg/ha with 94.2% control is quite on a par with that of T_4.

Data presented in Table 4 show that in the control (T_1), there was a gradual increase in gall-midge infestation from 6.0% at 30 DAT to 8.3% at 45 DAT and finally to 9.8% at 60 DAT in 2002-03. The same trend was observed in the revalidation trial of 2003-04, where the infestation increased from 3.0% at 25 DAT to 4.2% at 30 DAT and further

Table 3. Extent of control (%) -Ranchi (2003-04)

DAT Treatment	30 DAT	45 DAT
T_1: Control	—	—
T_2: *Parso* leaves @ 50 kg/ha	42.9	91.8
T_3: *Parso* leaves @ 100 kg/ha	52.4	94.2
T4: Carbofuran 3G @ 30 kg/ha	71.4	95.7

DAT, Days After Transplanting

to 6.5% at 45 DAT and 7.0% at 60 DAT. In the next treatment T_2, where *parso* leaves were applied @ 50 kg/ha, the pooled figures of the years 2002-03 & 2004, the infestation decreased from 2.8% at 30 DAT to 1.31 % at 45 DAT and finally to 1.1 % at 60 DAT. The third treatment, T,, i.e. application of *parso* leaves @ 100 kg/ha, was applied only in 2003-04. Here also the infestation shows a decline from 2.0% at 30 DAT to 0.05% at 60 DAT. The maximum decline was observed in carbofruran application (T_4), where the pooled values decreased from 2.6% at 30 DAT to 1.59% at 45 DAT and finally to 1.0% at 60 DAT.

The data presented in Table 5 indicate that gall fly affected shoots increased under control treatment from 3.3% on 25 DAT to 8.4% on 60 DAT. On the contrary in all the treatments where either ITK or carbofuran was used, the gallfly affected shoots decreased. The reduction in gallfly-affected shoots was maximum where *parso* leaf @ 100 kg/ha was applied. Reduction in gallfly-affected shoots was similar in the treatment where either *parso* leaf was applied @ 50 kg/ha or carbofuran was applied @ 30 kg/ha.

The infestation of gall-fly was mild, spanning over a brief period, at Central Research Farm, BCKV. At 60 DAT the average percentage of silver shoots observed in plots treated *with parso* leaves and carbofuran was 1.50% and 1.06% respectively compared with 3.02% in untreated control. However, on the basis of number of silver shoots

Table 4. Infestation (%) of rice gallfly *(Pachydiplosis oryzae)* observed during 2003 and 2004 at Ranchi

Treatment DAT	Infestation (%)									
	25DAT* (Pretreatment data)	30 DAT			45 DAT			60 DAT		
	2004	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean
T_1: Control	3.0	6.0	4.2	5.1	8.3	6.5	7.4	9.8	7.0	8.4
T_2: *Parso* leaves@ 50 kg/ha	3.5	3.2	2.4	2.8	2.1	0.53	1.31	2.0	0.2	1.1
T_3: *Parso* leaves@ 100 kg/ha	3.8	-	2.0	2.0	-	0.38	0.38	-	0.05	0.05
T_4: Carbofuran 3 G @ 30 kg/ha	3.5	4.0	1.2	2.6	2.9	0.28	1.59	2.0	0.01	1.0

*DAT=Days after transplanting

Table 5. Percentage silver shoots (mean of 2 years: 2003-04 and 2004-05) at Ranchi

DAT Treatment	25 (pre-treatment) *	30	45	60
T_1 Control	3.3	5.2	7.5	8.4
T_2 *Parso* leaf @50kg/ha	4.1	2.9	1.4	1.1
T_3 *Parso* leaf @100kg/ha	3.2	2.2	0.5	0.05
T_4 Carbofuran G @30 kg/ha	3.7	2.8	1.7	1.0

*Data pertain to 2003-04 only

Table 6. Gall fly damage, grain yield, additional return and benefitxost ratio in rice- Nadia (2004)

Treatment	Tillers (No./ m^2)	Silver shoots (No./ m^2)	Silver shoots (%)	Grain yield (q/ha)	Additional yield (q/ha)	Additional return* (Rs)	Additional expenditure** (Rs)	Benefit: cost	Net addition return (Rs/ha)
T_1-*Paraso* leaves (100 kg/ha)	407	6	1.50	39.41	1.62	972.00	286.00	3.40: 1	686
T_2–Carbofuran 3G (0.75 kg a. i./ha)	417	4	1.00	41.24	3.45	2070.00	1429.00	1.45: 1	641
T_3: Control	415	13	3.02	37.79	–	–	–	–	–
CD at p = 0.05	4			NS	–	–	–	–	–

*Price of rice–Rs 600/q.

**Cost of treatments: labour charge @ Rs 62.10/day; collection charge of paraso leaves @ Rs 1/kg; carbofuran 3G @ Rs 58/kg.

present/m^2 area in different treatments, both carbofuran 3G (4.0/m^2) and *parso* (6.0/m^2) were superior to the control (13.0/m^2), whose data are presented in Table 6.

Table 6 shows the effect of treatments on yield and benefit: cost. Carbofuran 3G produced highest average grain yield of 41.24 q/ha, followed by *parso* leaves (39.41 q/ha) and control (37.79 q/

Contents

ha). However, the treatments did not differ from the control in grain yield, because gallfly infestation was below the economic threshold level (10% silver shoots) even in untreated control. Carbofuran gave higher additional yield (3.45 q/ha) and additional return (Rs 2,070) but lower net additional return (Rs 641) and benefit: cost ratio (1.45: 1) compared with *parso* leaves (Rs 686/- and 3.4 : 1, respectively).

CONCLUSION

Results of the experiments, conducted both at Ranchi and Nadia revealed that application of *parso* leaves is effective in reducing the damage caused by gallfly in rice. Application of *parso* leaves @ 100 kg/ha was more effective at Ranchi. Although *parso* leaf reduced the number of silver shoots in rice in Nadia, it was not reflected in the grain yield, because the incidence of gallfly was below the economic threshold limit. The effectiveness of *parso* leaf application was similar to the application of carbofuran at both the locations.

□

Code : **368**

Title of the ITK **Management of *gundhi* (harmful green algae) in paddy field by *karada (Cleistanthus collinus)* leaves**

Description of the ITK : *Gundhi (Chard)* which occurs in *kharif* paddy fields in stagnant water, can be controlled by broadcasting 50-100 kg freshly plucked *karada* leaves in August. The algae consumes oxygen from water of the rice field and produces carbon dioxide, which results in yellowing and dwarfing of rice plants. The toxicants present in *karada* leaves damage chlorophyll of green algae. This practice has been in use since time immemorial in Panipila village of Nayagarh district in Orissa.

Name and address of the discloser : Shri M. Mohanty, Senior Research Fellow, Agroforestry Wing, Directorate of Research, Orissa University of Agriculture and Technology, Bhubaneshwar (Orissa) 751003.

Location of use of the ITK : Village Panipaila, block Nayagarh, Nayagarh (Orissa)

Experimenters : Dr (Ms) Mayabini Jena, Senior Scientist, Department of Entomology; Dr R.K.Sarkar, Scientist (Senior Scale) and Dr (Mrs) Padmini Swain (Senior Scientist), Department of Physiology and Biochemistry, Central Rice Research Institute, Cuttack (Orissa) 753 006.

METHODOLOGY

The green algae appears in rice fields in lowland ecosystem. It forms a cushion slowly around the young plant, thereby compressing it and seizing the growth. Tillering and growth of rice plant is affected to such an extent that sometimes the yield loss exceeds 50% or more. *Gundhi* consumes oxygen from rice-field water, adversely affecting respiration of rice plants, which become dwarf with yellowing effect and show reduced tillering.

Gundhi was found to be *Chara* (Division Charophyata, Class Charophyceae, Order Charaleas, Family Characeae). In some places Nitella spp.was found along with it. The algae occurs in *kharif* paddy field during August-September in stagnant water. *Cham* omits foul smell, for which it is known as *gundhi.*

Experiments

Experiments were conducted during the rainy *(kharif)* seasons of 2002,2003 and 2004 to identify the algae occurring at the disclosure site and to carry out experiments both at farmers' fields as well as in controlled condition in the net house of CRRI, Cuttack to validate the efficacy of *karada* against *gundhi*.

At CRRI, two sets of experiments were conducted, i.e. one with five replications with three treatments, viz., application *of karada* leaf @ 350 kg/ha; application of copper sulphate @0.5 g/ replication and untreated control in CRD. Cv Durga was used in the experiment. *Karada* was applied twice at *gundhi* population of 50 g/ replication. Observations were taken after 20 days of each application. Another set of experiment consisted of a series of doses ranging from 1 to 5

Contents

g leaf samples of *karada* applied to the 45 days old potted plants of variety Durga with 50 g *Chara* in each replication with a total number of three replications. Untreated plants with *Chara* were considered as the control. At farmers' fields the experiment was conducted in 10 replications in CRD with three treatments, viz. application of *karada* leaf @ 350 kg/ha; application of copper sulphate @ 100 g/ha and untreated control. *Karada* was applied twice, i.e. at *gundhi* population of 1.5 and 2 kg/ha. Observations were taken after 20 days of each application.

Some physiological and biochemical aspects of the *karada* leaf were studied during 2004 to work out its mode of action, which include measuring the amount of dissolved oxygen through oxygen electrode and analysis of content of chlorophyll in *gundhi* after *karada* treatment @ 350 kg/ha (5g leaves/test tray, each with 250 g *gundhi).* The quantity of phenol present in 5 g leaf sample was also analysed.

RESULTS AND DISCUSSION

Gundhi was identified to be *Chara and Nitella* spp., both present in their vegetative as well as mature stages. In the vegetative stage, they were green and filament type. With the increase of water depth, they also grew like a cushion around the rice plant. But when water level receded, these filaments concentrated to form a layer towards the base of the rice plant and finally remained on the soil. Both the stages gave very foul smell.

Results from both the sets of experiment, i.e. at CRRI and farmers' fields revealed that though one application of *karada* leaves reduced the population to below 50% level, another application was needed after 20 days of first application to make the rice plants completely free from *gundhi.* Accordingly, grain yield was also higher, i.e. 8.45 and 3.65 times more respectively, than the untreated control. Copper sulphate treatment was not found much effective, because the water level was more and the remaining algae multiplied after the first application (Tables 1 and 2).

Results of the experiment conducted at CRRI during 2002 showed that reduction of *Chara* was associated with increasing dose (1-5 g) of *karada* and with time. Reduction of *Chara* was found to be 20% at 3 g leaf treatment, which increased to 40% with application of 5 g at 15 DAT at maturity stage. The vegetative stage of *gundhi* was reduced 100% at 5 g and by 85% in 3 g leaf treatment. *Gundhi* released in glass jars disintegrated, including the control. But *gundhi* established itself in potted plants of rice. It showed reduction of *gundhi* at maturity stage by 20% at 3 g leaf treatment, which increased to 40% in 5 g at 15 DAT. But the vegetative stage of *gundhi* was reduced by 100% in 5 g and by 85% in 3 g leaf treatment.

Results also clearly showed a gradual decrease of dissolved oxygen as well as chlorophyll content in *Chara* after *karada* leaf application. The oxygen content varied from 9.8 mg/litre on first day of treatment (DAT) to 0.7 rug/litre on 4 DAT. Similarly,

Table 1. Effect of *karada* leaf and copper sulphate on gundhi in controlled condition (2003)

Treatment	*Gundhi* (%)		Yield (g/replication)	Relative increase*
	After 1st application	After 2nd application		
Karada (350 kg/ha)	3.2	0.0	125.0	8.5
Copper sulphate (0.5 g)	54.0	37.2	66.0	4.5
Control	110.0	135.0	14.8	1.0

CD at 5% 2.91; *Over untreated control

Contents

Table 2. Effect of *karada* leaf and copper sulphate on *gundhi* in farmers' fields (2003)

Treatment	*Gundhi* (%)				Yield (g/replication)	Relative increase*
	After	1st application	After	2nd application		
Karada (350 kg/ha) g/ha)		24.4		3.2	35.5	3.6
Copper sulphate		57.0		83.8	10.2	1.0
(10 Control		135.6		176.0	9.7	1.0
CD at *5%*		3.39				

*Over untreated control

Fig. 1. Gundhi *(Chara* sp.)

Fig. 2. Gundhi *(Nitella* sp.)

Table 3. Effect of *karada* leaf on oxygen release and chlorophyll content in *gundhi* (2004)

Treatment	Oxygen (mg/litre water) after different DAT					
	4 hr	1 DAT	2 DAT	4 DAT	5 DAT	10 DAT
Rice plant + *gundhi* + *karada* leaf	9.8	6.2	1.0	0.7	0.2	4.2*
Rice plant + *gundhi*	9.9	9.8	9.1	9.6	9.8	8.8
Rice plant	7.9	7.0	7.9	7.3	7.2	6.3
Chlorophyl content (mg/g fresh weight) in *gundhi* after different DAT						
Karada leaf	1.83	1.55	1.40	0.33	0.23	0**
Untreated (rice plant + *gundhi*)	1.83	1.83	1.83	1.82	1.82	1.80

DAT; Days after treatment; *oxygen in water after total death of *gundhi*; **total disintegration of *gundhi*

the chlorophyll content also showed reduction from 1.83 mg/g fresh weight of algae on first DAT to 0. 33 mg on 4 DAT (Table 3).

Biochemical analysis revealed high phenol content of *karada* leaves, which was 16.4 mg/g fresh weight in comparison with 2.3-2.4 mg in rice

leaf. Perhaps this high phenol content is responsible for killing *gundhi* so effectively.

CONCLUSION

Karada leaf proved effective in controlling *Chara* spp, a harmful green algae in rice field and increasing the yield of rice. It is effective due to its efficacy in reducing the chlorophyll content in *Chara,* which may be attributed to high phenol content in *karada* leaf. Application of *karada* at the vegetative stage of *Chara* was relatively more effective.

□

Code	: **170**
Title of the ITK	**Pest management in tomato *(*Lycopersicon esculentum*)* by using leaf extract of Cynodon dactylon**
Description of the ITK	: Root rot and damping off in tomato is controlled by applying *Cynodon* leaf extract. This is applicable only for tomato PKM, 1 (local variety) in Karikuttanoor village district Dharmapuri. Fresh leaves of *Cynodon dactylon (doob* in Hindi, *arugampul* in Tamil) are dried in shade. The dried sample is powdered and then mixed with water and placed in an air-tight mud pot and left undisturbed for 24 hr. This mixture is filtered twice, first using gunny cloth and then with a white cloth. The clear mixture is ready for use. Then 1 litre of this mixture is added to 1 litre water, which is sprayed either by using hand-sprayer or by power sprayer. When tomato seedling is 15 days old, this mixture can be sprayed at frequent intervals until harvest. For 1 acre land, 10 litres of this solution is recommended. Control of root rot and damping will result in good yield. It is best suited only for tomato PKM 1 in *Thaipattam* (January).
Name and address of the discloser	: Shri P. Krishnamoorthy, S/o Shri Perumal, Karikuttanoor, Thirumalvadi, Palacode, Dharmapuri (Tamil Nadu) 636 808
Location of use of the ITK	: Karikuttanoor, Thirumalvadi, Palacode, Dharmapuri (Tamil Nadu) 636 808
Experimenters	Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu) 641 003. Dr S. Palaniswamy, Professor and Head; Dr P. Karuppuchamy, Professor, Department of Agricultural Entomology. Indian Institute of Horticultural Research, Hessaraghatta Lake Post, Bangalore (Karnataka) 560 089: Dr S. Ganeshan, Principal Scientist; Dr Girija Ganeshan, Principal Scientist (Plant Pathology); Dr N.K. Krishna Kumar, Head, Division of Entomology; Dr PN. Krishnamooithy, Principal Scientist (Entomology); Dr Poonam Sinha, Senior Scientist (Plant Pathology).

METHODOLOGY

The study was conducted at Tamil Nadu Agricultural University, Coimbatore and Indian Institute of Horticultural Research, Bangalore.

Experiment

Field experiment was conducted during 2002-03,2003-04 and 2004-05 with 3 treatments, viz. (i) *Cynodon dactylon* extract spray, (ii) endosulfan

35 EC 0.07% spray, and (iii) untreated check. Tomato (variety PKM 1) was raised in 45 m^2 plots in 8 replications. Incidence of pest and yield were recorded.

Preparation of *Cynodon* decoction

Fresh leaves of *Cynodon* were sun dried and powdered. Then 2 kg powder is mixed with 10 litres water in a mud pot and is left for 24 hr. Filtrate obtained is diluted with equal quantity of water and sprayed at 15 days interval until harvest.

Replications: Eight

Date of sowing: 10 April 2004

Date of transplanting: 17 May 2004

Date of spray: 2 July, 16 July and 2 Aug 2004

The transplanting was delayed for 10 days due to continuous rain and hence the farmers were not able to prepare the land.

Date of harvest: 30 August 2004

1. The observations recorded were pre- and post-treatment counts of the larvae per 20 plants on 20 DAT (days after transplanting) and fruit damage, incidence of wilt, leaf curl and fruit rot at 10 days interval from 45 days after transplanting and yield per plot (kg).

Apart from this, laboratory experimentation was also done. Observations were recorded on the number of larvae of *Helicoverpa armigera/20* plants, fruit damage, incidence of wilt, leaf curl and fruit-rot diseases.

RESULTS AND DISCUSSION

Data on laboratory experiment presented in Table 1 show that *Cynodon* extract spray at 7.5

Table 1. Management of *Helicoverpa armigera* in tomato using *Cynadon dactylon* extract (April 2003-March 2004)

Treatment	Larval mortality (%) (after treatment)		
	24 hr	2 days	7 days
Cynadon dactylon 7.5% extract	0.00"	0.20"	0.40"
Cynadon dactylon 10% extract	0.20"	0.60"	0.80"
Endosulfan 0.07%	94.00"	96.00"	96.00"
Untreated check	0.00"	0.00"	0.20[b]

Note: Means followed by a common letter are not significantly different at 5% level

Table 2. Effect of spray of *Cynodon dactylon* extraction on pest incidence and yield of tomato at Coimbatore and Bangalore

Treatments		After I spray		After II spray		After III spray		
	Pre-treatment count	Larvae/ 20 plants	Fruit damage (%)	Larvae/ 20 plants	Fruit damage (%)	Larvae/ 20 plants	Fruit damage (%)	Yield (kg)/ 45 irrplot
				Coimbatore				
Cynodon dactylon leaf extract @ 10%	2.29	2.14	14.08	4.29	8.68	3.00	8.20	106.71
Endosulfan (0.07%)	2.57	1.00	3.02	2.57	5.20	1.14	3.80	114.43
Untreated check	2.57	3.57	22.41	7.29	13.91	3.86	13.62	97.86
				Bangalore				
Cynodon dactylon leaf extract @ 10%	2.00	1.25	8.45	1.62	6.94	2.00	7.64	89.12
Endosulfan (0.07%)	1.75	0.25	5.65	0.25	1.49	0.25	1.60	95.87
Untreated check	2.37	2.00	9.32	2.87	11.51	2.75	11.14	83.75

Table 3. Effect of spray of *Cynodon dactylon* extraction on pest incidence and yield of tomato (mean data of two sites)

Treatment	Pre-treatment count	After I spray		After II spray		After III spray		Yield kg/ 45 m^2 plot
		Larvae/ 20 plants	Fruit damage (%)	Larvae/ 20 plants	Fruit damage (%)	Larvae/ 20 plants	Fruit damage (%)	
		Mean of Coimbatore and Bangalore						
Cynodon dactylon leaf extract @ 10%	2.00	2.14	11.26	2.95	7.81	2.5	7.92	97.91
Endosulphan 0.07%	2.16	0.62	4.33	1.41	2.03	0.69	1.90	105.15
Untreated check	2.47	2.78	15.86	5.08	12.71	3.30	12.38	90.80

Table 4. Incidence (%) of different diseases at Banglore in 2003

Treatment	Wilt	Leaf curl	Early blight	Borer damage	Fruit rot	Yield (q/ha)
Chemical *Cynodon dactylon*	13.42	4.7	43.3	10.74	20.04	121.14
Control	7.40	5.00	51.6	10.93	17.49	124.42
	15.27	5.46	55.8	9.01	18.31	126.83

and 10% was not effective against *Helicoverpa.*

Experiment: The field experiment was repeated in Coimbtore and Banglore.The results are presented in Tables 2. In both the cases results showed that endosulfan at 0.07% was effective against fruit borer. *Cynodon* extract spray was not effective compared with endosulfan treatment. But the pooled results indicate that there was some reduction of fruit-borer incidence due to spraying of *Cynodon dactylon* extract.

In disease management (Table 3) *Cynodon dactylon* extract was little effective in the management of wilt, leaf curl and fruit-root disease. The component of *Cynodon* extract did not show anti-fungal activity in the TLC bioassy carried out in the laboratory. But it had shown reduction of disease compared with uncontrolled chamber.

CONCLUSION

Cynodon dactylon extract was not effective compared with 0.05% endosulfan spray in controlling fruit borer. But *Cynodon* had some effect in reducing the fruit-borer-incidence. In disease management against wilt, leaf curl and early blight, *Cynodon dactylon* extract showed reduction compared with untreated control. □

Code : **366**

Title of the ITK **Use of *kochila (Strychnos nux-vomica)-mixed* cowdung compost in brinjal for controlling fruit and shoot borer**

Description of the ITK : Cowdung, 10 kg *kochila (Strychnos nux-vomica)* seed powder and 25 kg *kochila* leaf are put in a compost pit of 10x3x3 feet by mixing thoroughly.Then 10 litres cow urine is added to the pit for 10 consecutive days and covered with soil. After 2 months the compost becomes ready. This compost (5 g) is added to each plant once at the time of sowing and at 45 days after planting. Due to its repellent action, incidence of shoot and fruit borer is reduced.

Name and address of the discloser : Shri Bivison Pradhan, Badakodanda, Bhanjanagar, Ganjam, (Orissa) 761 126

Location of use of the ITK Badakodanda, Bhanjanagar.Ganjam (Orissa) 761 126

Experimenters OUAT, Bhubaneshwar

1. Dr A.K.Das, Associate Professor, Department of Horticulture, Orissa University of Agriculture and Technology, Bhubnaneshwar 751 003 (Orissa); Shri N. Nayak, Training Organiser, Krishi Vigyan Kendra, Bhanjanagar (Orissa); Shri D. Maohapatra, Training Associate, Krishi Vigyan Kendra, Barachana (Orissa)

2. BCKV, Mohanpur (West Bengal); Dr S.K. Mandal, Professor, Department of Entomology, BCKV, Mohanpur, Nadia (West Bengal)

3. Dr S.K. Naskar, Head, Central Tuber Crops Research Institute, Regional Centre, Bhubaneshwar (Orissa)

METHODOLOGY

Location

The efficacy of *kochila-mixed* cowdung compost for controlling fruit and shoot borer was evaluated by participatory rural appraisal (PRA), field survey and experimental methods. These were conducted at village Badakodanda, Bhanjanagar, dist. Ganjam, Orissa.

Experiment

The experiment was conducted by OUAT at two sites at (i) Badakodanda village, and (ii) KVK, Bhanjanagar, with three treatments:

(i) *kochila-mixed* cowdung compost applied @ 5 g/plant at planting and @ 10 g/plant after 45 days of transplanting (ITK method); (ii) chemical pesticide (granular) at planting @ 10 kg a.i./ha, monocrotophos 15 days after transplanting, endosulfan 15 days after transplanting, Nukil 60 days after transplanting and Sevin-75 days after transplanting; and (iii) without any treatment (control).

The experiment was laid out in CRD with 15 replications. The variety used was Bhanjanagar Local. Observations were taken on: (i) percentage

Contents

Shoot borer in brinjal

Fruit borer in brinjal

of shoot infestation; (ii) percentage of fruit infestation; (iii) fruit weight; (iv) number of fruits/plant; (v) yield of fruits/plant; (vi) fruit taste; (vii) fruit yield/ha; and (viii) marketable fruit yield.

The experiment conducted in 2002-03 was repeated in the village Badakodanda during 2003-04 following the same package of practices. BCKV conducted the experiment in 2004. An additional treatment was imposed with tobacco-soaked water, whereas the three other treatments were the same as that of OUAT. Bioassay of decoction was done at Regional Station of Central Tuber Crops Research Institute, Bhubaneshwar.

RESULTS AND DISCUSSION

During 2003-04 the overall fruit- and shoot-borer incidence was less compared with 2002-03 but

Table 1. Efficacy of *kochila* mixed cowdung compost in controlling brinjal fruit and shoot borer for 2 years at OUAT

Parameter	Treatment										
	Application of *kochila* cowdung compost			Use of recommended practice			Without any control			C.D. (0.05)	
	2002–03	2003–04	Mean	2002–03	2003–04	Mean	2002–03	2003–04	Mean	2002–03	2003–04
Shoot-borer infestation (%)	4.99	2.86	3.92	4.50	2.56	3.53	17.71	10.13	13.92	1.17	0.369
Fruit borer infestation (%)	6.00	3.78	4.89	4.68	3.30	3.99	18.48	11.20	14.84	1.05	0.309
Average fruit weight (g/fruit)	132.52	84.51	108.51	135.08	85.73	110.40	126.48	78.11	102.29	5.27	1.588
No. of fruits/plant	11.74	12.49	12.11	11.80	12.48	12.14	7.80	7.04	7.42	0.48	0.369
Yield of fruits/plant (kg)	1.55	0.86	1.20	1.57	0.84	1.20	1.02	0.57	0.79	0.14	0.040
Fruit taste		*Palatable*			*Palatable*			*Palatable*			
Total fruit yield (q/ha)	270.81	218.92	244.86	272.54	220.97	246.73	181.61	155.85	168.73	0.31	3.879
Marketable fruit yield (q/ha)	253.66	210.70	232.18	262.54	213.73	238.13	150.61	138.29	144.45	21.17	3.951

the trend was maintained in both the years (Table 1). The pooled results (Table 1) revealed that with the use of *kochila* enriched cowdung the incidence was reduced in shoot and fruit borer by 3.92 and 4.89% respectively. The effect *of kochila* compost was at par with the pesticide for fruits/plant, yield of fruits/plant, number of fruits/plant and total fruit yield.

Table 2. Shoot infestation by fruit and shoot borer in brinjal at BCKV

Treatment	Shoot infestation (%)
T_1–*Kochila* compost	3.5
T_2–Tobacco-soaked water	5.48
T_3–Chemcial control	2.53
T_4–Control (no treatment)	8.68
CD (P=0.05)	2.93

At BCKV, all the treatments effectively controlled shoot infestation by fruit and shoot borer (Table 2). On the basis of average percentage of damaged shoots, the chemical treatment was found to be the best (2.53% shoot damage) followed by *kochila* compost (3.5% shoot damage) which were statistically at par with each other. Tobacco-soaked water harboured relatively higher proportion of shoot damage (5.48%). This treatment though differed significantly from the chemical treatment was at par with *kochila* compost.

The ITK treatment of *kochila* cowdung compost although recorded much better and superior performance but was less effective than the pesticide application remaining almost at par. Hence, owing to the fact that the pesticides applied to the crop have residual effects on the fruits and responsible for health hazards, the ITK practice may be preferred. More over the yield per plant and yield per ha under ITK treatment and pesticide schedule treatment in both the years, it showed similar trends.

Bioassay *(in-vitro)* of *kochila-mixed* cowdung compost and tobacco soaked water was carried out on knock-down and mortality of brinjal fruit and shoot borer at Regional Centre of CTCRI, Dumduma, Bhubaneswar, (Orissa), whose results are given in Table 3.

Significant mortality was noticed in *kochila* mixed cowdung compost treatment when compared with control, but it was on par with tobacco-soaked water and chemical control. Results revealed that *kochila-mixed* with cowdung compost used by farmers through generations would be promising for controlling fruit and shoot borer in brinjal.

Table 3. Bioassay of *kochila*-mixed cowdung compost and tobacco water on knock-down and mortality of brinjal fruit and shoot borer *(Leucinodes orbonalis)*

Duration	Mortality (%) of *Leucinodes orbonalis*			
	Control	*Kochila*-mixed cowdung compost extract	Tobacco-soaked water	Chemical control
Knock-down (1 hr)	4.23[a]	71.34[b]	62.11[b]	75.76[b]
1st day	2.12[a]	50.43[b]	43.23[b]	50.12[b]
2nd day	1.00[a]	15.89[b]	15.67[b]	20.23[b]
3rd day	1.00[a]	4.39[b]	3.44[b]	2.10[b]
Cumulative mortality	4.12[a]	70.71[b]	62.34[b]	72.45[b]

Values followed by same letters are not significantly different at *5%* level

CONCLUSION

Use of *kochi la* -mixed cowdung compost reduces the incidence of fruit and shoot borer in brinjal considerably, which also matches with the claim of the discloser. The mixture of tobacco-soaked water with soap was effective in controlling fruit and shoot borer but not as that of *kochila-mixed* cowdung compost. □

Code : **1415**

Title of the ITK : **Control of insect-pests in cucurbits, cowpea and lady's finger by spraying cow urine mixed with tobacco-soaked water**

Description of the ITK : Insect on leaves and fruits of cucurbits, cowpea and lady's finger are very common. These are controlled by spraying urine of domestic animals mixed with tobacco-soaked water. This age-old practice has been adopted by 56% farmers in Bahadurpur village of Dhanbad district of Jharkhand.

Name and address of the discloser : Shri Nepal Chander Ojha,Bhadurpur, Bagsuma, Dhanbad (Jharkkhand)

Location of use of the ITK Village Bhadurpur, post Bagsuma, block Govindpur, Dhanbad (Jharkhand)

Experimenters Birsa Agricultural University, Ranchi

Dr Devendra Prasad, Head, Department of Entomology and Dr Ravindra Prasad, Senior Assistant Professor, Department of Entomology and Dr R.P. Singh 'Ratan', Head, Department of Extension Education, Birsa Agricultural University, Ranchi (Jharkhand)

Orissa University of Agriculture and Technology, Bhubaneshwar

Dr A.K. Das, Associate Professor, Department of Horticulture, OUAT, Bhubaneswar (Orissa) 751 003; Bidhan Chandra, Krishi Viswavidyalaya, Mohanpur, Nadia (West Bengal); and Dr S. K. Mandal, Professor, Department of Entomology.

Central Tuber Crops Research Institute, Regional Centre, Bhubaneshwar, Orissa

Dr S.K. Naskar, Principal Scientist and Head, and Dr K.R. Rao, Scientist (Entomology)

METHODOLOGY

Location

Village Bhadurpur, P.O. Bagsuma, block-Go vindpur, Dhanbad (Jharkhand).

Experiment

To validate the ITK practice, experiments were taken up both in farmers' fields and in research stations or institutes. During 2003-04 and 2004-05 validation of field experiments were taken up in the farmers' fields with three treatments on cucurbits, cowpea and lady's finger. The treatments were:

T_1, control; T_2, use of animal urine mixed with

Contents

tobacco-soaked water @ 25 kg tobacco stalk soaked in water and mixed with 500 litres animal urine/ha; and T_3, application of monocrotophos @ 1.0 litre/ha.

Observations were recorded on the parameters like number of infested fruits and extent of control.

During 2004 the field experimentations were undertaken for cross-sectoral revalidation of the ITK practice comprising same treatments as field validation, and *in-vitro* studies were also taken up. The cross-sectoral validation was done at Orissa University of Agriculture and Technology, Bhubaneshwar (Orissa), Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia (West Bengal) and Birsa Agricultural University, Kanke, Ranchi. The *in-vitro* studies were taken up at CTCRI, Regional Station, Dumduma, Bhubaneshwar (Orissa).

Observations were recorded on insect infestation on the crops, yield, additional return and cost: benefit under different treatments.

RESULTS AND DISCUSSION

The results obtained from the experiments conducted at various centres mentioned earlier were pooled and presented. The results of the effects of different treatments on control of insect-pests, yield and additional return are given in Table 1 for cucurbits, cowpea and okra. In cowpea spraying by insecticide (tobacco+cow urine mixture) was effective in reducing the incidence of fruit borer (8.75 to 14.94%), though the chemical insecticide was most effective. The highest fruit yield (53 to 131 q/ha) was recorded by chemical insecticide, followed by ITK method (51.4 to 105.6 q/ha). These two treatments were superior to the control in all cases.

In cucurbits, the application of chemical insecticide and ITK method were more effective in controlling pod borers than the control. At BCKV, West Bengal the chemical treatment and ITK method were at par. In cucurbits the chemical control was most effective, followed by ITK method in all the cases.

In-vitro studies on the effect of cow urine mixed with tobacco-soaked water and chemical control on the mortality of insect pests of cucurbits, cowpea and lady's finger was done at Regional Center of CTCRI at Bhubneshwar. The *in vitro* bioassay tests revealed that the cow-urine mixed with tobacco-soaked water was equally effective in slowing the knock-down effect and mortality of *Helicoverpa armigera* on bitter gourd lady's finger and *Acyrthosiphum pisum* on cowpea. When compared with the systemic insecticide application, both insecticide and the ITK methods showed very high knok-down effect of the pest, showing that some active principles

Table 1. Fruit damage (%) in lady's finger, cowpea and cucurbits

Parameter	OUAT Bhubaneswar			BCKV, Mohanpur			BAU, Ranchi		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
				Lady's finger					
Fruit infestation	8.5	4.1	2.0	39.5	30.0	27.4	15.7	8.9	3.3
Fruit yield (q/ha)	25.3	42.0	62.3	48.0	65.8	66.2	112.0	135.0	171.0
				Cowpea					
Pod infestation	17.5	8.7	3.1	18.4	14.9	14.0	21.6	10.0	4.1
Pod yield (q/ha)	46.6	62.5	83.9	14.3	51.4	53.0	78.6	105.6	131.0
				Cucurbits					
Fruit infestation	20.0	10.0	4.9	46.7	40.1	39.9	11.9	6.7	2.1
Fruit yield (q/ha)	69.7	96.4	121.6	27.6	45.7	49.5	77.2	117.2	134.5

Table 2. Bioassay of cow urine mixed with tobacco-socked water on mortality of different pests in bitter gourd, cowpea and lady's finger

Crops	Pest	Mortality (%)		
		Cow urine mixed with tobacco-soaked water	Chemical insecticide	Control
Bitter gourd	Fruit borer	79.57	84.31	4.33
Cowpea	Aphid	68.85	59.65	4.33
Lady's finger	Fruit borer	77.97	73.44	5.89

Table 3. Yield and the additional and net economic return in lady's finger, cowpea and cucurbits

Parameter	OUAT, Bhubaneshwar			BCKV		
	T_1	T_2	T_3	T_1	T_2	T_3
		Lady's finger				
Fruit yield (q/ha)	25.3	42.0	62.3	48.0	65.8	66.2
Additional yield (q/ha)	-	16.7	37.0	-	17.8	18.2
Additional expenditure (Rs)	-	1,500.0	1,715.0	-	1,597.0	1,340.0
Additional return (Rs)	-	5,010.0	11,100.0	-	9,376.0	9,555.0
Net return (Rs)		3,510.0	9,385.0		7,779.0	8,215.0
		Cowpea				
Fruit yield (q/ha)	46.62	62.51	83.90	14.36	51.38	52.98
Additional yield (q/ha)	-	15.80	37.20	-	10.02	11.62
Additional expenditure (Rs)	-	1,500.00	1,715.00		1,597.00	1,340.00
Additional return (Rs)	-	3,177.00	7,452.00	-	5,010.00	5,810.00
Net return (Rs)	-	1,677.00	5,731.00	-	3,413.00	4,470.00
		Cucurbits				
Fruit yield (q/ha)	69.7	96.4	121.6	27.6	45.7	49.5
Additional yield (q/ha)	-	26.7	51.9	-	18.1	22.0
Additional expenditure (Rs)	-	1,500.0	1,715.0	-	3,194.0	2,680.0
Additional return (Rs)	-	8,011.0	15,591.0	-	7,252.0	8,800.0
Net return (Rs)	-	6,511.0	13,876.0	-	4,050.0	6,128.0

involved in showing the effect. Tobacco leaf contains nicotine in different forms and it acts systemically on the insects, which proved harmful to many insect pests of different crops. The nicotine in tobacco and some compounds in cow urine showed synergistic effect on the mortality of the pest. The results are substantially superior to the control.

The economics of the different treatments was calculated at two sites (Bhubneshwar and West Bengal). The chemical treatment gave higher net return (Rs 6,128-13,878) than ITK methods (Rs 4,059-6,511) for cucurbits. In lady's finger the highest net return was recorded by chemical control (Rs 8,215-9,385) than ITK (Rs 3,510-7,779). The result on cowpea indicted higher net return in chemical control (Rs 4,470-5,731) than ITK methods (Rs 1,677- 3,413).

Contents

CONCLUSION

The use of animal urine mixed with tobacco-soaked water was found effective in controlling major pests in lady's finger, cucurbits and cowpea. The economic return from ITK is also higher, but not more than from chemical control. □

Code : **1416**

Title of the ITK **Control of insect-pests by spraying starch, animal urine and dusting of cowdung ash in vegetables**

Description of the ITK : The sticky nature of starch and uric acid of animal urine helps in killing the insects. Dusting of cowdung ash helps in controlling the biting and chewing types insects, especially aphids. Rice starch and animal urine are sprayed on vegetable plants. These traditional practices are adopted by 85% farmers in Kurchi village of Dhanbad district in Jharkhand.

Name and address of the discloser : Shri Sitaram Mahto, village Kurchi, block Govindpur, Dhanbad (Jharkhand)

Location of use of the ITK : Village Kurchi, block Govindpur, dist. Dhanbad (Jharkhand)

Experimenters : Birsa Agricultural University, Ranchi
Dr N. Kudada (Assistant Professor-cum-Junior Scientist, Department of Plant Pathology), Dr (Mrs) N. Bara (Scientist, Department of Extension Education), Dr Devendra Prasad (Head, Department of Entomology), Dr Ravindra Prasad (Head, Department of Entomology) and Dr R.P. Singh Ratan (Head, Department of Extension Education)

OUAT, Bhubaneshwar (Orissa)
Dr A.K. Das (Associate Professor, Department of Horticulture in College of Agriculture)

Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia (West Bengal)
Dr S.K. Mandal (Professor, Department of Entomology)

METHODOLOGY

Location: Experiments were conducted at Kharkotoli and Hisalpuri in Jharkand, OUAT Bhubneshwar, and Central Research Farm. BCKVV, W.B. The design was R.B.D. with 10 replications. There were three treatments, viz. T_1, control, T_2, spraying of animal urine mixed with starch, followed by dusting of cowdung ash (@ 500 litres of animal urine mixed with 5 litres rice starch followed by dusting of 40 kg cowdung ash/ha) and T_3, application of monocrotophos @ 1 litre/ ha.The treatments were imposed on tomato and lady's finger at BAU, Ranchi and lady's finger at OUAT, Bhubneswar and bitter gourd and brinjal at BCKVV, W.B.

RESULTS AND DISCUSSION

The results presented in Table 1 show that in tomato the application of insecticide was more effective than ITK but ITK was better than the

Contents

Table 1. Effect of application of starch, animal urine and dusting of cowdung ash vis-a-vis chemical insecticides on insect-pest infestation in vegetables

Treatments	BAU, Ranchi						BCKVV, W.B					
	Tomato			Lady's finger			Bitter gourd			Brinjal		
	Damage (%)			Damage (%)			Damage (%)			Damage (%)		
	No. of fruit	Fruit wt	Fruit yield (q/ha)	Shoot damage	Fruit damage	Fruit yield (q/ha)	No. of fruits plant	Fruit wt plant	Fruit yield (q/ha)	No. of fruit	Fruit wt	Fruit yield (q/ha)
Control	22.5	22.9	142.3	19.4	20.7 (7.9)	74.6 (26.9)	51.7	44.8	12.3	43.8	41.4	97.3
ITK	11.6	6.5	168.8	14.5	10.9 (4.7)	96.9 (41.5)	58.0	46.3	13.2	36.4	34.3	113.3
Chemical insecticide	4.2	2.6	205.3	5.7	4.8 (2.4)	113.9 (53.5)	63.8	48.8	12.7	36.8	40.2	105.6

Figures in parentheses represent data of OUAT, Bhubaneshwar

control. The fruit yield observed at BAU, Ranchi was maximum (205.29 q/ha) in insecticide application than the other treatments. In lady's finger, insecticide spray was more effective than the other treatments, but ITK was better than control in reducing the insect pest. All the treatments were ineffective in bitter gourd. A similar trend was observed by OUAT, Bhubneshwar at BCKVV, W.B. The yield of bitter gourd was very poor due to attack of fruit fly and epilachana beetle. But ITK method was more effective to control the insect pests in brinjal and gave highest yield (113.30 q/ha), followed by chemical insecticide (105.59 q/ha) and control (97.27 q/ha).

CONCLUSION

Spraying of animal urine mixed with starch followed by dusting of cowdung ash to control major insect pests in tomato and lady's finger was effective, compared to control but the application of insecticide was more effective than ITK at BAU, Ranchi. In brinjal the ITK method was more effective than that of chemical insecticide. However, no treatment was found effective in bitter gourd. □

Code	**: 1417**
Title of the ITK	**: Control of shoot and fruit borer through use of tobacco *(Nicotiana tobaccum)* soaked water in brinjal *(Solanum melongena)***
Description of the ITK	: The shoot and fruit borers are very common in Kauwakol, Jorawardih and Mananiyatari villages in Kauwakol block in Nawada district of Bihar. Tobacco is soaked in water in the ratio of 1 : 10 overnight and the extracted liquid is filtered through fine cotton cloth. The filtered material is sprayed either with spray machine or fine broom. Before spraying, 1-2 teaspoonful detergent powder is mixed in the filtered liquid. This is an age old practice by majority of the farmers in these villages.
Name and address of the discloser	Shri Mahavir Singh, village Kauwakol, block Kauwakol, district Nawada 805 106 (Bihar)
Location of use of the ITK	Village Kauwakol, Sokhodeora, block Kauwakol, district Nawada, State Bihar 805 106
Experimenters	Dr S. Choubey, Sr Scientist-cum-Training Organiser, Department of Agronomy and Dr R.P. Singh Ratan, Head, Department of Extension Education, Birsa Agricultural University, Kanke, Ranchi (Jharkhand) 834 006

METHODOLOGY

PRA and field study: Participatory Rural Appraisal (PRA) tools were used covering randomly selected 20 respondents in Kauwakol, Sokhodeora and Tikodih villages of Nawada district to elucidate information on the efficacy of the practice focusing the points such as extent of control, effect on quality, effect on human health and environment and on the yield of the brinjal. Qulk matrix scoring method was applied to know the perceptions of the respondents.

Experiment

Field experiments for validation of the ITK were conducted during 2002-2003, 2003-2004 and 2004 in the months of October to April, August to February and April to December, respectively in three different growing seasons. The experiment was designed in Randomised Block Design (RBD) with 20 replications using three treatments, viz., T_1 control, T_2, spray of tobacco soaked water (1 : 10) and T_3, recommended practice (spray of endosulphan @ 1.0 litre/ha) as chemical insecticide. Each treatment covered an area of 1000 m^2. During 2002-2003 and 2003-2004 the brinjal variety—Pusa Purple Long was used whereas during 2004 variety—Mukta Keshi was used for experimentation.

Seedlings of brinjal were raised in nursery bed by sowing seed @ 600 g/ha during all the 3 years of experimentation. The seed bed was prepared 10' long, 4' wide and 6" raised. Between 2 seed beds two feet wide path was provided for care and management of the nursery plants. About 25 days old seedlings were planted in the 1 st week of November 2002, July 2003 and May 2004 at the spacing of 60 cm row to row and 45 cm plant

Contents

to plant. The crop was fertilized with 85 : 50 : 30 kg NPK/ha. Tobacco stalk @ 60 kg/ha alongwith 40 g/ha detergent powder was used in 600 litre water. Similarly, endosulphan @ 1.0 litre/ha was also sprayed at the same intervals.

The spraying was started after 5-6 weeks of transplanting at an interval of 15 days. However, during 2004 control measures were applied at the intervals of 8-10 days, as the insect infestation was observed during peak of the rainy season. Altogether 5 sprays were done during 2002-03 and 2003-04 whereas 10-12 sprays were done during 2004.

Observations recorded were number of infected shoot/m^2, number of infected fruit/m^2, yield and economics of cultivation and the data statistically analysed.

RESULTS AND DISCUSSION

PRA and field survey: The farmers were of opinion that tobacco stalk is easily available at cheaper rate in the market. It is eco-friendly and has no side effect either on soil or on human health. In most of the houses in villages people use tobacco as chewing purpose and waste product is utilized in controlling the insect pest in brinjal. Hence, no additional monetary involvement is there. That is why they practice this treatment. Data generated through Qulk have been presented in Table 1.

Table 1. Qulk matrix scoring for control of shoot and fruit borer in brinjal through use of tobacco-soaked water

Parameter	Tobacco soaked water	Chemical pesticide
Extent of control	8	9
Effect on quality	8	(–)8
Effect on human health and environment	2	(–)8
Availability	10	4
Cost effectiveness	8	(–)4
Liking of the farmer	10	6
Yield	7	8

Results revealed that application of tobacco soaked water to control shoot and fruit borer in brinjal crop is as good as chemical insecticide endosulphan. Further, tobacco-soaked water has no adverse effect on human health and soil, like chemical pesticides as reported by the respondents.

Experiment

Effect on shoot

Data presented in Table 2 reveal that the lowest insect infestation in shoot (6.2/m^2) was recorded when tobacco-soaked water was used to control the shoot borer and it was at par with the number of shoot (6.4/m^2) infected when chemical insecticide endosulphan was applied to control the same. These treatments were superior over control. These two treatments showed about 63% less insect infestation in shoot than control. However, when individual year data were taken into consideration, it was revealed that due to use of tobacco soaked water and endosulphan, 82.9% and 86.4% respectively less infestation was recorded than control. Results of 3 years indicate that the efficacy of tobacco-soaked water and endosulphan was similar in controlling shoot borer in brinjal.

Effect of fruit

Table 2 also reveals that the lowest insect infestation (4.7/m^2) in fruit was recorded when the crop was sprayed with endosulphan @ 1.0 litre/ha and it was at par with the treatment of tobacco-soaked water. These two treatments were superior over control. The data further indicated that due to application of tobacco-soaked water and endosulphan about 72% less infestation than control was found in brinjal fruit. However, among these two control measures endosulphan was only 2% more effective in controlling fruit borer than tobacco-soaked water. Almost similar trends were observed under individual year data.

Table 2. No. of infested shoot and fruits of brinjal as influenced by different control measures

Treatment	No. of infected shoot/m²				No. of infected fruit/m²			
	2002–03	2003–04	2004	Mean	2002–03	2003–04	2004	Mean
Control	11.2	11.9	28.3	17.1	10.6	11.30	28.50	16.8
Use of tobacco-soaked water (1 : 10)	1.4	2.55	14.5	6.2	1.05	2.30	10.95	4.8
Use of endosulphan @ 1.0 litre/ha	1.2	2.35	15.7	6.4	0.85	2.05	11.25	4.7
CD (P=0.05)	0.32	1.34	9.81	2.16	0.57	2.62	4.08	2.98

Table 3. Yield and economics of brinjal as influenced by different control measures for shoot and fruit borer

Treatment	Yield (q/ha)				Net return (Rs/ha)				Return/rupee spent (Rs)			
	2002–03	2003–04	2004	Mean	2002–03	2003–04	2004	Mean	2002–03	2003–04	2004	Mean
Control	245	156	211	204	33,086	38,400	65,000	45,495	1.84	1.97	2.6	2.14
Use of tobacco-soaked water (1 : 10)	354	278	315	316	1,35,906	97,800	1,12,300	1,15,335	4.31	3.34	3.48	3.71
Use of endosulphan @ 1.0 litre/ha	365	285	318	323	1,39,886	99,950	1,11,500	1,17,112	4.28	3.35	3.35	3.66
CD (P=0.05)	17.4	85.3	15.38	14.9	4,245	27,124	7,690	6,092	0.43	0.69	0.23	0.13

Yield

Data presented in Table 3 reveal that the highest fruit yield (323 q/ha) was recorded with the application of endosulphan which was at par with yield (316 q/ha) obtained with application of tobacco-soaked water and these two treatments were superior over control. These two treatments produced 36.8% and 35.4% more fruit yield of brinjal than control (204 q/ha). However, endosulphan treated crop gave 2.2% more fruit yield than the crop treated with tobacco-soacked water. Similar trends were observed when data of individual year were taken into consideration.

Tobacco-soaked water treated brinjal crop in village Gularia Tari

Economic viability

It is further indicated in Table 3 that the highest net return (Rs 1,17,112/ha) was recorded when the crop was sprayed with endosulphan and it was at par with the net return (Rs 1,15,335/ha) obtained through use of tobacco-soaked water.

The highest return/rupee spent (Rs 3.71) was recorded with the treatment tobacco-soacked water and it was at par with the return/rupee spent (Rs 3.60) obtained with use of endosulphan. These two treatments were superior over control and also gave 42% more return/rupee spent than control. Similar trends were observed under

individual year data. Thus, it seems that both tobacco-soaked water and endosulphan are equally good in controlling shoot and fruit borer in brinjal and economically viable for production of brinjal.

CONCLUSION

Results of the experiments conducted for 3 years reveal that tobacco-soaked water is effective in controlling shoot and fruit borers of brinjal, as claimed by the discloser. □

Contents

Code	**:**	**701**
Title of the ITK	**:**	**Protection of cabbage from pests**
Description of the ITK	:	Cabbage is one of the important cash crops of Shimla district. In cabbage plants a special type of pest spoils the inner portion of cabbage, the cabbage remains loose, and ultimately plant falls down. Ash and cow urine are used to protect cabbage plants from insect pests. This ITK is useful to check insect pests and also to enhance cabbage productivity. Cow urine may have same chemical that may have insecticidal properties.
Name and address of the discloser :		Shri Devkant Prakash, village Bhagheog, P.O. and tehsil Theog, Shimla (Himachal Pradesh) 171 201
Location of use of the ITK		This ITK is prevalent in Theog area of Shimla district in Himachal Pradesh. This area forms a part of high hills temperate wet Himalayan region and lies between the longitudes 77°-0" and 78°-19" east and latitudes 3O°-45" and 31 °-44". This zone is physiographically a mountainous tract with terraces. Mainly dry farming is practised and soil is shallow, silt to loam in texture and acidic in nature. This zone at present contributes to about 96% of the total temperate fruit production. Apple is the most predominant fruit grown in the zone.
Experimenters		Himachal Pradesh University, Shimla 171 005 Dr L.R. Verma, Vice-Chancellor, Shri Chamanlal and Shri Sanjeev Noel, Scientific Assistant, Himachal Pradesh University, Summer Hill, Shimla 171 005, Himachal Pradesh, and Shri Devkant Prakash, village Bhagheog, P. O. and tehsil Theog, Shimla 171 201 (Himachal Pradesh) Indian Institute of Horticultural Research, Bangalore and Dr P Ganeshan and P. N. Krishna Moorty, Principal Scientists, IIHR, Hessargahtta, Lake Post, Banglore 560 089 (Karnataka).

METHODOLOGY

During 2004 at MRDA farm station, Shimla cabbage aphids were collected for carrying out bioassay test and were recorded in pepti-dishes at ambient room temperature and relative humidity, and fed on fresh cabbage leaves in Entomology laboratory of HPU. Aphids were groomed and sprayed with 1 ml of each concentration of the stock solutions (94 ml/ 100 ml water) for insecticidal treatments of phenol, cathnol, 2,5 di phenyl phenol, paracresol, ammonia, urea and uric acid. The treated insects were transferred to separate specimen tubes

Contents

containing untreated cabbage leaves on food. Mortality counts were taken for hour after the treatment. The moribund insects were also counted as dead. The data were statistically analysed by applying analysis of variance and the $LD_{5()}$ values were calculated by using the probit analysis.

Bangalore

During *kharif* 2004 the ITK was revalidated experimentally at IIHR, Bangalore where only cow urine and cowdung ash were tested for their efficacy in reducing the insect pests. Cabbage F hybrid Krishna was planted on 30 May 2004 in plots of 3x3 m with a total cabbage plant population of 24 per plot. On the same day of planting 3 litres fresh cow urine was collected in an earthen pot and buried near the experimental plot. After 1 month, 100 ml of the buried and waine fresh cow urine were tested for their total nitrogen, total protein and albumin at the National Institute of Animal Nutrition and Physiology, Banglore. Cowdung ash was obtained by burning dried cowdung. On the day of the treatments, fresh urine was brought for spray and used. The treatments were: spray of old cow urine and fresh urine at 10, 20 and 30% density, cowdung ash @ 50, 100 and 150 g/plant, sprays of standard insecticides (alimethoate 30 EC@ 2ml/litre to control aphid and the untreated check. The treatments were given thrice, i.e. first on 10 June 2004 when the cabbage plants were having 4-5 leaves and the second on 20 June 2004, i.e. 10 days after the first spray. Observations on the incidence of insect pests were taken up just before the first and second treatments on the same dates. Subsequently four observations were taken at 10 days interval. For this 10 plants from each plot were selected randomly and observed carefully for the pests. On 30 July 2004, the incidence of the cocoons of the larvae parasitoid of diamond back moth, *Costesia plutelae* was also taken. The observation on the incidence of a major pest, stem-borer, causing aborted head formation was taken on 26 June 2004. For this all the plants in each plot were observed and the incidence percentage, was worked out. The toxicity data were also taken and calculated. Cabbage was harvested on 19 August 2004 and the number of healthy cabbage and damaged due to insect pest was counted plot-wise and percentage marketable heads was worked out plot wise. The experiment was conducted in RBD.

RESULTS AND DISCUSSION

Data obtained during 2002 from the experiments conducted in Himachal Pradesh showed that there was significant decline in aphid population in cabbage after 10 days of treatment by aged cow urine. Full control of aphid population was obtained after day 35 in urine treatment. This phenomenon was observed much earlier with higher concentration. There was consistent positive effect in controlling the aphid population and the differences were significant. Almost similar results were obtained with aged urine of cows, buffaloes and sheeps. Fresh urine of all the animals showed relatively less effect than the aged urine. The treatment with 150 g cowdung ash/plant was found to be most effective.

On the contrary, the data obtained from experiments conducted at Banglore during 2004 showed that there was low incidence of aphids during the experimental period. It ranged from 0 to 25 per 10 plants in the control. In the treated plots it ranged from 0 to 336 per plant (Table 1).

The pest was observed only after 20 days of the first treatment. The late and low incidence was due to the continuous rain received during the cropping period. However, cabbage aphid incidence was significantly affected by ash and urine application. The incidence of *Lipaphis erysimi* was also low during the experimental period (Table 2).

There was no significant difference between any of the tertaments during the first three dates of observations. However, on 20 July 2004 the

Table 1. Incidence of cabbage aphid *(Brevicoryne brassicae)* in cabbage under different treatments

Treatment	*Brevicoryne brassicae*/10 plants		
	30 June 04	10 July 04	20 July 04
Cow urine old 10%	0.0 (0.0)	175.0 (3.68)	336.6 (5.57)
Cow urine old 20%	0.0 (0.0)	83.3 (3.21)	153.3 (4.88)
Cow urine old 30%	0.0 (0.0)	25.0 (1.44)	540.0 (5.72)
Cow urine fresh 10%	0.0 (0.0)	51.6 (1.68)	16.6 (1.31)
Cow urine fresh 20%	0.0 (0.0)	0.0 (0.0)	216.6 (3.86)
Cow urine Fresh 30%	0.0 (0.0)	6.6 (1.01)	135.0 (3.38)
Cowdung ash 50 g/plant	20.0 (2.29)	66.6 (1.77)	26.6 (2.39)
Cowdung ash 100 g/plant	20.0 (2.29)	0.0 (0.0)	120.0 (4.48)
Cowdung ash 150 g/plant	0.0 (0.0)	0.0 (0.0)	23.3 (2.33)
Control	0.0 (0.0)	25.0 (1.44)	0.0 (0.0)
Dimethoate spray	33.3 (2.62)	11.6 (1.19)	70.0 (2.57)
CD (P=0.05)	1.66	3.60	3.61

Figures in parentheses are log (x+l)-transformed values

incidence of aphid was noticed only in control plot and it was nil in other plots treated with urine, ash and dimethoate.

Data pertaining to diamond back moth indicated that there was some reduction in the incidence of the insect due to spraying of fresh cow urine, old cow urine and cowdung ash (Table 3). However, the decrease in pest incidence was not uniformly consistent when doses were taken into account. Data on stem borer (Table 4) and percentage of marketable heads as well as mean head weight, (Table 5) were not significantly different in any of the treatments.

The old cow urine spayed at all the three dates showed mild toxicity symptoms of yellow patches and roughness in leaves after the spray. However,

Table 2. Incidence of mustard aphid *(Lipaphis erysimi)* in cabbage under different treatments

Treatment	*Brevicoryne brassicae*/10 plants			
	21 June 04	30 June 04	10 July 04	20 July 04
Cow urine old 10%	33.3 (3.47)	40.0 (2.73)	160.0 (3.76)	0.0 (0.0)
Cow urine old 20%	45.0 (2.81)	45.0 (2.81)	35.0 (2.63)	0.0 (0.0)
Cow urine old 30%	50.0 (2.81)	53.3 (2.88)	36.6 (2.68)	0.0 (0.0)
Cow urine fresh 10%	10.0 (1.14)	16.6 (1.31)	0.0 (0.00)	0.0 (0.0)
Cow urine fresh 20%	43.3 (2.79)	36.6 (2.66)	12.0 (1.79)	0.0 (0.0)
Cow urine Fresh 30%	11.6 (1.19)	41.6 (1.61)	33.3 (1.54)	0.0 (0.0)
Cowdung ash 50 g/plant	33.3 (2.57)	26.6 (3.30)	20.0 (3.04)	0.0 (0.0)
Cowdung ash 100 g/plant	63.3 (3.03)	36.6 (1.57)	33.3 (1.54)	0.0 (0.0)
Cowdung ash 150 g/plant	40.0 (2.73)	83.3 (3.21)	66.6 (3.08)	0.0 (0.0)
Control	20.0 (1.37)	20.0 (1.37)	43.3 (2.68)	516.6 (6.23)
Dimethoate spray	6.6 (1.01)	0.0 (0.00)	23.3 (1.42)	0.0 (0.0)
CD (P=.05)	NS	NS	NS	0.12

Figures in parentheses are log (x+1)-transformed values

Table 3. Incidence of diamond-back moth under different treatments

Treatment	Diamond-back moth/10 plants					
	10 June 04 (pre-treatment)	20 June 04	30 June 04	10 July 04	20 July 04	30 July 04
Cow urine old 10%	2.3	4.3	2.0	7.6	3.3	3.6
Cow urine old 20%	2.3	8.3	2.6	8.0	5.0	3.0
Cow urine old 30%	1.3	6.6	2.0	6.0	2.0	3.6
Cow urine fresh 10%	2.0	7.0	4.3	6.6	7.0	2.3
Cow urine fresh 20%	1.3	6.3	3.3	5.0	6.0	1.6
Cow urine fresh 30%	1.0	5.3	3.0	5.0	5.3	2.0
Cowdung ash 50 g/plant	1.0	8.3	4.3	6.6	7.3	2.3
Cowdung ash 100 g/plant	1.3	7.3	3.3	6.3	4.0	1.0
Cowdung ash 150 g/plant	1.3	5.0	2.6	6.0	3.6	2.6
Control	1.6	7.3	5.6	11.0	14.6	6.6
Dimethoate spray	1.6	7.3	4.3	7.3	4.6	1.3
CD (P=.05)	NS	NS	1.8	2.2	2.5	1.9

the leaves did not show any toxicity symptoms. In addition the plots treated with old cow urine showed low incidence of the larval parasitoides *Protecia plutella* compared with the control (Table 6).

The nutrition status of fresh cow urine and old cow urine was also found out as presented in Table 7.

The nutrient status indicated that old urine has more nitrogen, total protein and albumin content than fresh urine.

Data emerged from experiments conducted in Himachal Pradesh during 2004 revealed that the

Table 4. Stem-borer incidence in cabbage under different treatments

Treatment	Incidence of stem borer (%)
Cow urine old 10%	19.7 (25.33)
Cow urine old 20%	27.0 (31.05)
Cow urine old 30%	23.2 (28.62)
Cow urine fresh 10%	24.2 (29.46)
Cow urine fresh 20%	23.8 (28.84)
Cow urine Fresh 30%	25.0 (29.25)
Cowdung ash 50 g/plant	26.0 (30.51)
Cowdung ash 100 g/plant	25.3 (30.08)
Cowdung ash 150 g/plant	27.0 (31.20)
Control	28.3 (31.98)
Dimethoate spray	27.0 (31.22)
CD (P=0.05)	NS

Figures in parentheses are log (x+l)-transformed values

Table 5. Mean cabbage-head weight under different management practices

Treatment	Marketable heads	Mean head weight (kg)
Cow urine old 10%	45.7 (42.54)	2.02
Cow urine old 20%	48.1 (43.87)	1.40
Cow urine old 30%	45.7 (42.49)	2.82
Cow urine fresh 10%	49.5 (44.74)	1.80
Cow urine fresh 20%	49.6 (44.79)	1.60
Cow urine fresh 30%	49.5 (44.67)	1.60
Cow dung ash 50 g/plant	43.5 (41.24)	1.60
Cowdung ash 100 g/plant	36.8 (37.19)	1.62
Cowdung ash 150 g/plant	36.4 (37.01)	1.84
Control	42.1 (40.33)	1.40
Dimethoate spray	38.5 (38.36)	2.22
CD (P=0.05	NS	NS

Figures in parentheses are log (x+1)-transformed values

Table 6. Plants (%) showing toxicity and incidence of parasitoid ***(Cotesia** plutellae)* under different treatments

Treatment	Plants (%) showing toxicity	*Cotesia*/10 plants
Cow urine old 10%	16.7 (8.67)	0.0
Cow urine old 20%	19.3 (11.00)	0.0
Cow urine old 30%	23.2(15.67)	0.0
Cow urine fresh 10%	0.0	6.3
Cow urine fresh 20%	0.0	1.3
Cow urine Fresh 30%)	0.0	0.6
Cowdung ash 50 g/plant	0.0	5.0
Cowdung ash 100 g/plant	0.0	2.6
Cowdung ash 150 g/plant	0.0	1.3
Control	0.0	13.6
Dimethoate spray	0.0	0.0
CD (P=0.05)	2.47	6.4

Table 7. Nutrition status of fresh cow urine and old cow urine

Parameter	Old urine	Fresh urine
Total nitrogen (mg/100 ml)	508.50	18.00
Total true protein (rng/100 ml)	46.08	20.41
Albumin (mg/100 ml)	2.28	1.65

cabbage aphids mortality with four different concentrations behaved very closely when recorded at 1 and 2 hr after the spray (Table 8).

Relative efficacy of alcoholic excretory waste treatments

On overall basis, the toxicity of alcoholic excretory waste treatments was greater than of the nitrogenous excretory waste treatments, i.e. 40-81 (42.71%) in the former and 31-76 (27.70%) in the latter. In terms of different concentrations of alcoholic excretory waste treatments the order of toxicity was as follows: 100%>75%>50%>25%. The efficacy of treatments at different concentrations was 52.51% at 100%, 47.38% at 75%, 43.38% at 50% and 16.75% at 25%. Among alcoholic excretory waste treatments, the phenol showed 62.79 (79.10%) efficacy, followed by 2, 5-phenyl phenol with 43.61 (56.30%), catechol with 34.50 (32.10%) and by paracresol with 17.32 (8.85%) efficacy. On overall basis the order of toxicity was phenol>2,5 phenyl phenol> catechol>paracresol. Higher concentrations of all the treatments provided statistically ($P<0.05$) better control than their lower concentrations. The 100% and 50% concentrations of phenol were statistically at par in their efficacies. Statistically similar trend was found with 75% and 50% concentrations of catechol, 100% and 75% concentrations of 2, 5-diphenyl phenol and para-cresol. Statistically significant differences were found among all the treatments.

Relative efficacy of nitrogenous excretory waste treatments

Among nitrogenous excretory waste treatments, the toxicity was in the order: ammonia (51.05 or 60.50%) > urea (44.22 or 48.64%) > uric acid (9.00%). On overall basis, among nitrogenous excretory waste treatments the order of toxicity with different concentrations was: 38.07 (38.02%) with 100%, 32.89 (29.48%) with 75%, 31.92 (29.95%) with 50% and lastly 24.15 (16.75%) with 25%. Among the different

A healthy cabbage

Table 8. Relative bio-efficacy of same ingredients of cow-urine against cabbage aphid *(Brevicoryne brassicae)*

Treatment	Mortality count of cabbage aphid population (out of 10 aphids in each petri-dish)		
	Concentration (%)	1 hr after spray	2 hr after spray
Phenol (4 ml/100 ml of water)	100	8(10)	8(10)
	75	8(10)	8(10)
	50	8(10)	9(10)
	25	7(10)	7(10)
Catechol (4 ml/100 ml water)	100	5 (10)	5 (10)
	75	3(10)	3 (10)
	50	3(10)	3(10)
	25	2(10)	2(10)
2, 5-Phenyl phenol (4 ml/100 ml water)	100	6(10)	6(10)
	75	6(10)	6(10)
	50	5(10)	6(10)
	25	5(10)	5(10)
Paracresol (4 ml/100 ml/water	100	2(10)	2(10)
	75	2(10)	2(10)
	50	1 (10)	2(10)
	25	0(10)	0(10)
Ammonia (4 ml/100 ml water)	100	8(10)	8(10)
	75	6(10)	6(10)
	50	6(10)	6(10)
	25	4(10)	4(10)
Urea (4 ml/100 ml water)	100	6(10)	6(10)
	75	5(10)	6(10)
	50	5(10)	5(10)
	25	3(10)	3(10)
Uric acid (4 ml/100 ml water)	100	0(10)	0(10)
	75	0(10)	0(10)
	50	0(10)	0(10)
	25	0(10)	0(10)

concentrations of nitrogenous excretory waste treatments, the order of toxicity was: 100%>75%>50%>25% (Table 9).

The 100% concentration of ammonia provided statistically better control in comparison with other treatments. The 75% and 50% concentrations of ammonia and 100% concentration of urea were statistically equally effective. The treatment differences were highly significant ($P<0.01$) among the rest of the treatments.

On overall basis, all the treatments showed the efficacy or toxicity level as: Phenol>ammonia>2, 5-phenyl phenol>urea>catechol>paracresol> uric acid.

Estimation of $LD_{S(}$ values

Probit analysis for the toxicity of different pesticides was undertaken on cabbage aphids *(B.brassicae)*.The estimated probit equation is presented in Table 10 along with log $LD_{50}$and LD_{50} values.

Table 10 shows that phenol was the most effective pesticide with a $LD_{50}$of only 0.703. 2,

Table 9. Relative efficacy of alcoholic and nitrogenous excretory waste products of cow urine against cabbage aphids *(Brevicoryne brassicae)*

Treatment	Concentration *(%)"*■				
	100	75	50	25	Mean
Alcoholic excretory waste products					
Phenol	63.43	63.43	67.50	56.79	62.79
Catechol	45.00	33.21	33.21	26.57	34.50
2, 5 di-phenyl phenol	50.77	50.77	47.89	45.00	48.61
Paracresol	26.57	26.57	16.15	0.00	17.32)
Mean	46.44	43.50	41.19	32.09	40.81
Nitrogenous excretory	waste products				
Ammonia	63.43	50.77	50.77	39.23	51.05
Urea	50.77	47.89	45.00	33.21	44.22
Uric acid	0.00	0.00	0.00	0.00	0.00
Mean	38.07	32.89	31.92	24.15	31.76

Table 10. Estimation of LD_{S0} values of some of the ingredients found in cow urine against cabbage aphid through Probit analysis

Treatments	P = a + bx	$LogLD_{50}$	LD_{TO}(inml/100ml of distilled water)
Phenol	P = 5.70 + 4.57 x	-0.1532	0.703
Catechol	P = 4.26+ 1.32 x	0.559	3.624
2, 5-phenyl phenol	P = 4.99+ 0.511 x	0.020	1.047
Paraceresol	P = 3.01 +2.08x	0.956	9.031
Ammonia	P = 4.94 + 1.056 x	0.055	1.136
Urea	P = 4.58+ 1.38 x	0.304	2.014
Uric acid	PI.13 + 3.81 x	1.017	10.398

P = Probit, P = a + b × is the probit equation, × = $\log_{10}$ dose
LD_{50} (lethal dose) to kill 50% cabbage aphid population

5-diphenyl phenol and ammonia were also somewhat closer to phenol for making an effective kill (50%) of cabbage aphids.However, paracresol and uric acid required a much higher concentration to achieve the same toxicity levels. Catechol and urea were of intermediary category. Further, the LD_{50} doses of these pesticides except paracresol and uric acid are quite within safe range and are not likely to cause any environmental degradation. Therefore, these safer pesticides may be advocated for adoption under field conditions.

These findings, show a strong indication of effectiveness of cow urine compared with other treatments. The performance of cow urine has been due to phenol, paracresol, catechol, orcinol, halogenated phenol and 2, 5-phenyl phenol, etc. which are known to be antibacterial, antifungal and antibiotic which might be insecticidal in view of these findings.

CONCLUSION

The results of the study conducted in Himachal Pradesh during 2002 showed that cow urine

treatments is effective in controlling aphid in cabbage. Application of cowdung ash and fresh urine treatments took a little longer time for pest eradication than the aged urine. The treatments with cow urine (30 and 100% concentration) were more effective than those of 10 and 20% respectively. All the urine types (cow, buffalo and sheep), whether fresh or aged, showed nearly similar effects for similar concentration levels without any significant difference. Treatments with 150 g ash per plant was most effective compared with other quantities used and neither cattle urine nor cowdung ash showed any marked effect on the growth of cabbage plant. However, the results of the study conducted at IIHR, Banglore revealed that the ITK was not effective in reducing the aphid population in cabbage, the effect being inconsistent and sporadic perhaps due to receipt of continuous rains during growth period of crop.

Literature showed that cow urine contains other ingredients like allantion, allantoic acid, hippuric acid, creatine, amino acids like glycine, arginine, methionin, etc. creatinine, carbonic acid, carbonates, bicarbonates, inorganic salts, agglutinins, precipitins, DHEA, natural cortisone, urine peptides, vitamins (A, B, C, D and E), malic acid, citric acid, tetris, succeneic acid, hiperic acid, some hormones and enzymes, etc. which might have certain additive or synergistic effect and these ingredients might have influenced the results obtained at Shimla.

The nutritive status of old and fresh cow urine indicated that old urine had more nitrogen, total protein and albumin compared with fresh urine. The overall order of toxicity at 100% concentration was: phenol > ammonia > 2, 5 di-phenyl phenol> urea > catechol > paracresol> uric acid and at 25% concentration it was: phenol > 2, 5 di-phenyl phenol > ammonia > urea > cathenol > para cresol > uric acid.

Code	**: 141**
Title of the ITK	**: Control of rhinocerous beetle in coconut by using cowdung slurry**
Description of the ITK	: Cowdung slurry in wide-mouthed vessel is kept at ground level under coconut plantations to trap the rhinocerous beetle *(Oryctes rhinocerous).* This practice is in use for the last five years by the coconut growers of Thummanayakakanpatty village in Madurai district of Tamil Nadu
Name and address of the discloser	Mr M. Jagadeesan S/o Mr C. Muniyandy, South street, Chelaimalaipatty, Thumamanayakakanpatty, Peraiyur, Madurai 626 703, Tamil Nadu
Location of use of the ITK	Thummanayakakanpatty, Peraiyur, Madurai 626 703, Tamil Nadu
Experimenters	Dr K. Koodalingam, Professor (Breeder Seeds), Centre for Plant Breeding and Genetics, Sugarcane Research Station, Melalathur, Gudiyathum 635 806, Tamil Nadu and Dr K. Rajamanickam, Associate Professor of Entomology, Coconut Research Station, Aliyar Nagar 642 101, Tamil Nadu Agricultural University, Pollachi, Coimbatore, Tamil Nadu

METHODOLOGY

In the third phase, four trials were conducted at Nangegoundanpur, Thensangam-palayam, Angalakurchi and Thengaiparai villages at Pollachi between January-December 2004. The treatments included in the study are: T_1 cowdung slurry @5 kg/2 litre water, T_2: cowdung slurry @ 5 kg/4 litre water: T_3 cowdung slurry @ 5kg + @ 100g/2 litre water, T_4: recommended practice: castor cake @ 2.5 kg/one litre water, T_5: untreated check: 5 litre water alone in pot.

Wide-mouthed pots (24 cm width x 30 cm height x bottom width 27 cm) were used to trap insects for different treatments.

Observations on trapped rhinocerous and scarabeid beetles on fortnightly basis were collected.

RESULTS AND DISCUSSION

In all the locations, cowdung slurry and fishmeal powder (T_3) attracted more rhinocerous beetles. Castor cake suspension (T_4) recorded equal performance in controlling insects as that of cowdung slurry and fishmeal powder. Castor cake suspension (T_4 was found superior in mass trapping of scraboid beetles (19 to 74) followed by cowdung slurry and fishmeal (T_3) that ranged from 15 to 67. The results are presented in Table 1.

CONCLUSION

Setting up wide-mouthed pots containing cowdung slurry @ 5 kg + 100 g dried fish meal powder placed at ground level attracted adult rhinocerous beetles up to 29 followed by cowdung slurry @ 5 kg with 2 litre water (18). Castor cake

Contents

Table 1. Number of Rhinoceros and Scrabeid beetles trapped by the treatments at different locations

Location: Nangegoundanpur, Pudur East Garden

Treat No.	1.01.04 to 15.1.04		16.01.04 to 30.1.04		1.2.04 to 15.02.04		16.02.04 to 28.02.04		01.03.04 to 15.03.04		16.03.04 to 30.03.04		01.04.04 to 15.04.04		16.04.04 to 30.04.04		1.05.04 to 15.05.04	
	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB
T_1	2	9	4	10	3	5	2	6	2	3	5	3	-	2	-	1	1	2
T_2	1	7	1	3	2	4	5	6	2	4	2	5	-	1	-	1	-	1
T_3	3	10	3	12	1	4	7	9	5	5	5	8	1	2	2	2	-	2
T_4	4	15	5	8	2	7	5	10	6	8	6	3	2	6	3	6	7	6
T_5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Treat No.	16.05.04 to 31.05.04		1.06.04 to 15.06.04		16.06.04 to 30.06.04		1.07.04 to 15.07.04		16.07.04 to 30.07.04		1.08.04 to 15.08.04		16.08.04 to 31.08.04		1.09.04 to 15.09.04		16.09.04 to 28.09.04	
	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB
T_1	1	2	-	1	-	2	2	1	1	5	1	2	2	3	-	3	1	3
T_2	1	2	-	2	-	1	-	1	2	3	1	1	1	2	-	4	1	2
T_3	1	2	-	2	1	3	-	1	5	9	1	7	1	3	2	4	3	3
T_4	1	2	7	3	2	1	3	1	4	3	2	9	2	6	2	3	3	3
T_5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Location: Thengaiparai

Treat No.	1.01.04 to 15.1.04		16.01.04 to 30.1.04		1.2.04 to 15.02.04		16.02.04 to 28.02.04		01.03.04 to 15.03.04		16.03.04 to 30.03.04		01.04.04 to 15.04.04		16.04.04 to 30.04.04		1.05.04 to 15.05.04	
	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB
T_1	3	10	5	9	2	11	3	7	3	5	2	7	-	-	-	1	1	2
T_2	2	7	1	9	2	5	3	9	2	2	1	1	-	-	-	-	-	-
T_3	3	13	4	12	6	15	4	8	7	10	5	14	1	2	1	2	1	1
T_4	7	15	5	20	5	10	3	5	5	12	7	12	1	3	1	3	2	4
T_5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Treat No.	16.05.04 to 31.05.04		1.06.04 to 15.06.04		16.06.04 to 30.06.04		1.07.04 to 15.07.04		16.07.04 to 30.07.04		1.08.04 to 15.08.04		16.08.04 to 31.08.04		1.09.04 to 15.09.04		16.09.04 to 28.09.04	
	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB
T_1	1	4	2	3	1	3	1	1	-	1	1	2	1	2	1	3	-	3
T_2	1	5	-	2	1	2	-	-	-	1	1	2	-	4	-	1	-	-
T_3	2	6	1	3	1	4	1	1	1	2	1	3	1	3	1	4	1	2
T_4	2	5	2	3	1	3	1	2	1	3	2	5	1	4	1	3	1	2
T_5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Contents

Location: Angalakurichi

Treat No.	1.01.04 to 15.1.04		16.01.04 to 30.1.04		1.2.04 to 15.02.04		16.02.04 to 28.02.04		01.03.04 to 15.03.04		16.03.04 to 30.03.04		01.04.04 to 15.04.04		16.04.04 to 30.04.04		1.05.04 to 15.05.04	
	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB
T_1	1	8	1	4	1	5	1	4	2	2	1	4	-	3	-	4	-	1
T_2	-	2	-	3	1	4	-	3	1	3	1	4	-	-	-	-	-	-
T_3	1	7	2	5	1	6	3	8	3	3	2	2	-	2	1	3	1	1
T_4	2	9	3	7	2	4	3	10	2	6	2	3	1	3	1	4	1	5
T_5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Treat No.	16.05.04 to 31.05.04		1.06.04 to 15.06.04		16.06.04 to 30.06.04		1.07.04 to 15.07.04		16.07.04 to 30.07.04		1.08.04 to 15.08.04		16.08.04 to 31.08.04		1.09.04 to 15.09.04		16.09.04 to 28.09.04	
	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB
T_1	1	2	1	1	1	2	-	-	-	1	1	1	-	1	1	2	-	1
T_2	-	2	1	3	1	4	-	-	-	-	-	-	-	1	1	2	-	1
T_3	1	2	-	-	2	1	-	1	1	2	1	2	1	2	1	3	-	2
T_4	1	8	1	8	3	1	1	2	1	2	1	3	1	3	1	2	-	3
T_5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Location: Thensangampalayam

Treat No.	1.01.04 to 15.1.04		16.01.04 to 30.1.04		1.2.04 to 15.02.04		16.02.04 to 28.02.04		01.03.04 to 15.03.04		16.03.04 to 30.03.04		01.04.04 to 15.04.04		16.04.04 to 30.04.04		1.05.04 to 15.05.04	
	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB
T_1	1	7	2	5	3	8	2	5	2	5	6	12	-	-	1	2	-	4
T_2	-	4	1	5	2	6	1	7	2	8	6	3	-	-	-	-	-	2
T_3	2	13	3	12	4	10	2	7	3	8	8	6	1	1	1	3	1	5
T_4	3	15	4	10	5	12	2	13	4	6	6	12	1	1	1	4	1	7
T_5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Treat No.	16.05.04 to 31.05.04		1.06.04 to 15.06.04		16.06.04 to 30.06.04		1.07.04 to 15.07.04		16.07.04 to 30.07.04		1.08.04 to 15.08.04		16.08.04 to 31.08.04		1.09.04 to 15.09.04		16.09.04 to 28.09.04	
	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB	RB	SB
T_1	1	3	1	4	1	5	-	1	-	1	-	3	1	2	1	2	1	1
T_2	-	3	1	4	1	2	-	-	-	-	-	-	-	2	1	3	1	2
T_3	-	2	1	6	2	5	1	2	1	2	1	2	-	1	1	6	1	2
T_4	1	5	1	5	2	5	1	3	1	2	1	2	1	3	1	5	1	3
T_5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

RS, Rhinocerous beetle; SB, Scrabeid beetle

Contents

suspension @ 2.5 kg + 2 litre water attracted highest number of adult beetles (32). Cowdung slurry in semi-solid form was effective in emanating odour compared with the watery state. Red palm weevil, black headed caterpillar and other coconut pests were not attracted due to the above treatments. It can be concluded that the cowdung slurry, dried fish meal powder and castor cake can be explored as components in integrating pest management in coconut ecosystem. □

Contents

Code	**370**
Title of the ITK	**Sprouting in yam by cowdung slurry**
Description of the ITK	Tuberous roots of yam are divided into many pieces, weighing 150 to 200 g dipped in freshly prepared cowdung slurry, dried in shade and kept in sand for sprouting. This results in sprouting within 5-6 days, giving 100% germination. Application of cowdung slurry prevents the entry of micro-organisms, loss of moisture from the cut ends and supply the nitrogen required during initial stages. By this practice the farmers get additional income of Rs 10,000/acre over planting only tops of the tuber. It is being followed by almost all the yam-growing farmers in Benakunda village of Ganjam district in Orissa.
Name of the discloser	Shri Narendra Bisoyi, C/o Binayak Bisoyi, Bhanjanagar, Ganjam (Orissa) 761 126
Location of use of the ITK	Village Benakunda, Bhanjanagar, Ganjam, (Orissa) 761 126
Experimenters	Dr S. K. Naskar, Principal Scientist; Shri P. Sethuraman Sivakumar, Scientist (Agricultural Extension) and Dr R. C. Ray, Principal Scientist, Regional Tuber Crops Research Centre, Bhubaneshwar 761 126 (Orissa)

METHODOLOGY

Efficacy of cowdung slurry in inducing sprouting of yam was evaluated through field study and experimental methods during 2002-2004. The results obtained through field study and experimental data generated up to 2003 have been reported earlier in *Document-3* of the project publication. Continuation of the experiment has resulted in conducting in-depth studies, whose results are presented in this publication.

For determining the efficiency the details of the methodologies of the experiments conducted at the Regional Centre of Central Tuber Crops Research Institute, Bhubaneshwar, (Orissa) and farmers' fields are presented here.

Sprouting and yield of tubers

The experiments were conducted with 3 treatments, viz. (i) ITK method (treatment with fresh cowdung slurry),'(ii) recommended practice (treating with 0.05% Bavistin) and (iii) control (no treatment). Sprouting behaviour was studied at the Research Centre and under on-farm conditions (at Bhanjanagar) with 3 replications and 36 tubers in each replications. Cowdung used

Fig. 1. Farmers showing sprouted yam tubers

Fig. 2. Treated yam setts spread on the moist sand for sprouting

during 2002-03 contained 0.30-0.45% nitrogen, 0.15-0.25% phosphorus, 0.05-0.15% potassium and 14.6% total organic material, and that used during 2003-04 contained 0.62% nitrogen, 0.30% phosphorus, 0.53% potassium and 28.6% total organic material.

Sprouting under controlled conditions

Experiments with various conditions of organisms, isolated from cowdung; unsterilized and sterilized cowdung were conducted to study its effect on sprouting behaviour. Three replications were used with 36 tubers in each replication. The microorganisms were inoculated with the spore concentration of 2x 10^6 forming units (CFU) per liter. The isolates were identified at the Institute of Microbial Technology, Chandigarh. Biochemical changes occurring during sprouting with relation to phenol, reducing sugar, total sugar and protein were assessed following standard methods.

Post-harvest tuber rot

Dioscorea (yam) tubers were subjected to storage and natural rotting. The rotted tubers were planted in petri plates on potato dextrose agar medium under aseptic conditions. The causal organisms were transplanted to PDA slants. The cultures were again plated and re-isolated. The pathogenicity of rotting organisms was confirmed by inoculation on healthy tubers, for identical symptoms. Soil samples were also subjected to serial dilution agar planting to detect the presence of rotting pathogens.

One antagonistic experiment was conducted in order to study the inhibitory effect of bacteria and actinomycetes, isolated from the cow dung, against rotting pathogens. The test organisms were inoculated alongwith the individual rotting fungus in PDA petri dishes.

RESULTS AND DISCUSSION

Sprouting of yam setts was higher when treated with fresh cowdung slurry under both on-farm (100%) and research station (92%) situations (Table 1).

In contrast, the application of Bavistin + ash resulted in sprouting of 78% and 84% under on-farm and research station conditions respectively. Sprouting of all the 36 setts was achieved in 35 days when the setts were treated with fresh cowdung slurry, which was 97% with chemical method (Table 2). About 81% setts were sprouted in 35 days when no treatment was imposed.

Table 1. Effect of fresh cowdung slurry on sprouting of yam setts in 2002-03

Treatment	Sproutin g(%)	
	Bhanjanagar (on-farm)	Bhubaneswar (research [illegible])
Cowdung slurry	100	92
0.05%Bavistin and ash	78	84
Control (no treatment)	76	62

Yield

Early sprouting, facilitated by application of fresh cowdung slurry, resulted in obtaining higher yield of tubers both at research station and at farmers' fields (Table 3).

Higher yield was, however, obtained under on-farm conditions. Yield of the setts treated with Bavistin was similar to that obtained without any

Table 2. Sprouting behaviour of yam tubers (Bhubaneshwar, 2003-04)

Treatment	Sprouting (%)					
	10th day	15th day	20th day	25th day	30th day	35th day
Fresh cowdung slurry	13.9	36.1	77.8	91.7	97.2	100.0
0.05% Bavisitin	11.1	19.7	69.4	83.3	94.4	97.2
Control	0.0	8.3	50.0	69.4	75.0	80.5

Table 3. Yield of tubers (n=48, average of two years)

Treatment	Bhubaneshwar	Bhanjanagar
Fresh cowdung slurry	73.44	81.6
0.05% Bavisitin	62.40	72.00
Control	60.00	70.80

treatment through Bavistin helped the setts sprout earlier.

There was no incidence of disease in yam at both research centre and farmers' fields during both the years studied.

Inoculation effect on sprouting

Results obtained on the effect of inoculation on sprouting of yam are given in Table 4. About 97% of the treated tubers sprouted on 20th day after inoculation with SI04 micro-organism, which was 100% on 30th day.

Unsterilized fresh cowdung helped in better sprouting (97% on 30 th day) over the sterilized treatment, observed on different days, indicating the role of micro-organisms present in fresh cowdung. Effect of other bacteria and actinomycetes strains was less effective.

Phenol content with days of treatment: With increasing days of treatment, phenol content of tubers decreased. T recorded lesser phenol content whereas T_4 recorded the maximum compared with other treatments. All the treatments recorded maximum phenol content at day '0'.

Reducing sugar (RS) and total sugar (TS): With the increasing days of treatment, the amounts of reducing sugar and total sugar were decreased. All the treatments recorded maximum RS and TS content at the first day of treatment. Content on 30th day, lowest RS content (71 ug/g fresh weight) was recorded in T_5.

Protein content: With the increase in days of

Table 4. Sprouting behaviour of yam (Bhubaneshwar 2003-04)

Treatment	Sprouting (%)					
	10th day	15th day	20th day	25th day	30th day	35th day
Unsterilized fresh cowdung	19.44	41.66	86.10	94.44	97.22	97.22
Sterilized fresh cowdung SIOI	13.88	36.10	77.77	80.55	86.10	86.10
Bacillus subtilis SI02	11.10	36.10	63.88	72.22	80.55	83.33
Bacillus subtilis SI04	5.53	25.00	47.22	63.88	72.22	75.00
Bacillus subtilis SI05	22.22	52.77	97.22	97.22	100.00	100.00
Alcaligena latus	13.88	36.10	69.44	83.33	83.33	83.33
Untreated tuber	5.55	22.22	55.55	69.44	72.22	72.22

treatment, protein content of tubers increased for all the treatments. Among the treatments, T_5 recorded highest protein content (262 ug/g fresh weight).

Post-harvest tuber rot

Five major pathogens that caused post-harvest rotting of dioscorea (yam) were identified. Of the five, four fungal pathogens, viz. *Sclerotium rolfsii, Botryodiplodia theobromae, Fusarium* and *Rhizopus* species caused considerable damage *o seed tubers of yam. One bacterial pathogen *Erwinia carotovora* was also found to cause damage to yam tubers.

The reduction (%) in growth over the control was calculated on 3rd and 5th days and is presented in Table 6.

It is evident that all the 4 cultures studied inhibited the growth of the pathogens tested *in vitro.*

CONCLUSION

Application of fresh cowdung to the cut tubers induced early sprouting. There was not much difference in sprouting behaviour beyond 30 days, and hence yam sets can be kept in nursery not more than 30 days before planting in the main fields. Results of the study also indicate that enhancement of early sprouting is due to nutrients, organic matter content of cowdung as well as effect of bacteria and actinomycetes present in the cowdung. The micro flora present in the cowdung and inoculation with three bacteria strains and one actinomycete isolated from cowdung reduced the phenol content in the tuber that is toxic for sprouting and helps in enhancing it. However, sprouting is inversely related to phenol content. Further, in the treated tubers the protein content was high, resulting to increased enzymatic activity in tubers during germination process. One bacterium strain of *Bacillus subtilis* (S104) found to induce early sprouting as well 100% sprouting than other treatment. The additional nutrient in the cowdung accelerated the

Table 5. Biochemical changes occurring during sprouting of greater yam tubers

Treatment	Phenol (µg/g fresh weight)				Reducing sugars (µg/g fresh weight)				Total sugars (µg/g fresh weight)				Protein (µg/g fresh weight)			
	0	10	20	30	0	10	20	30	0	10	20	30	0	10	20	30
Unsterilized fresh cowdung	29.00	15.0	5.0	5.0	130	100	80	76	224	182	145	130	152	200	240	250
SIO1 *Bacillus subtilis*	29.00	17.0	7.0	7.0	130	103	88	80	224	188	155	145	152	175	202	210
SIO2 *Bacillus subtilis*	29.00	19.0	8.0	8.0	130	104	95	90	224	193	160	148	152	185	201	207
SIO4 *Bacillus subtilis*	29.00	14.0	4.0	4.0	130	99	82	71	224	185	140	132	152	205	250	262
SIO5 *Alcaligena latus*	29.00	19.0	6.0	6.0	130	105	100	96	224	200	150	141	152	175	206	211
Untreated tuber	29.00	20.0	9.0	8.0	130	112	104	95	224	196	156	138	152	192	210	225
Total	203	117	45	43	910	725	643	593	1.568	1.329	1.054	969	1.064	1.337	1.534	1.605
Mean	29.00	16.71	6.42	6.14	130	103.57	91.85	84.71	224	189.85	150.57	138.42	152	219	219	229

Table 6. Reduction (%) in growth of rotting fungus in dual plants over control

Pathogen	Reduction (%) over control							
	Organism-1		Organism-2		Organism-3		Organism-4	
	3rd day	5th day	3rd day	5th day	3rd day	5th day	3rd day	5th day
Sclerotium rolfisii	31.25	53.06	2500	46.93	18.75	36.73	34.37	40.81
Botryodiplodia theobromae	*44.11*	62.06	39.47	36.20	31.57	41.37	23.68	56.89
Fusarium sp.	58.62	59.18	31,03	30.61	55.17	32.65	20.68	28.57
Rhizopus sp.	36.84	45.83	34.21	56.94	42.10	54.16	26.31	56.94

sprouting process and the organic matter present in the cowdung absorbed more moisture and prevented water loss. Thus it helps in maintaining moisture status in the tuber required for sprouting. In addition, *Bacillus subtilis* strain and actinomycetes have the property of controlling disease and fungal pathogens. They reduce the disease incidence during sprouting the antagonistic effect of three *Bacillus subtilis* strains, as actinomycetes strain against four fungal diseases, viz., *Sclerotium rolfisii*, *Botryodiplodia theobromae*,. *Fusarium* sp. and *Rhizopus* sp. was confirmed by *in-vitro* study.

Code	**: 403**
Title of the ITK	**: Off-season flowering in guava**
Description of the ITK	: The farmers bend down the branches of guava about 45 to 60 days before flowering in 3 to 8 years old plants. The branches are bent towards outer periphery to open the centre and allow penetration of sunlight. After 25 to 30 days, new shoots emerge from the bent portion, which bear profuse flowers. This practice results in 39% increase in flowering in early summer and 28% increase in late autumn. Off-season flowering fetches Rs 590 to Rs 600/plant, instead of Rs 150 to Rs 180/plant in the normal season.
Name and address of the discloser	Dr Dipankar Saha, Training Organiser, Ramkrishna Ashram KVK, Nimpith Ashram, South 24-paraganas, West Bengal 743 338.
Location of the use of the ITK	Twenty six villages in 4 blocks: block Baripur-I and Baripur II, Joynagar-I and Jaynagar-II, South 24 parganas (West Bengal).
Experimenters	Dr Bikas Ghosh, Professor, Department of Orchard Management, Faculty of Horticulture, and Dr Premasis Sukul, Professor, Department of Agricultural Bio-Chemistry, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur, Nadia (West Bengal).

METHODOLOGY

Experiment

Experiments were conducted in seven different guava orchards belonging to farmers of Baruipur. The experimental design was complete randomized design (CRD) and the treatments were: T_1, being of branches during summer (April-June) and autumn (October-November), T_2, complete removal of leaves from the shoot and decapitation, and T_3, control (without any treatment). The ITK technique was also tested at Horticultural Research Station, BCKV during autumn 2003. The number of plants per treatment and per season was three.

Uniformly growing 3 years old trees of the varieties Allahabad Safeda and Khaja were selected and all the trees were given uniform cultural practices. Each plant received 450 g N, 300 g P_2O_5 and 450 g K_2O in two equal split doses, once during 12-15 days before bending operation, and again during marble stage of the fruit growth. The control plants were fertilized during August-September and January. Irrigation was given as and when required. Adequate plant-protection measures were taken. The observations taken were on days required to emerge new shoot, number of new shootlets/branch, days required to initiate flowering, days required for fruit setting, length of new shootlets at flowering time (cm), pair of new leaves produced per shootlet at flowering time, number of shootlets with flower buds/branch, number of fruits/branch at fruit set stage, number of fruits/shootlet at fruits set stage,

Contents

number of fruits retained up to harvest/branch, number of fruits/plant, average weight of the fruit (g), colour of the fruits, sweetness of the fruits, market price and cost effectiveness.

RESULTS AND DISCUSSION

The result of the investigation showed that bending of branch has a profound effect on morphological changes and fruit yield during the course of investigation. The different plant morphological and fruit yield attributing characters of the plant and bio-chemical estimation of shoot, bark and mature fruits are discussed here.

Allahabad Safeda

Days required to emerge new shoot

The data presented in Table 1 show that T_1 (summer bending of branches) as well as T_2 (complete removal of leaves and deapitation) caused early emergence of new shootlets during autumn season and T_3, (bending of branches) caused earliest emergence of shootlet in 26.0 and 9.5 days during autumn and summer season respectively.

Number of shootlets per branch

The summer season of bending increased the number of new shootlets per branch (18.8) than autumn season of bending (11.0). The same trend of increment in number of new shootlets per branch was noted in other treatments during summer season (Table 1).

Days required to initiate flowering

The summer bending of branches (Table 1) produced early initiation of flowering (24.4 days) than autumn bending (44 days). Early initiation of flowers was also noted with other treatments during summer season of bending.

Days required for fruit set

Earliness in fruit setting was observed during summer season than autumn season in all the treatments. Fruit set was advanced by 26.2 days during summer bending of branches (42.8 days) than autumn bending (69 days).

Pair of new leaves/shootlet at flowering time

The data presented in Table 1 showed that pair of new leaves per shootlet at flowering time ranged from 4.2 to 7.00 among the treatments during the season of experiment. The control plant had more pair of new leaves at flowering compared with other treatments.

Number of shootlets with flower buds/branch

In spite of having more number of shootlets/ branch in summer bending it recorded less number of shootlets with flower buds per branch.

During summer bending of branch some of the newly emerged shoots became vegetative instead of reproductive. High temperature with high relative humidity during summer has a deleterious effect on the production of reproductive shoots. If the rainy days continued for 2 to 3 days after bending operation, the newly emerged shootlet made excessive growth and became vegetative. These vegetative shoots should be removed (Table 1).

Number of flowers/shootlet

It was found that summer season of bending had greater effect in different morphological characters of the plant, but the autumn season of bending had positive effect on fruit yield-attributing characters. The autumn bending of branches (T_1) gave maximum number of flowers/ shootlet (7.5), followed by T_2, and T_3 with 6.0 flowers each per shootlet in the same season (Table 3), whereas summer bending of branches (T_1) produced 6.8 flowers/shootlet, followed by T_2 (5.7) and T_3 (4.8).

Number of fruits/shootlet at fruit set stage

Number of fruits per shootlet at initial stage

Table1. Morphological changes and fruit yield of guava (Allahabad Safeda) as affected by re-structuring of canopies during autumn 2002–03 and summer 2003–04

Parameter	Treatments											
	Autumn bending of branch (T_1)				Complete removal of leaves from the shoot and decapitation (T_2)				Control (normal plants) (T_3)			
	Autumn		Summer		Autumn		Summer		Autumn		Summer	
	2002–03		2003–04		2002–03		2003–04		2002–03		2003–04	
Days required to emerge new shoots	23.0	26.0	10.2	9.5	29.0	32.0	14.8	13.7	44.0	44.0	—	40.5
Number of new shootlets/branch	13.9	11.0	21.4	18.8	6.90	5.0	12.0	6.7	1.83	1.9	5.0	6.2
Days required to initiate flowering	41.5	44.0	33.6	24.4	47.7	52.0	42.4	34.4	26.8	25.0	23.2	25.8
Days required for fruit set	64.1	69.0	46.6	42.8	70.3	74.0	52.4	53.6	45.4	44.0	38.2	43.6
Pair of new leaves produced/shootlet at flowering time	4.8	4.2	5.8	5.0	5.0	4.8	6.2	6.0	5.5	5.0	7.6	7.0
No. of shootlets with flower buds/branch	11.4	9.0	10.0	8.6	5.5	3.5	6.0	3.1	1.7	1.5	4.0	2.9
No. of flowers/shootlet	7.5	7.5	7.2	6.8	6.9	6.0	7.2	5.7	5.8	6.0	5.8	4.8
No. of fruits/branch at fruitset stage	65.0	50.4	43.0	39.0	27.2	15.7	21.8	10.55	6.6	5.7	12.4	8.99
No. of fruits/shootlet at fruitset stage	5.9	5.6	4.6	4.6	5.0	4.5	3.8	3.5	4.0	3.8	3.9	3.1
No. of fruits retained up to harvest/branch	22.6	16.0	12.0	—	9.8	4.6	3.0	—	3.3	2.0	8.0	—
No. of fruits/plant at harvest	258.8	251.0	180.0	—	117.2	69.0	45.0	—	22.6	30.0	200.0	—
Average weight of fruits (g/fruit)	187.9	190.0	185.0	177.9	186.0	—	180.0	—	168.7	182.0	1,788.0	—

was also higher during autumn bending of branches (5.6) than summer bending (4.6). Other treatments also showed similar trend in results in this regard (Table 1).

Number of fruits/branch at fruit set stage

The maximum number of fruits per branch at fruit set stage (Table 1) was observed during autumn bending of branches (50.4) than summer bending (39.0). Summer bending of branches

produced maximum number of new shootlets per branch but the fruit set was reduced due to excessive fruit drop during summer season. Production of reproductive shoots was also reduced during summer months.

Number of fruits/branch retained at harvest

Maximum number of fruits per branch at harvest was observed in T_1 (16.6) compared that

in T_2 (4.0) and T_3 (2.0) during autumn season of 2003 (Table 1).

Number of fruits/plant at harvest

Highest number of fruits per plant at harvest was observed in T_1 (251.0), whereas T_2 and T_3 produced 69.0 and 30.0 fruits per plant at harvest

Fig. 2. Profuse fruitlets after bending

during autumn season of 2003 (Table 1).

Average fruit weight (g/fruit)

Bending of varieties (T_1) produced highest fruit weight (190 g/fruit), followed by T_2 and T_3 with 186.0 and 182 g/fruit respectively (Table 1).

Khaja

All the morphological and yield-attributing characters of the plant showed a trend of variation similar to that of the previous year of observation (during Autumn 2002 and Summer 2003).

Days required to emergence of new shoot

In both the seasons early emergence of shoot was observed in T_1, and T_2 compared with the control. However, during summer 2004 the emergence of new shoot after the treatment was very early, producing new shootlet within 9.7 days and 15.0 days in T_1 and T_2 respectively compared with 29.0 days and 34 days in T_1 and T_2 during autumn, 2003.

Number of new shootlet/branch

Production of new shootlet was increased in all the treatments during summer seasons compared with autumn season. Bending of branch (T_1) gave maximum number of new shootlets per branch (15.2), whereas T_2 and T_3 (control) recorded 7.6 and 6.4 shootlet/branch respectively (Table 2).

Days required to initiate flowering

Table 2 shows that during summer flowering started earlier than in autumn season in all the treatments. Bending of shoot (T_1) required 29.7 and 48.0 days during summer and autumn bending respectively.

Days required for fruit set

Table 2 reveal that early fruit set was recorded in T_1, in both the season followed by T_2 and T_3. Lowest period of 43.1 days was required for fruit set in summer bending of shoot, whereas the same treatment (T_1) took 68 days for fruit set during autumn bending.

Table 2. Morphological changes and fruit yield of guava (cv. Khaja) as affected by re-structuring of canopies during autumn 2002-03 and summer 2003-04

Parameters	Treatment											
	Autumn bending of branch (T_1)				Complete removal of leaves from the shoot and decapitation (T_2)				Control (normal plants) (T_3)			
	Autumn		Summer		Autumn		Summer		Autumn		Summer	
	2002–03		2003–04		2002–03		2003–04		2002–03		2003–04	
Days required to emerge new shoots	26.3	29.0	11.5	9.7	31.0	34.0	17.0	15.0	46.4	44.0	0	39.0
Number of new shootlets/branch	10.8	9.0	19.0	15.2	6.4	6.0	8.5	7.6	1.9	2.0	4.8	6.4
Days required to initiate flowering	45.2	48.0	36.4	29.7	49.7	53.0	45.4	39.6	28.9	27.0	23.4	23.8
Days required for fruit set	64.8	68.0	51.8	43.1	69.7	72.0	55.0	54.4	46.9	45.0	38.0	40.7
Pair of new leaves produced/shootlet at flowering time	5.1	4.5	5.9	4.8	5.2	5.0	6.6	5.5	5.7	6.5	8.1	7.0
No. of shootlets with flower buds/branch	9.0	8.0	9.2	7.0	4.9	4.2	5.5	4.1	1.9	1.4	4.6	3.8
No. of flowers/shootlet	8.3	8.0	6.8	8.0	7.7	7.0	6.4	7.5	6.8	6.5	6.4	6.5
No. of fruits/shoots at fruit set stage	56.5	6.0	39.6	4.1	27.2	5.5	18.6	3.0	8.6	5.0	10.4	2.6
No. of fruits/branch at fruit set stage	6.7	48.0	4.2	29.0	6.0	23.0	3.8	12.8	5.0	7.0	3.5	9.88
No. of fruits/branch at harvest	18.7	13.5	11.0	—	9.0	6.3	9.2	—	3.6	2.4	9.0	—
No. of fruits/plant at harvest	225.0	202.0	176.0	—	110.0	94.5	138.0	—	21.0	36.0	225.0	—
Average weight of fruits (g/fruit)	289.0	300.0	280.0	—	227.0	294.0	275.0	—	269.0	272.0	265.0	—

Contents

Pair of new leaves per shootlet at flowering time

The maximum pair of new leaves was observed at flowering time with control plants in both the seasons, i.e. 6.5 and 7.0 pairs in autumn and summer season respectively. However, other treatments also showed slight increment in pair of new leaves/shootlet during summer season than autumn season (Table 2).

Number of shootlets with flower buds/branch

About 88% of the newly emerged shoots produced flower buds during autumn bending (Table 2), whereas only 46.05% of the newly emerged shoot produced flower buds during bending in summer season. During summer season due to warm and humid condition the newly emerged shootlets made excess growth and became vegetative instead of producing flowers in them.

Number of flowers/shootlet

The number of flowers per shootlet did not vary significantly among the treatments in both the season. However, maximum flowers per shootlet (8.0) was recorded with T_1 in both the season of bending (Table 2).

Number of fruits/shootlet at fruit set stage

The maximum fruits per shootlet at fruit set stage were higher in autumn season of bending (6.0) than in summer bending (4.1). Other treatments also showed similar trend of variation (Table 2).

Number of fruits/branch at fruit set stage

The maximum fruits per branch at fruit set stage (48.0) was observed in autumn season of bending than summer bending (29.0). T_2 (complete removal of leaves and decapitation) also recorded increase in fruit set during autumn season. The increment of fruit set in autumn season was probably due to more number of shootlets with flower buds as well as suitable environmental condition during flowering reduced fruit drop at fruit set stage (Table 2).The fruits of summer season of bending in year 2004 are presently in pre-harvest stage as a result the parameters like number of fruits retained at harvest per branch, number of fruits per plant at harvest and average weight of fruits (g/fruit) could not be incorporated, for which the findings of autumn season, 2003 were given.

Number of fruits retained up to harvest per branch

T_1 (bending of branch) produced maximum number of fruits per branch at harvest (13.5) whereas T_2 and T_3 (control) recorded 6.3 and 2.4 fruits/branch at harvest respectively during autumn season 2003 (Table 2).

Number of fruits/plant at harvest

Maximum number of fruits per plant at harvest was recorded T_1, (bending of branch) whereas T_2 and T_3 produced 94.5 and 36.0 fruits per plant at harvest during autumn season, 2003 (Table 2).

Average weight of fruit (g/fruit)

T_1 (bending of branch) produced highest fruit weight of 300.0 g/fruit in 2003 followed by T_2 and T_3 with 294.0 and 272.0 g/fruit respectively during autumn season (Table 2).

Biochemical analysis of leaf and bark

The leaves were collected from the new shoots in their different growth stages from the treated and control plants respectively. The barks were collected from the lateral branches of guava from which the new shoots were emerged. The biochemical parameters like total chlorophyll, chlorophyll a, chlorophyll b, moisture, total soluble protein, total soluble sugar, total free amino acids, reducing sugar, non-reducing sugar, starch, lipid, tryptophan, proline, total phenol content and the enzyme activity like peroxidase, catalase, polyphenol oxidase in leaves and barks were studied in the laboratory at different stages

of shoot development. The experiment had five treatments, viz T_0 (control), T_1 (bending of branches), T_2 (one leaf pair pruning), T_3 (10 cm pruning) and T_4 (20 cm pruning) at three different times, viz. (i) old leaves and barks before any treatments, (ii) S_1, new tender leaves at the time of shoot initiation after treatments possessing 2 leaf pairs (16 to 19 days after treatments), (iii) S_2, before flower initiation from the new shoots (41 to 52 days after treatments). The results are given in the Tables 3-13 and Figures 1-4.

Moisture content

The moisture content (%) of leaves and barks in guava is presented in Table.3. Initially no difference was found among the treatments in leaf; whereas in barks T_2, T_3 and T_4 treatments contained lesser amount of moisture than T_0 and

Table 3. Moisture content (%) in leaf and bark of guava shoots under different treatments

Treatment	Moisture content (%) in guava leaves and barks					
	Leaf			Bark		
	S_1	S_2	Average	S_1	S_2	Average
T_0 : control	51.0	49.2	50.1	58.3	56.3	57.3
T_1 : bending of branches	52.0	48.0	50.0	57.6	46.6	52.1
T_2 : one leaf : pruning	51.0	46.6	48.8	53.3	50.0	51.6
T_3 : 10 cm height	51.6	48.6	50.1	52.3	53.0	52.6
T_4 : 20 cm height	50.3	49.3	49.8	52.6	51.0	51.8
Average	51.2	48.7		54.8	51.8	—
S.Em (±)			1.18			1.07
C.D. at 5%			2.93			2.65

Table 4. Total free amino acids content (mg/g dry-sample basis) in leaf and bark of guava shoots under different treatments

Treatment	Moisture content (%) in guava leaves and barks					
	Leaf			Bark		
	S_1	S_2	Average	S_1	S_2	AverageT_0
T_1 : control	488.4	519.6	449.45	1754.7	1417.7	1586.20
T_2 : bending of branches	269.4	448.6	359.00	1078.1	491.30	784.70
T_3 : 10 cm : height	224.2	342.2	283.20	712.10	263.20	487.65
T_4 : 20 cm height	181.2	368.6	174.90	534.70	981.70	758.20
Average	314.9	417.8	-		869.70	-
SEm (±)			10.12			32.21
C.D. at 5%			25.30			79.88

T_1, which is statistically significant. In both cases moisture percentage reduced significantly at later stage, perhaps due to ageing of the plants. The bark contains higher amount of moisture (51.8 to 54.8%) than leaf (48.3 to 51.2%). Presence of less amount of moisture in leaf compared with bark is probably because of reduced translocation of water from roots to leaves. The moisture percentage in leaf and bark has been considered while calculating the different biochemical constituents expressed on dry weight basis.

Total free amino acids content

Total free amino acid content (mg/g dry sample) of guava leaves and barks as influenced by different treatments are presented in Table 4. At early stage the leaf contained low amount of total free amino acids (av. 340.9 mg/g), which increased at flower-initiation stage (417.8 mg/g). But the position was just reversed in bark. Under bending the total free amino acid was found more, which is statistically significant in leaves and barks with compared that in the control. In other treatments, it decreased significantly. Out of leaf and bark, the leaf sample was found to accumulate significantly higher free amino acids. Bark samples showed significant decrease in free amino acids at flowering stage, perhaps due to translocation of free amino acids from barks to leaves. The tendency to increase in total free amino acids from initial stage to initiation of flowering stage is well in agreement with the total soluble protein content, which was found to decrease at flowering stage. This may again be explained with inefficient utilization of free amino acids to protein or the case of proteolysis under different treatments. All the events might enhance the accumulation of total free amino acids.

Total soluble protein content

The effect of different treatments of total soluble protein content in leaves and barks of guava was recorded (Table 5). Protein content significantly varied with the treatments. The highest protein content (av. 60.32 mg/g dry weight basis) was measured in the leaf under bending treatment (T_1), followed by T_2, T_3, T_4 and T_{fl}. Barks contained lesser protein than leaves. A decrease in total soluble protein content was found in leaves with ageing. However, in control soluble protein content in the leaf increased significantly. Under treatments, the decrease in protein content can be attributed to either inhibition of protein synthesis or increased proteolysis or a combination of both, or reduced rate of incorporation of amino acids into proteins.

Proline content

The effect of different treatments on proline

Table 5. Total soluble protein content (mg/g dry sample) in leaf and bark of guava shoots under different treatments

Treatment	Protein content (mg/g)					
	Leaf			Bark (µg/g)		
	S_1	S_2	Average	S_1	S_2	Average
T_0	14.83	29.01		13.01	15.20	14.11
T_1	60.97	59.67		13.64	12.97	13.31
T_2	54.88	43.60		10.19	12.37	11.28
T_3	48.96	40.10		12.68	14.03	13.36
T_4	48.77	34.43		11.14	14.07	12.61
Average	45.68	41.36	-	12.13	13.72	-
SEm (±)			1.02			0.39
C.D. at 5%			2.52			0.96

Table 6. Proline content (mg/g) in leaf and bark of guava shoots under different treatments

Treatment	Protein content (µg/g)					
	Leaf			Bark (µg/g)		
	S_1	S_2	Average	S_1	S_2	AverageT_0
T_0	22.4	23.2	22.8	6.6	6.8	6.7
T_1	63.5	72.4	67.9	89.5	60.7	75.1
T_2	51.0	52.4	51.7	49.8	50.6	50.2
T_3	58.1	47.5	52.8	50.9	45.2	48.1
T_4	50.6	45.9	48.3	31.4	33.8	32.6
Average	49.1	48.1	-	45.6	39.4	-
SEm (±)		0.72			1.69	
C.D. at 5%		1.78			4.19	

content in leaf and bark of guava is given in Table 6. The proline content varied significantly with the treatments. In leaf the highest value was obtained at the initiation of flowering stage from S_2T_1 (72.4 mg/g), followed by S_2T_2 (52.4 mg/g), S_2T_3 (47.5 mg/g), S_2T_4 (45.9 mg/g) and S_2T_0 (23.2 mg/g) whereas in bark the highest proline content was obtained in S_1T_1 (89.5 mg/g) and lowest in S_1T_0 (6.6 mg/g). From initial stage to flower-initiation stage a statistically significant increase in proline content was found in leaves of T_1, T_2 and T_4 treatments. Bending effect showed a maximum accumulation of proline in leaves and a decline in the bark at the flower initiation stage, which may be explained by the translocation of the same from the bark to the leaf. A high degree of proline accumulation might also be due to an increase in proline-synthesizing enzyme viz. P5CS (pyrolline-5 carboxilate synthetase), reduced rate of proline catabolism inhibition of enzymes involved in degradation of proline. Osmotic adaptation is considered to be one of the mechanisms in higher plants to tolerate stress conditions. Osmotic adjustment helps in maintaining physiological and metabolic processes at reasonable rates to sustain life under adverse condition. If one considers the process of bending and pruning as a stress parameter, accumulation of proline, an osmo-regulator found in the present investigation, is well justified.

Table 7. Tryptophan content (mg/g) in leaf and bark of guava shoots under different treatments

Treatment	Tryptophan content (µg/g)					
	Leaf			Bark (µg/g)		
	S_1	S_2	Average	S_1	S_2	Average
T_0	124.0	125.1	124.6	118.6	119.2	118.9
T_1	401.2	211.6	306.4	62.1	104.9	83.5
T_2	129.1	214.4	171.8	114.1	44.9	79.5
T_3	142.7	331.1	236.9	32.4	42.8	37.6
T_4	238.0	284.6	243.3	114.5	87.7	101.1
Average	207.0	233.4	-	88.34	79.80	-
SEm (±)		4.26			6.65	
C.D. at 5%		10.56			16.26	

However, in leaves total pool of proline decline at initiation of flowering stage under T_1, treatment (10 cm pruning).

Tryptophan content

Table 7 shows tryptophan content in leaves and barks of guava under different treatments of bending and pruning. At initial stage, in leaves highest tryptophan content was found in bending (T_1; 401.2 mg/g) and lowest in control (T_0; 124.0 mg/g), the corresponding data in barks were in control (118.6 mg/g) and in T_3 (32.4 mg/g). All the treatments except T_2 showed higher value of tryptophan, which is highly statistically significant in leaves at the initial stage compared with the control. In the barks at the initial stage tryptophan content was maximum in the control compared with all other treatments, but in S_1T_2 S_1T_4 and S_2T_1, the difference in tryptophan content with the control was not statistically significant. In T_2, T_3 and T_4, tryptophan content increased at the flowering-initiation stage.

One of the possible mechanisms for increased tryptophan accumulation at initial stage under different bending and pruning treatments might be due to protein breakdown, which might be correlated with reduced amount of total soluble protein found in the present investigation in the leaves at flower initiation stage. This might also be explained with the appearance of N-malonyl D-tryptophan, which is supposed to induce tryptophan synthesis. However, this had not been studied in the present study. 6.Total phenol: Total phenol content (mg/g dry wt. basis) in leaves and barks of guava shoots as affected by different bending and pruning treatments are given in Table 6. As such the leaves and barks in control sample showed higher amount of total phenols, i.e. 11.7 to 13.8 and 4.48 to 5.42 mg/g, respectively. But under treatments the leaves showed an increase in phenol content at flower-initiation stage from the initial stage, whereas there was a decreasing trend in phenol content in bark at later stage except T_4 treatment where phenol content increased in bark at mature stage. The result emphasized translocative nature of total phenol from bark to leaves. Higher accumulation of total phenolics might be due to liberation of phenolic amino acids. Besides translocation, the possible reason for decrease in phenol content at later stage in bark might be attributed to increased activity of peroxidase, catalase and polyphenoloxidase.

Petroleum ether extracted lipid fraction

Lipid content (%) in leaf and bark of guava shoots under different bending and pruning system is presented in Table 9. Lipid content

Table 8. Total phenol content (mg/g) in leaf and bark of guava shoots under different treatments

Treatment	Total phenol content (µg/g)					
	Leaf			Bark (µg/g)		
	S_1	S_2	Average	S_1	S_2	Average
T_0	11.7	13.8	12.75	4.48	5.42	4.95
T_1	3.16	6.66	4.91	1.60	1.46	1.53
T_2	0.90	3.48	2.24	1.16	1.03	1.09
T_3	0.85	1.70	1.27	0.46	0.19	0.33
T_4	1.12	2.50	1.18	0.18	0.88	0.53
Average	3.56	5.23		1.58	1.80	-
SEm (±)		0.36			0.16	
C.D. at 5%		0.89			0.39	

Table 9. Lipid content (%) in leaf and bark of guava shoots under different treatments

Treatment	Lipid content (µg/g)					
	Leaf			Bark (µg/g)		
	S_1	S_2	Average	S_1	S_2	Average
T_0	17.0	21.2	19.1	27.3	29.4	26.9
T_1	15.0	25.0	20.0	33.0	16.0	24.5
T_2	46.3	39.6	42.9	27.0	22.7	24.9
T_3	19.6	40.3	29.9	26.3	23.3	24.8
T_4	20.3	26.3	23.3	26.7	30.3	28.5
Average	23.6	30.5	-	28.1	24.34	-
SEm (±)		2.62			1.51	
C.D. at 5%		3.49			3.70	

increased markedly in leaves (except T_2), but in bark it decreased significantly (except T_3 and T_4) with maturity. There was no significant difference in the control samples of leaf and bark from initial stage to flower-initiation stage. The bark sample in initial stage contained more amount of lipid than leaf. Changes in lipid content might be due to the changes in lipid-metabolizing enzymes. Usually lipids are the important constituent of all the cell membranes, which play a central role in functional integrity of cell and organelles. The higher percentage of lipid in the bark at the initial stage and in the leaves at the later stage might be due to the tendency of the plants to overcome the shock effect of bending and pruning while maintaining the functional integrity of cells and organelles.

Enzyme activity

Peroxidase *and* catalase activity

Peroxidase and catalase activity in leaves and barks at only initial stage under bending treatment respectively. The new leaves emerged after bending of shoots contained higher amount of peroxidase and catalase activity than that of control leaves. But the bark under bending treatment contained lower amount of peroxidase and catalase activity than of control.

Both peroxidase and catalase enzymes act rapidly to destroy the potentially damaging forms of active oxygen, in which O_2 released is metabolized to water, consuming reductant generated by the photosynthetic system. Increase in catalase and peroxidase activity under stress condition had already established. In the present investigation it is clear that probably plants under bending treatments use a self-defensive mechanism by increasing the activity of the two enzymes in the leaves.

Polyphenoloxidase

Polyphenoloxidase in leaves and bark at only initial stage under bending treatment had been monitored. In both leaf and bark polyphenol-oxidase activity increased under bending treatment compared with the control.

The activities of this enzyme are important with regard to plant defense mechanism and O_2 scavenger in photosynthetic tissues, mainly under stress condition. As bending and pruning are both considered as a shock treatment to the plants, increased amount of PPO activity under bending and pruning compared with the control found in the present investigation might be attributed as an adoptive mechanism of the plant to overcome from the shock.

Chlorophyll Content

Chlorophyll is one of the major factors that

governs the rate of photosynthesis and thereby formation of carbohydrate. From the data (Table 10) it is evident that leaves and bark of control plants contain highest total chlorophyll (7.37-8.93 and 0.96-1.43 mg/g dry weight basis respectively). Under different bending and pruning treatments, total chlorophyll content in leaf and bark was significantly very low compared with the control plants, corresponding to 0.93-1.83 and 0.34-0.68 mg/g respectively. In all the treatments total chlorophyll content in leaf and bark decreased with maturity. The decline in chlorophyll pigmentation with ageing is the common observation in plants, probably due to the senescence factor. However, significantly low chlorophyll pigmentation under bending and pruning treatments may be due to destruction of chloroplast's ultrastructure. Decrease in total chlorophyll content with maturity might also be due to transformation of chloroplasts to chromoplasts.

Carbohydrate content

Total soluble sugar, reducing sugar and starch content in leaves and bark of guava under different bending and pruning treatments are given in Table 11. In leaves at initial stage except T_4 (15.67 mg/g) all the treatments showed higher amount of total soluble sugar, i.e. ranging 30.88-64.67 mg/g compared with control (27.59 mg/g). Under T_2 and T_3 treatments soluble sugar content showed a significant decrease at later stage, whereas in other treatments sugar content increased. Soluble sugar content present in the bark is lower than that in the leaf. In the bark at the later stages there is an increasing trend in total soluble sugar content in all the treatments except T_1.

The starch found in the leaf and bark under control treatment was significantly more than in other treatments. Lower amount of soluble sugar and higher amount of starch in control compared with other treatments proves the conversion of simple sugar to starch. This is further proved from the observation in T_2 and T_3, where, with maturity in leaves the soluble sugar content decreased and starch increased. Rate of simple sugar to starch conversion was more pronounced under different bending and pruning treatments than that in the control. The present observation also shows that accumulation of soluble sugar and starch in leaves was also influenced by their translocation behaviour from the bark.

The pattern in the amount of reducing sugar present in the leaves was same as found for total soluble sugar. In bark, the reducing sugar content increased under control treatment with maturity, but all the bending and pruning treatments showed a decreasing trend in reducing sugar content and the difference was statistically significant. This proved the sple influence of bending and pruning

Table 10. Total chlorophyll content in leaf and bark of guava shoots under different treatments

Treatment	Total chlorophyll content (mg/g dry weight basis)					
	Leaf			Bark (µg/g)		
	S_1	S_2	Average	S_1	S_2	Average
T_0	8.39	7.37	8.15	1.43	0.96	1.19
T_1	1.15	0.93	1.04	0.68	0.36	0.52
T_2	1.61	0.98	1.29	0.53	0.34	0.87
T_3	1.68	1.47	1.57	0.66	0.35	0.51
T_4	1.83	1.21	1.52	0.56	0.36	0.46
Average	2.39	3.04	-	0.77	0.47	-
SEm (±)		0.02			0.01	
C.D. at 5%		0.05			0.02	

Table 11. Carbohydrate content in leaf and bark of guava shoots under different bending and pruning treatments

Treatment	Leaf			Bark (µg/g)		
	S_1	S_2	Average	S_1	S_2	Average
			Reducing sugar content (mg/g)			
T_0	24.62	25.0	24.81	10.6	12.6	**11.6**
T_1	27.90	35.4	31.65	06.8	04.4	**5.6**
T_2	46.80	21.9	34.35	04.2	03.4	**3.8**
T_3	39.40	33.9	36.65	04.6	03.0	**3.8**
T_4	08.80	40.9	24.85	04.6	03.2	**3.9**
Average	29.50	31.4	-	06.2	04.9	-
SEm (±)		1.10			**0.18**	
C.D. at 5%		2.72			**0.44**	
			Total soluble sugar (mg/g)			
T_0	27.59	29.50	28.54	15.81	18.51	17.16
T_1	30.88	37.12	34.00	20.12	14.03	17.08
T_2	54.51	40.69	47.60	07.68	21.15	14.42
T_3	64.75	36.82	50.78	08.42	09.46	08.94
T_4	15.67	55.58	35.63	08.55	11.11	09.83
Average	38.68	39.56	-	12.12	14.13	-
SEm (±)		0.42			**0.29**	
C.D. at 5%		1.04			**0.73**	
			Starch content (mg/g)			
T_0	1317.7	1321.8	1319.6	941.7	951.6	946.7
T_1	998.6	1041.3	1019.9	743.7	731.8	737.8
T_2	797.6	904.5	851.1	501.4	646.0	573.7
T_3	147.1	929.5	538.3	795.1	743.6	769.4
T_4	87.8	1136.0	611.9	882.5	988.8	935.7
Average	669.8	1066.6	-	772.9	810.4	-
SEm (±)		17.29			**2.59**	
C.D. at 5%		42.87			6.42	

treatments in decreasing the reducing sugar content in bark.

The decline in total soluble sugar with maturity under T_2 and T_3 might be attributed to the fact of declining in chlorophyll content (Table 9) in leaves with maturity, resulting in less CO_2 fixation and reduced the rate of carbohydrate formation. Another reason for this type of behaviour might be due to the loss of 80% of Calvin cycle enzyme activity, due to transformation of chloroplasts to chromoplasts. T_1 (bending) and T_4 (20 cm pruning) showed a profound effect in accumulating total soluble sugar and starch with maturity.

Yield

Guava yield under different treatments is shown in Table 12. The number of fruits retained up to harvest/branch, number of fruits retained up to harvest/plant, average fruit weight (g) and total yield/plant (kg) were taken into consideration as the yield parameters to

distinguish the effect of different bending and paining treatments from the control. In all the yield parameters, the bending and pruning treatment showed a marked, positive and significant effect over control. T_1 (bending) produced the highest yield (48.64 kg/plant) followed by T_4 (20 cm pruning, 23.03 kg/plant), T_2 (one leaf pair pruning, 21.13 kg/plant), T_3 (10 cm pruning, 18.55 kg/plant) and T_Q (control, 15.13 kg/plant).

Assessment of nutritive value of guava under different bending and pruning treatments

Data on the nutritive value of mature guava fruits such as vitamin-c, reducing sugar, total soluble solids (TSS), total soluble sugar and acid content are given in Table 13. The TSS was highest in control and T_4 (8.2 °Brix) and lowest in T_1 (8.0 °Brix). In case of T_2 and T_3, TSS content remained same (8.1 °Brix). The total soluble sugar was highest in T_1 and T_4 (7.69%). Soluble sugar content in the control fruit was lowest (6.60%). The soluble sugar content was significantly influenced by the different bending and pruning treatments. For the reducing sugar content in guava fruits the different bending and pruning treatments showed a marked significant effect over the control. The vitamin-c content decreased significantly in guava fruits of different treatments when compared with the control fruits. But the reverse trend was observed in free acidity, except T_4, which showed free acid content at par with control (0.32%).

CONCLUSION

Now-a-days a tendency of bending and pruning of guava shoots has been extensively practised among the farmers. This not only enhances the production but also increases the availability of the fruit throughout the year. It was concluded that summer bending of branches produced early emergence of more number of shootlets/branch, which caused flowering and fruit set in them. But the number of reproductive shoots/branch and fruit set is reduced during summer bending compared with autumn season of bending, which proved superior in respect of production with quality fruits. Bending of branches in both the seasons produced more fruits during off-season than normal plants. This ITK is remunerative and cost effective, as the rainy season crop was sold @ Rs 1.80 to 2.0/kg fruits, whereas production during November-January fetched Rs 12-15/kg fruit and the fruits during February-May fetched Rs 10-12/kg fruit from the farmers' fields. Guava is now available almost all the year round due to this innovative technique. Bending and pruning treatments induced off-season flowering in guava. Previously it was shown that bending an annual shoot of apple increased the number of lateral flower buds. The hormonal regulation such as ethylene, IAA and

Treatment	Yield parameters of guava			
	No. of fruits retained up to harvest/branch	No. of fruits retained up to harvest/plant	Average fruit weight (g)	Yield (kg/plant)
T_0	1.82	75.74	203.3	15.13
T_1	12.99	195.53	242.0	48.64
T_2	2.27	89.79	222.0	21.13
T_3	1.96	77.38	220.0	18.55
T_4	6.06	94.07	233.7	23.03
SEm (±)	0.04	0.16	7.43	0.03
C.D. at 5%	0.10	0.40	18.43	0.07

Table 13. Assessment of nutritive value of guava fruit under bending and pruning

Treatment	Nutritive quality of guava under different treatment				
	Total soluble sugar (%)	Ascorbic acid (vit. C) (%)	Reducing sugar (%)	TSS (°Brix)	Acidity (%)
T_0	6.60	0.226	4.44	8.2	0.32
T_1	7.69	0.222	5.26	8.0	0.38
T_2	6.66	0.221	4.87	8.1	0.38
T_3	7.14	0.215	5.26	8.1	0.32
T_4	7.69	0.224	5.12	8.2	0.38
SEm (±)	0.002	0.001	0.01	0.001	0.01
C.D. at 5%	0.004	0.002	0.02	0.002	0.02

GA_3 of new shoot initiation under stress condition had already been established. In the present experiment, an attempt was initiated to establish a relationship between new shoot initiation and different bio-molecular changes occurred in the tender leaves and barks of the guava branches. Definite changes had been observed under the treated shoots in respect of total soluble protein, free amino acid, proline, tryptophan, enzyme activity, total carbohydrate, total phenol, chlorophyll and lipid content compared with the control plant, the treated plants contained high lipid (av. 0-42.9% in leaf), tryptophan (av. 171.8-306.4 ug/g in leaf), protein (av. 41.14-60.32 mg/g in leaf) polyphenol oxidase activity (0.11 and 0.23 A: activity/min./g in leaf and bark, respectively), Peroxidase activity (0.6 unit/min/g in leaf and catalase activity (3.5 units/min./g in leaf) but less in chlorophyll (av. 1.04-1.57 and 0.46-0.87 mg/g in leaf and bark, respectively), Phenolics (av. 1.88-4.99 and 0.33-1.53 µg/g in leaf and bark, respectively) protein content in bark (11.28-13.36 mg/g) and peroxidase and catalase activity in bark (0.1 and 7.0 unit/min/g, respectively). These changes might have influenced profuse shoot initiation from the node of the branches, leading to flowering even in the off-season. Hence the yield in the bending and pruning treatment also increased (18.55-48.64 kg/plant) compared with the control plants (15.13 kg/plant). The nutritive value of the guava fruits had also been influenced by this new practice. In the fruits of treated plants under bending and pruning, total soluble sugar increased (6.66 2-7.69%) but ascorbic acid content decreased (0.212-0.222%) compared with those of control. □

FARM IMPLEMENTS

Code : **2039**

Title of the ITK : ***Pingali dhanti* for intercultural operation in tomato**

Description of the ITK : Bullock-drawn *pingali dhanti* can be effectively used for weed control in tomato both during *kharif and rabi* instead of hand-weeding. It can cover an area of 0.4 ha/day with a cost of operation of Rs 150/ha. By adopting this, clean weeding is achieved. It costs about Rs 100.

Name and address of the discloser : Shri B. Narsimha Rao, Meerkhanpet, Kandukur, Ranga Reddy (Andhra Pradesh)

Location of use of the ITK : Meerkhanpet village, Kandukur mandal, Ranga Reddy dist. (Andhra Pradesh)

Experimenters : Dr B. Sanjeeva Reddy, Scientist, Senior Scale (FMP), Dr G. Nirmala, Scientist, Senior Scale (Agricultural Extension) and Dr G.Subba Reddy, Head, Division of Crop Sciences,Central Research Institute for Dryland Agriculture, Hyderabad (Andhra Pradesh) 500 059

METHODOLOGY

The Meerkhanpet village of Kandukur mandal of Ranga Reddy district, where the ITK is being practised was chosen for validation during 2002-03,2003-04 and 2004. The farmers in that village were stratified as per the size of the holding into marginal (<1.0 ha), small (1-2 ha), medium *(2-A* ha) and big (>4.0 ha). The farmers for this investigation were selected by stratified random sampling, representing 5% under each category. Focus group interactions were organized to identify the farmers voluntarily to participate in the validation process.

The implement as per the specifications of *pingali dhanti* was fabricated with the help of local artisans. Five farmers representing different categories were selected and trained to acquaint with the various methodologies to implement the programme of validation. Based upon the interaction of selected farmers, an understanding was developed between the farmers and facilitators in selection of the experimental sites, implementation of the programme and collection of the pertinent data. The critical inputs required for the investigation like implements and seeds of improved variety of tomato (cv. Kanchana) were provided by the project. The farmers contributed for the investigation in terms of land preparation, transplanting, imposition of the treatments and harvesting of the experimental produce. The pertinent data of the investigation were jointly collected by the farmers and

Fig. 1. *Pingali dhanti*

facilitators. This process facilitated increase in the participation of the farming community and also brought awareness on the utility of indigenous implement and recording the farmers' indicators on the efficiency and effectiveness of the implement under their own situations. Each farmer was treated as a replication, and statistical analysis of data was done for various parameters to find out actual effectiveness of the treatments.

The parameters such as field capacity, weeding efficiency and draft of the implements were worked out based upon the following formulae.

Field capacity: It is the actual average rate of field coverage by the implement (ha/day)

Weeding efficiency: It is the ratio of weeds removed by interculture implement or weeding tool to the weeds present in the field. Weeding efficiency was computed by the formula:

Wn =[(Wc-Wt)Wc] x 100

where

Wn =Weeding efficiency

Wc =Total weed count before weeding/unit area

Wt =Total weed count after weeding/unit area

Draft of implement: The horizontal component of pull requirement to pull each implement was measured using spring-type dynamometer (kg).

Energy expenditure: To obtain better comparative results, the energy required to carry out interculture and weeding operations under each treatment was converted into energy units using standard conversion factors, and the total energy expenditure per hectare was calculated.

The specifications of the implements used to implement the validation of ITK are as follows:

Pingali dhanti: Frame width: 25 cm; frame length: 30 cm; height of the frame at the blade point: 60 cm; effective blade length: 30 cm; total weight of the implement: 45 kg; cost Rs. 700/- (Fig. 1).

Traditional blade harrow: Frame length: 53 cm; height of the frame at the blade point: 38 cm; effective blade length: 29 cm; total weight of the implement: 25 kg; cost Rs 700.

The experiment was conducted in Meerkhanpet village with four treatments: T_1, interculture with *pingali dhanti;* T_2, interculture with blade harrow; T_3, T_1, + hand weeding, twice; and T_4, T_2 + hand weeding twice.

The gross plot size was 60 x 16 m. Each treatment was replicated 5 times in 5 farmers' fields.

Observations recorded: 1, field capacity of the implements; 2, drudgery or draft; 3, weeding efficiency; 4, total energy expenditure; 5, cost of each operation for various implements; 6, cost of production; 7, gross income; 8, net income; 9, cost:benefit ratio; and 10, farmers' reaction (performance of the treatments).

Refinement of the ITK: Difficulty in fabrication of exact shape of *pingali dhanti* was observed while fabricating the implement. Another difficulty was the availability of a suitable size of steel flat for shanks. Hence in 2004, the shape of the shank was modified without sacrificing the effective width of the blade. The local artisans found it easy to fabricate the modified model.

RESULTS AND DISCUSSION

Data presented in Table 1 showed the rainfall-distribution pattern during the rainfed tomato crop-growing season in 2002, 2003 and 2004. It was observed that all the three years experienced deficit rainfall when compared with the mean rainfall over 34 years (1970-2004). Among the years under study, 2003 received better rainfall than the other 2 years. The crop in different farmers' fields experienced short-duration dry spell during vegetative and flowering stages in 2002 and long-duration dry spell during vegetative stage of the crop in 2004.

The results on the farmers' fields in 2002-03 (Table 2) indicated that a combination of hand-weeding either with *pingali dhanti* or blade harrow enhanced the tomato yield by 15 and 20% and net income by 83 and 50% and compared with the interculture implements alone. However,

Table 1. Rainfall pattern and deviation from the mean during the experimental years in Meerkhanpet area

Month	Rainfall (mm) Mean	2002	Deviation (%) to mean	2003	Deviation (%) to mean	2004	Deviation (%) to mean
June	93.7	92.6	-1.2	60.6	-35.3	26.0	-72.3
July	89.9	14.9	-83.4	108.3	20.4	84.0	-6.6
August	113.6	84.5	-25.6	117.2	3.2	9.1	-92.0
September	86.4	21.5	-75.1	184.0	112.8	81.4	-5.8
October	41.5	90.0	116.9	35.1	-15.4	27.0	-34.9
November	18.8	6.5	-65.4	0.0	-100.0	—	—
December	4.5	0.0	-100.0	0.0	-100.0	—	—

there was no significant difference with regard to field capacity, draft and energy expenditure of the treatments (Table 3).

The results obtained in 2003-04 revealed that the use of *pingali dhanti* for interculture operation significantly increased the productivity and net income (Rs 1245/ha) compared with the interculture with blade harrow (Rs 1697/ha). Interculture with *pingali dhanti* along with hand-weeding gave 11 % increase in yield and 84% increase in net income over the blade harrow with one hand-weeding (22.49 q/ha). Operation of *pingali dhanti* along with one hand-weeding showed higher weeding efficiency at different days after transplanting over interculture with *pingali dhanti* alone. There was no significant variation between the two interculture implements in respect of field capacity, draft and energy requirement.

Fig. 2. *Pingali dhanti* in operation in a farmer's field

The pooled results on the farmers' fields showed th where was no significant difference with regard to field capacity and draft between the indigenous *pingali dhanti*, blade harrow and its combination with hand-weeding (Table 3). The use of *pingali dhanti* for interculture operation enhanced the productivity and net income (Rs 583/ha) compared with the interculture with traditional blade harrow (21.74 q/ha). Interculture with *pingali dhanti* along with hand-weeding gave 47% increase in net income over the blade harrow with hand-weeding (Rs 2,303/ha). To overcome the operational difficulties, the implements were operated 15 and 45 days after transplanting of tomato crop in 2002-03, and 15, 45 and be d 45 days in 2003-04 and 2004. Operation of *pingali dhanti* along with hand weeding showed higher weeding efficiency (89.53%) over interculture with *pingali dhanti* alone (65%). There was variation between two interculture implements in respect of weeding efficiency and energy expenditure for interculture operations (Table 3).

To verify the feasibility of use *of pingali dhanti* for more number of times, the implements were operated in the crop beyond 45 days after transplanting. The edges of blade harrow caused damage to the standing crop with combing action, due to which the farmers were reluctant to use the implement beyond 45 days. But *pingali dhanti*

Contents

Table 2. Effect of different interculture operations on yield and economic parameters in rainfed tomato

Treatment	Tomato yield (q/ha)			Gross income (Rs/ha)			Cost of production (Rs/ha)			Net income (Rs/ha)		
	2002–03	2003–04	Mean	2002–03	2003–04	Mean	2002–03	2003–04	Mean	2002–03	2003–04	Mean
T_1: Interculture with *pingali dhanti*	22.0	21.4	21.7	11,022	11,793	11,407	9,419	8,850	9,134	1,603	2,943	2,273
T_2: Interculture with blade harrow	22.2	19.4	20.8	11,080	10,673	10,877	9,397	8,976	9,186	1,683	1,697	1,690
T_3: T_1 + hand-weeding	25.4	25.0	25.2	12,708	13,728	13,218	9,745	9,885	9,815	2,945	3,843	3,394
T_4: (T_2) + hand-weeding	26.6	22.5	24.5	12,298	12,370	12,334	9,772	10,289	10,030	2,526	2,080	2,303
Mean	24.1	22.1	23.1	11,777	12,141		9,583	9,500	9,541	2,189	2,641	2,415
CD (0.05)	300.5	196.1	189.1	641	1,079	695	104	503	239	604	1311	743

(*Note*: Since the crop is in fruiting, yield data of 2004 are not included)

Table 3. Engineering parameters as influenced by intercultural tools in rainfed tomato

Treatment	Field capacity (ha/day)				Weeding efficiency (%)				Draft (kg)				Energy (MJ/ha)			
	2002–03	2003–04	2004	Mean	2002–03	2003–04	2004	Mean	2002–04	2003 -	2004	Mean	2002–04	2003–04	2004	Mean
T_1: Interculture with *pingali Dhanti*	0.56	0.59	0.64	0.59	63.4	63.8	67.7	65.0	171.84	175.26	177.75	174.95	180.1	128.2	187.7	165.3
T_2: Interculture with traditional blade harrow	0.57	0.56	0.54	0.56	63.8	63.0	60.7	62.5	173.56	184.27	173.30	177.04	175.9	135.5	188.0	166.5
T_3: (T_1) + hand-weeding	0.56	0.57	0.61	0.58	89.0	87.4	92.2	89.5	171.84	175.26	177.75	174.95	250.4	131.9	261.3	214.6
T_4: (T_2) + hand-weeding	0.57	0.56	0.55	0.56	89.2	86.3	87.6	87.7	173.56	184.27	173.30	177.04	259.2	134.6	257.1	216.9
Mean	0.56	0.57	0.59	0.57	76.3	75.1	77.0	7.1	172.70	179.76	175.52	175.99	216.4	132.6	223.5	190.8
CD (0.05)	0.005	NS	NS	NS	NS	8.75	12.01	2.37	NS	7.41	NS	NS	NS	NS	12.92	39.91

facilitated 1-2 times extra operations depending upon the intensity of crop growth. The perception of the farmers regarding the performance of *pingali dhanti* was also collected from the group of farmers while operating the implement in the farmers' fields. The conclusions derived from the focus group interactions are: *pingali dhanti* has an edge over traditional blade harrow in terms of coverage, extended period of operation during the crop-growth period and efficacy in controlling weeds, ease in handling, cost effectiveness, durability and replicability of the implement. However, blade harrow has edge over indigenous tool in terms of cost, availability and ease in fabrication.

CONCLUSION

Use of *pingal dhanti* alongwith hand weeding enhanced profitability (47.1), weeding efficiency (24.53%) in rainfed tomato compared to the traditional blade harrow. It facilitated to control weeds effectively beyond 45 days after transplanting. Farmers perceived that *pingali dhanti* has an edge over traditional blade harrow in terms of coverage, extended period of operation during crop growth period efficiency in controlling weeds and ease in handling.

□

Code	**2132**
Title of the ITK	***Guddeli* to uproot ginger**
Description of the ITK	Good harvest with total recovery of ginger with less power is obtained by use of *guddeli* at harvest. It is easy to operate and cost of operation per hour is Rs 300. The cost of *guddeli* is Rs 60 per piece.
Name and address of the discloser :	Shri Pandu, Girgitpally, mandal Vikarabad, district Ranga Reddy (Andhra Pradesh)
Location of use of the ITK	Village Girgitpally, mandal Vikarabad, district Ranga Reddy (Andhra Pradesh)
Experimenters	Dr B.Sanjeeva Reddy, Scientist, Senior Scale (FMP), Dr G. Nirmala, Scientist, Senior Scale, (Agric. Extn) and Dr V. Maruthi, Senior Scientist (Agron), Central Research Institute for Dryland Agriculture, Hyderabad

METHODOLOGY

Girigatepalli village of Vikarabad mandal of Ranga Reddy district, where the ITK is being practised was chosen for validation of the practice during 2002-03 and 2003-04. The farmers of the village were stratified as per the size of the land holding into marginal (< 1.0 ha), small (1-2 ha), medium (2-4 ha) and big (>4 ha). The farmers were selected by stratified random sampling, representing 10% under each category. Focus group interactions were organized to identify the farmers to participate in the validation process voluntarily. The hand tools as per the specification of *guddeli* were fabricated with the help of local artisans.

Five fanners representing different categories in each year were selected and trained to acquaint the various methodologies to implement the programme of validation. Based upon the interaction of the selected farmers, an understanding was developed between the farmers and facilitators of the investigation in selection of the experimental sites, implementation of the programme and collection of the relevant data. The critical inputs required for the investigation like hand tool and fertilizer were provided. The farmers contributed for the investigation in terms of land preparation, ginger rhizomes for transplanting, imposition of the treatments and harvesting of the experimental produce. The relevant data of the investigation were jointly collected by the farmers and facilitators. This process facilitated increase in participation of the farming community and also brought about awareness on the utility of the implement and recording the farmers' indicators on the efficiency and effectiveness of the implement under their own situations. Each farmer was treated as a replication and statistical analysis of data for various parameters were done to find out actual effectiveness of the treatments. The parameters such as field capacity, energy expenditure and cost of operation to carry out the operation using different hand-tools were worked out based upon the formulae given below.

Field capacity: It was the actual average rate of field coverage by the implement (ha/day or ha/hr).

Energy expenditure: To obtain better

comparative results, the energy required for carrying out rhizome planting and digging operations under each treatment were converted into energy units using standard conversion factors, and total energy expenditure per hectare was calculated.

The experiment with the following four treatments was conducted in Girgitpally village of Ranga Reddy district in Andhra Pradesh with five farmers: T_1, farmers' method of planting using sickle; T_2, planting with *guddeli;* T_3, farmers' method of harvesting using sickle, and T_4, harvesting with *guddeli.* Ginger (local variety) was taken as the test crop.

Observations were taken on the following aspects: field capacity of the implements (ha/day), total energy expenditure (MJ/ha), cost of each operation for various implements, cost of production (Rs/ha), gross income (Rs/ha), net income (Rs/ha), cost benefit ratio and farmers' reaction (performance of the treatments).

RESULTS AND DISCUSSION

Data presented in Fig. 1 indicate the rainfall distribution pattern during the ginger-growing season. During the experimental years, Girigitpally village received deficit rainfall when compared with the normal rainfall over 15-years (1988-2003). The deficit was more prominent during the rhizome development and vegetative growth stages. However, the ginger being a long-duration and high-value cash crop, farmers

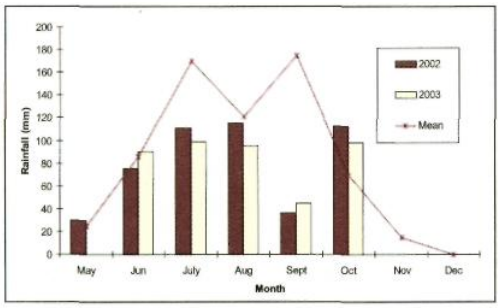


Fig. 1. Rainfall pattern at Girigatepally area during the project period

Table 1. Influence of sowing and harvesting of tools on production and profitability of ginger

Treatment	Yield (q/ha)			Cost of production (Rs/ha)			Gross income (Rs/ha)			Net income (Rs/ha)		
	2002–03	2003–04	Mean	2002–03	2003–04	Mean	2002–03	2003–04	Mean	2002–03	2003–04	Mean
T_1: Farmers' method of planting	126.95	119.05	123.00	65,175	67,775	66,475	152,340	168,462	160,401	87,165	98,895	93,030
T_2: Planting with *guddeli*	130.20	126.49	128.34	64,950	67,570	66,260	156,240	187,320	171,780	91,290	109,536	100,413
t-value	4.29	5.1178	NS	2.39	2.3369	2.990	15.00	16.11	NS	6.09	2.3558	7.596
T_3: Farmers' method of harvesting	129.90	120.33	125.11	69,594	72,194	70,894	155,880	168,462	162,171	86,286	101,238	93,762
T_4: Harvesting with *guddeli*	131.67	133.80	132.73	68,598	71,198	69,898	158,004	187,320	172,662	90,486	116,122	103,304
t-value	NS	NS	NS	2.47	3.0036	3.00	25.09	49.00	2.453	5.61	NS	2.602

provide protective irrigation. Hence farmers irrigated the crop whenever there was a deficiency of moisture in the soil.

The planting of the ginger crop was carried out from last week of May to second week of June and the crop was harvested during March to April in both the years (2002-03 and 2003-04). The data pertaining to ginger rhizomes planting and harvesting operation were collected for the treatments (Tables 1 and 2). The results obtained in 2002-03 revealed that use of *guddeli* for planting operation significantly increased the productivity (3.25 q/ha) and net income (Rs 4,125/ha) over the farmers method of planting (126.95 q/ha and Rs 87,165/ha). Harvesting with *guddeli* reduced the cost of operation up to Rs 1,000/ha (17.5%) and 14.7% increase in net income over the traditional practice (Rs 86286/ ha).

The results of the field experiments in 2003-04 indicated that use of *guddeli* in planting and harvesting of ginger crop enhanced the yield by 7.44 and 13.47 q/ha respectively and net income by 10.76 and 14.70% over the farmers' method. However, there was no significant difference with regard to cost of operation in planting, field capacity and yield of the crop.

The pooled results of the 2 years revealed that there was no significant difference with regard to cost of operation in planting, field capacity and yield of the ginger rhizomes between the farmers' method and use of *guddeli* in the operations. The use *of guddeli* for planting significantly enhanced the field capacity (46%) and reduced the energy expenditure and cost of operation up to 28% and 19.8% respectively. Harvesting with *guddeli* gave Rs 10,274/ha increase in net income over the traditional farmers' method of harvesting with sickle. Use of *guddeli* at the time of harvesting reduced the energy expenditure (346 MJ/ha) and cost of operation (Rs 988/ha) when compared with farmers' practices.

The overall improved perfomance of *guddeli* was observed due to its optimum size and weight of the tool. Hence the operator felt convenient to use the tool continuously for a period of 8 hr of operation. During operation the tool was also able to penetrate to the required depth to uproot the ginger rhizomes. The same conditions were not achievable in sickle due to its light weight. The sickle needed 3 to 6 repeated hits to perform the job satisfactorily. Consequently the operating time increased considerably, which had direct bearing on the field capacity, energy expenditure, cost of

Table 2. Performance of *guddeli* on engineering parameters in sowing and harvesting of ginger rhizomes

Treatment	Field capacity (ha/day)			Energy expenditure (MJ/ha)			Cost of operation (Rs/ha)		
	2002–03	2003–04	Mean	2002–03	2003–04	Mean	2002–03	2003–04	Mean
T_1: Farmers' method of planting	0.0204	0.0116	0.016	461.55	695.26	587.4	1,225	1,745	1,485
T_2: Planting with *guddeli*	0.029	0.018	0.0235	337.15	507.99	422.57	1,000	1,380	1,190
t-value	NS	30.2343	5.597	2.72	2.9966	3.5989	NS	NS	2.402
T_3: Farmers' method of harvesting	0.0044	0.00476	0.00458	1841.92	2250.646	2046.3	5,644	5,656	5,650
T_4: Harvesting with *guddeli*	0.0053	0.0056	0.00545	1537.45	1863.012	1700.23	4,648	4,677	4,662.5
t-value	NS	NS	NS	1.98	1.7648	2.508	1.42	1.7787	2.422

Fig. 2. Harvesting of ginger by *guddeli*

operation and quality of work.

The conclusions derived from the focus group interactios revealed that *guddeli* has an advantage over traditional practice in terms of field capacity, energy expenditure and cost of operation. However, the sickle has an edge over *guddeli* in terms of the cost and availability.

CONCLUSION

The results show that use of *guddeli* for harvesting rhizomes in ginger enhanced the net income (Rs.lO,274/ha), reduced the energy expenditure (346 MJ/ha) and cost of operation (Rs 9.88/ha) compared to the traditional sickle. But there was no significant difference between *guddeli* and sickle for planting in terms of cost of operations, field capacity and yield of rhizomes. Farmers' perceived that harvesting with *guddeli* was able to penetrate to the required depth to uproot ginger rhizomes compared to sickle.

□

FISHERY

Code	: 424
Title of the ITK	**: Use of banana pseudostem in fish pond to enhance productivity offish**
Description of the ITK	: Pseudostems of banana, after harvesting the bunch, are added to the pond by cutting longitudinally, which increases the pH and oxygenation of pond water. This practice increases the fish yield. As it involves low cost, it is being followed by 80% of the farmers in Bastar village of Balasore district in Orissa.
Name and address of the discloser :	Shri Rabinarayan Mishra, College of Fisheries, Orissa University of Agriculture and Technology, Rangailurda, Berhampur, dist. Ganjam (Orissa) 760 007.
Location of use of the ITK	Village: Bastar, dist. Balasore (Orissa)
Experimenters	Dr C. Lodh, Lecturer, Department of Veterinary Medicine, Ethics and Jurisprudence, and Dr B.K. Chand, Farm Manager, Directorate of Research, Extension and Farms, West Bengal University of Animal and Fishery Sciences, Kolkata 700 037 (West Bengal).

METHODOLOGY

The efficacy of banana pseudostem for increasing the water quality of pond was evaluated by experimental methods. The experiment was conducted in village Bastar, district Balasore (Orissa).

Water depth of the fish-pond starts reducing and biomass of the fish gradually increases from September to May. Hence during that period there is shortage of dissolved oxygen in the pond water. The pH of the water reduces gradually and due to unfavorable condition fish starts swimming on the upper surface of the pond water in early morning hours. If such conditions prevail for a longer period, fish starts dying. The study was conducted through field experimentation during 2002-2003 and through laboratory experimentation during 2003-2004.

The experiment was conducted using four treatments, with three replications, viz. (i) T_1, control (no treatment); (ii) T_2, use of banana pseudostem @ 2,000 kg/ha (here banana pseudostem was allowed to decompose and disintegrate in the pond, designated ITK-1); (iii) T_3, use of banana pseudostem @ 2,000 kg/ha, (here banana pseudostem was removed from the pond after 12-15 days of application, designated ITK-II); and (iv) T_4, use of lime @ 5,000 kg/ha. Before initiation of the experiment, all ponds were treated with cowdung, urea and single superphosphate at equal doses. IMC fingerlings of 2-3 inches size were stocked @ 5,000/ha with species combination of catla:rohu:mrigal in the ratio of 4:3:3. Duration of experiment was 10 months (September 2002 to June 2003). Observations were taken on: (a) water-quality parameters: pH of pond water, dissolved oxygen content (ppm), total alkalinity (ppm) and total hardness (ppm); (b) growth parameters of fish: growth at harvest, yield (kg/ha), survival percentage and incidence of diseases; (c) economic parameters: total expenditure, total income and benefitxost ratio', and (d) chemical

characteristics of the juice extracted from banana pseudostem.

Collection of water sample

The pond water was collected in pre-treated polythene bottles taking precaution not to entrap any air bubbles while sampling. The samples were collected at monthly intervals in the early hours of the day.

(a) pH: It was measured at site by using pocket electronic pH-meter.

(b) Dissolved oxygen: The following formula was used: Dissolved oxygen (ppm or mg/ litre) = 0.1 x A x 1,000/ml sample, where A=volume of 0.0125 N sodium thiosulphate solution required up to end point.

(c) Total alkalinity: It was calculated from the sum of bicarbonate and carbonate alkalinity.

(d) Total hardness: It was calculated from the sum of calcium and magnesium ions present in water.

(e) The mineral content in juice extracted from banana pseudostem was estimated using atomic absorption spectrophoto-meter.

(f) Collection of fish samples for growth studies: The net was cast randomly to collect fish from pond. The length and weight of fish were recorded and then released into pond. Average values of length and weight were obtained by dividing by total number of fish.

Laboratory experiment

The laboratory study was carried out in two parts, *i.e.* indoor experiment (28 days) and out door experiment (90 days) during 2004, the details of which are furnished in Table 1.

The pH of water samples was measured on the spot following the electrometric method by using a pH pen and was confirmed again in the laboratory with a digital pH meter (Systronics: Model No. MK-VI).

Total alkalinity, total hardness, dissolved oxygen, turbidity, calcium and ammonium nitrogen (NH_4-N) were estimated following APHA (1995) method. Nitrate nitrogen ($N0_3$-N) content of water was estimated following the spectrophotometric method (Stikcland and Parson, 1960). The plankton samples were examined under research microscope for qualitative and quantitative analyses following drop method (Battish, 1992).

Tannin content in juice was estimated by volumetric method. The trace mineral contents in juice like that of Fe, Cu, Zn, Mn, Mg and Ca was estimated using Atomic absorption spectrophoto-meter (Model: Perkin Elmer, A Analyst-100) after digesting the sample with nitric acid. Total tannin was estimated by APHA, (1995).

RESULTS AND DISCUSSION

The efficacy of banana pseudostem in improving pond water quality and enhancing growth of fish was determined through field experimentation conducted during 2002-03 at Bastar village of Balasore district of Orissa, whose results were published in Document 3 of the project. Results of the controlled studies conducted during 2003-04 are presented here.

Chemical characteristics of juice extracted from banana pseudostem

The quantity of juice extracted from banana pseudostem was 700 ml/kg. The juice was yellowish brown in colour and slightly acidic (pH= 6.2). It contained 12.47 g/litre total tannin, 2.47 mg/litre Fe, 0.82 mg/litre Zn, 0.816 mg/litre Mn, 89.4 mg/litre Ca, 0.74 mg/litre Cu and 25.8 mg/litre Mg. Total alkalinity and hardness of the extracted juice were 1720 and 798 mg/litre respectively (Table 2).

pH of experimental water

In the case of indoor experiment, the pH values

Table 1. Details of variables in different treatments in indoor and outdoor study

Variable	Treatment				
	T_0	T_1	T_2	T_3	T_4
		Indoor study			
Volume of aquarium (litre)	40	40	40	40	40
Duration of study (day)	28	28	28	28	28
Treatmeat employed	-	Banana-stem juice	Banana-stem juice	Banana-stem juice	Lime ($CaCO_3$)
Concentration of treatment (ml/litre)	-	0.5	1.0	1.5	50
Stocking density/aquarium	10	10	10	10	10
Supplementary feed	Pellet feed	Pellet feed	Pellet feed	Pellet feed	Pellet feed
Water exchange (%) week	10	10	10	10	10
Fish species used	Mrigal	Mrigal	Mrigal	Mrigal	Mrigal
Initial length (cm)	1.6 ± 0.02	1.6 ± 0.02	1.6 ± 0.02	1.6 ± 0.02	1.6 ± 0.02
Initial weight (g)	0.031 ± 0.001	0.031 ± 0.001	0.03 1± 0.001	0.031 ± 0.001	0.031 ± 0.001
Sampling interval	Weekly	Weekly	Weekly	Weekly	Weekly
		Outdoor study			
Volume of the cement cistern (litres)	150	150	150	150	150
Duration of study (day)	90	90	90	90	90
Treatment employed	No treatment	Banana-stem juice	Banana-stem juice	Banana-stem juice	Lime ($CaCO_3$)
Conc. of treatment (ml/litres)	-	0.5	1.0	1.5	50
Stocking density/cistern	15	15	15	15	15
Water exchange (%)/fortnight	10	10	10	10	10
Fish species used	Mrigal	Mrigal	Mrigal	Mrigal	Mrigal
Initial length (cm)	3.91 ± 0.19	3.91 ± 0.19	3.91 ± 0.19	3.91 ± 0.19	3.91 ± 0.19
Initial weight (gm)	0.311 ± 0.09	0.311 ± 0.09	0.311 ± 0.09	0.311 ± 0.09	0.311 ± 0.09
Sampling interval	Fortnight	Fortnight	Fortnight	Fortnight	Fortnight

in control (T_o) varied between 6.06 ±0.1 and 7.10 ± 0.0; whereas in lime treatment (T_4) it varied in the range of 7.57 ± 0.06 to 7.43 ± 0.12 and similar variations were observed in different treatments of banana pseudostem juice (T_1, T_2 and T_3) (Table 2a). In case of out door experiment the pH values varied from 7.10 to 7.73 in control whereas in lime treatment it varied from 7.50 to 8.53 and similar distribution was also observed in treatments T_1, T_2 and T_3 (Table 2b). Both from indoor and outdoor experiments, it was observed that banana pseudostem juice treated water and

Table 2. Characteristics of juice extracted from banana pseudostem

Character	Description/value
Colour of juice	Yellowish brown
Quantity of juice extracted from banana pseudostem	700 ml/kg
pH	6.2
Alkalinity	1720 mg l^{-1}
Hardness	708 mg l^{-1}
Total tannin	12.47 g l^{-1}
Fe	2.47 mg l^{-1}
Zn	0.82 mg l^{-1}
Mn	0.816 mg l^{-1}
Mg	25.8 mg l^{-1}
Ca	89.4 mg l^{-1}
Cu	0.74 mg l^{-1}

lime treated water had little higher pH than that of control. It is clear from the results that the juice is responsible for the increase in water pH, similar to that of lime despite the fact that juice itself was slightly acidic. This might be due to high alkalinity of juice and juice treated water. According to Boyd (1979), the most ideal pH for fish culture is 7.5 to 8.5. Since the pH of juice and lime treated samples had high pH, it can be concluded that the lime and juice treated water are more suitable for fish culture than that of control (T_0). The results of growth of fish also justify the above statements.

Total alkalinity

In the study, alkalinity showed a narrow range of variation (Tables 3a and 3b). In indoor experiment the total alkalinity values varied from 225.33 ± 1.15 to 256.0 ± 6.92 mg/litre in T_0 (control water), and it varied from 269.33 ± 5.77 to 294.0 ± 0.0 mg/litre in T_4 (lime treatment). In banana pseudostem-juice treatment, variation of total alkalinity values was more or less similar to that in lime treatment. In the outdoor experiment, the total alkalinity values in T_0 (control) were lower than lime and banana pseudostem-juice treatments. Ohle (1933) concluded that waters having alkalinity more than 50 ppm are most productive and those with less than 10 ppm cannot support good fish growth. Thus the juice as well as lime increased the alkalinity of water, thereby making the water more suitable for fish growth.

Table 2a. pH of water (mean ± S.D.) during indoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	6.63±0.12	7.46±0.06	7.36±0.06	7.53±0.06	7.5±0.0
D_7	7.03±0.12	7.30±0.0	7.27±0.06	7.53±0.06	7.43±0.06
D_{14}	6.06±0.1	7.36±0.06	7.27±0.06	7.40±0	7.37±0.06
D_{21}	7.00±0	7.37±0.06	7.27±0.06	7.50±0	7.40±0
D_{28}	7.10±0	7.53±0.12	7.47±0.23	7.4 0±0	7.43±0.12

Table 2b. pH of water (mean ± S.D.) during outdoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	7.73±0.40	8.33 ±0.29	8.5 ±0	8.2 ±0.1	7.97±0.42
D_{15}	7.20 ±0.53	7.97 ±0.45	8.2 ±0.2	8.03 ±0.57	7.50±0.44
D_{30}	7.57 ±0.06	8.47 ±0.06	8.43 ±0.15	8.67 ±0.15	8.17 ±0.06
D_{45}	7.51±0.06	8.1±0.26	8.33 ±0.38	8.3±0.1	8.53±0.15
D_{60}	7.07±0.58	8.5 ±0.26	8.07 ±0.12	8.33 ±0.06	8.00 ±0.26
D_{75}	7.03±0.50	8.33 ±0.21	8.17 ±0.15	8.0 ±0.2	7.70 ±0.26
D_{90}	7.10 ±0.00	7.5 ±0.50	7.67 ±0.55	7.47 ±0.35	7.50±0.62

Contents

Table 3a. Total alkalinity (mean ± S.D. in mg/litre) during indoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	236.66±5.77	276.0±27.71	273.33±4.61	296.66±4.61	294.0±0.0
D_7	225.33±1.15	288.0±0	272.66±5.77	296.66±4.61	279.33±2.30
D_{14}	234.66±9.23	274.66±9.23	269.33±4.61	290.0 ±3.46	282.66±1.15
D_{21}	227.33±1.15	278.66±2.30	272.0±3.46	292.66±1.15	282.66±1.15
D_{28}	256.0 ±6.92	284.0±3.46	266.0±0	282.0±3.46	269.33±5.77

Table 3b. Total alkalinity (mean ± S.D. in mg/litre) during outdoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	105.33±9.24	126.0±2.0	164.0±0	133.33±10.05	112.0±4
D_{15}	82.66±7.48	105.33 ±2.31	132.0±4	127.33±3.08	91.33±1.15
D_{30}	101.33±3.88	113.33±10.07	124.0±0	136.66±6.41	97.33±4.62
D_{45}	120.0±4.37	200.0±4.0	150.66±4.62	165.33±4.44	148.0±7.44
D_{60}	127.0±4.12	177.33±5.96	144.0±0	157.33±6.65	118.66±9.73
D_{75}	107.33±4.06	185.33±4.88	153.33±9.24	134.66±2.31	133.33±11.54
D_{90}	146.66±5.47	169.33±2.44	162.66±6.29	144.44±3.33	188.66±6.11

Total hardness

Total hardness of water is due to presence of calcium and magnesium ions along with ferrous and aluminium ions. Swingle (1967) suggested that water hardness of at least 15 mg/litre is required for satisfactory fish growth. In the present investigation hardness values ranged from 193.33 ± 4.61 to 244.66 ± 1.15 mg/litre as $CaCo_3$ in all the treatments under indoor experiment (Table 4a). But in outdoor experiment it varied from 36.66 ± 4.16 to 128.0 ± 5.73 mg/litre in all the treatments, which were conducive ranges for primary production (Table 4b). In indoor experiment the overall total hardness values were higher, perhaps because of summer months during which the experiment was conducted. The high value of hardness is generally recorded during summer due to higher temperature, which accelerates the salt concentration of water through evaporation.

Dissolved oxygen

Dissolved oxygen is perhaps the best indicator of water quality, especially for fish culture. Banerjee (1967) opined that ponds should have dissolved oxygen concentration above 5 ppm for average or good fish production. In the present investigation the treatments of both indoor and outdoor experiments had average dissolved oxygen concentration above 5 mg/litre (Tables 5a and 5b). The dissolved oxygen content varied from 6.07 ± 2.19 to 9.87 ± 0.92 in all of the treatments in indoor experiment, but in outdoor experiment the dissolved oxygen values varied from 5.2 ± 1.06 to 13.26 ± 1.10 mg/litre during the study period. In both the experiments, the dissolved oxygen levels were slightly low during summer due to the low solubility of oxygen at higher temperature. No significant impact of the juice on the dissolved oxygen concentration could be observed.

During indoor study the turbidity of water decreased from D_0 to D_{28} in all the treatments. This might be due to settling of suspended particles in the water as the experiment proceeded (Table 6). The turbidity values varied from 6.53 ± 0.17 to 17.57 ± 3.92 NTU in control (T_0). The turbidity value varied from 3.7 ± 0.17 to 25.53 ±

Contents

Table 4a. Total hardness (mean ± S.D. in mg/litre) during indoor experiment

Days	T_0	T_1	T_2	T_3	T_4
D_0	219.33±5.77	222.66±2.30	193.33±4.61	206.66±4.61	227.33±4.61
D_7	214.66±4.61	220.0±0	201.33±11.54	221.33±4.61	218.66±4.61
D_{14}	220.0±6.92	236.0±0	206.66±2.30	228.0±0	225.33±2.30
D_{21}	218.66±18.47	229.33±2.30	209.33±4.61	229.33±4.61	230.66±2.30
D_{28}	234.66±15.01	244.66±1.15	212.0±10.39	228.0±6.92	244.0±3.46

Table 4b. Total hardness (mean ± S.D. in mg/litre) during outdoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	89.33±5.40	60.66±4.6	107.33±4.16	69.33±6.11	55.33±3.26
D_{15}	68.0±7.71	62.66±6.11	90.0±8.72	93.33±9.46	42.66±4.07
D_{30}	52.0±7.71	60.0±3.75	65.33±6.16	68.0±8.33	36.66±4.16
D_{45}	116.0±5.43	128.0±5.73	84.0±3.74	94.66±2.86	93.33±8.04
D_{60}	122.66±6.49	97.33±4.38	70.66±9.24	77.33±6.24	51.33±3.32
D_{75}	92.0±4.0	116.0±4.33	94.66±2.30	68.0±2.8	46.66±6.56
D_{90}	88.0±5.12	88.0±2.17	68.0 ±4.0	62.66±2.22	54.66±6.17

Table 5a. Dissolved oxygen (mean ± S.D. in mg/litre) during indoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	8.73 ±0.57	7.40 ±0	7.73 ±0.12	6.27 ±0.23	7.47 ±0.23
D_7	7.20 ±0.35	8.67 ±0.29	9.33 ±2.54	6.67 ±0.23	6.07 ±2.19
D_{14}	7.87 ±0.23	7.20 ±0	7.60 ±1.39	7.47 ±0.46	6.40 ±0.69
D_{21}	9.87 ±0.92	8.40±1.39	8.00 ±1.39	7.73 ±0.46	7.73±0.46
D_{28}	8.66±0.23	8.93±1.15	7.46±0.92	7.60±0.92	7.46±1.15

Table 5b. Dissolved oxygen (mean ± S.D. in mg/litre) during outdoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	12.13 ±0.57	12.36±1.20	9.73±0.41	9.13±0.64	13.26±1.10
D_{15}	8.06±0.11	8.03 ±0.05	6.8±0.4	5.67±0.11	7.06±0.23
D_{30}	7.73±0.46	8.46±0.30	8.13 ±0.23	5.2±1.06	7.93±0.12
D_{45}	7.2 ±1.39	9.33 ±0.46	9.33 ±0.46	9.86 ±0.92	8.8 ±0.8
D_{60}	10.06 ±1.1	8.13 ±0.23	6.13 ±0.23	6.13 ±0.23	9.06 ±0.23
D_{75}	12.8 ±0.69	10.66 ±0.46	10.46 ±0.46	9.46 ±0.46	12.93 ±0.83
D_{90}	8.26 ±0.61	10.0±0.69	10.53 ±0.61	8.4 ±0.8	9.6 ±0.4

Contents

Table 6. Turbidity (mean ± S.D. in NTU) during indoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	17.57±0.92	16.76±0.58	18.8±2.59	25.5±0.23	14.6±1.21
D_7	9.46±1.27	5.13±0.58	5.13±0.75	5.07±0.12	5.37±0.12
D_{14}	10.23±1.50	6.43±0.81	6.10±0.17	5.60±0.35	5.43±0.46
D_{21}	6.63±0.23	4.10±0.17	3.70±0.17	4.23±0.40	4.40±0.17
D_{28}	6.53±0.75	4.63±0.40	4.00±0.35	3.67±0.23	5.37±0.23

0.23 NTU in lime treatment (T_4 and different treatments of banana juice (T_1, T_2, T_3 Among treatments, at the end of the experiment, the turbidity was the lowest in T_3 followed by T_1, T_2, T_4 and T_0. Thus juice of banana pseudostem is most effective in reducing the turbidity of water. This shows that this juice has coagulating effect in water, which helped in lowering of turbidity. The formation of flocculates by the juice might be responsible in separation of suspended and colloidal particles from the water through coagulation or precipitation.

Calcium content

Calcium normally occurs in combination with carbonates, and their formation depends upon the loss of carbon dioxide from the carbon dioxide-carbonate system, which is related to temperature, pH, partial pressure across the water surface and the nature of other substance present in water. Calcium is considered one of the essential nutrients present in lime. Calcium deficiency is often associated with acidity. In the present study (Tables 7a and 7b) calcium content varied from 22.70 ± 4.44 to 31.78 ± 0.92 mg/litre in control (T_0) in outdoor experiment. In lime treatment (T_4) and banana pseudostem-juice treatments (T_1 to T_3), the calcium contents were higher than in the control (T_0) which varied from 21.75 ± 5.60 to 44.24 ± 2.42 mg/litre. In case of indoor experiment the calcium value in T_0 fluctuated between 30.10 ± 3.23 and 45.90 ± 10.86 mg/litre but in lime and banana juice treatments it varied from 32.83 ± 1.38 to 64.59 ± 12.24 mg/litre which was higher than that of control. A similar trend was observed both in indoor and outdoor experiments. The results, thus show that the lime and banana pseudostem juice increased the calcium concentration in water. Banerjea (1967) suggested that the pond with less concentration of available calcium both in soil and water will be less productive than others where calcium is abundant.

Ammonium nitrogen

Content of ammonium nitrogen showed slight oscillation during indoor experiment, and in general recorded higher values during initial period and decreased gradually as the experiment advanced (Tables 8a and 8b). The ammonium nitrogen values varied from 0.04 ± 0.024 to 0.4 ± 0.15 mg/litre irrespective of treatments. In outdoor experiment it varied from 0.061 ± 0.001 to 0.835 ± 0.129 mg/litre. Ammonium nitrogen concentration was more in outdoor experiment than in indoor experiment. It was found that mostly the concentration of ammonia was low (0.56 mg/litre). Ellis *et al.* (1946) suggested that a concentration of more than 1 mg/litre NH_4-N indicates pollution by organic matter. Unionized ammonia is highly toxic to fish, but the ammonium ion is relatively non-toxic (Boyd, 1982).

Nitrate nitrogen

Nitrate nitrogen is considered as one of the limiting nutrients because of its regulatory influence on organic production in aquatic environments and its low concentration available for utilization. Banerjee (1967) suggested that water having less than 0.1 ppm nitrate is

Table 7a. Calcium (mean ± S.D. in mg/litre) during indoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	30.10±3.23	32.83 ±1.38	38.43±1.38	43.85 ±0.88	44.78±2.87
D_7	33.51±0.92	42.97 ±0.46	38.92±3.23	44.04 ±0	39.77±0.92
D_{14}	34.84±0	51.24 ±2.77	42.17±0.92	50.71±0.92	51.25±0
D_{21}	46.05±8.32	64.59 ±12.94	47.57±1.79	57.64±0	49.61±2.78
D_{28}	45.90±10.86	57.64 ±11.09	50.70±4.62	49.09±1.84	49.76±3.69

Table 7b. Calcium (mean ± S.D. in mg/litre) during outdoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	24.77 ±6.71	29.35±1.84	44.24 ±2.42	34.43±2.11	35.09 ±.33
D_{15}	23.51 ±3.72	25.63±1.6	32.56±0.92	31.9±1.60	32.51±4.21
D_{30}	24.02±5.55	21.75 ±5.60	35.29 ±1.25	30.74 ±3.25	34.03 ±1.6
D_{45}	22.70 ±4.44	23.22 ±1.19	33.10±4.22	38.96 ±3.35	36.22±3.62
D_{60}	31.78±0.92	32.56 ±0.92	33.10 ±4.90	38.44 ±0.0	38.29 ±0.92
D_{75}	30.51 ±2.2	31.59 ±2.56	33.40 ±2.36	36.25 ±2.21	43.85±.3
D_{90}	27.12±5.67	31.80 ±4.45	34.17 ±1.22	33.23 ±5.65	38.59 ±5.36

Table 8a. Ammonium nitrogen (NH_4-N) of water (mean ± S.D. in mg/litre) during indoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	0.40 ±0.149	0.25±0.032	0.11 ±0.004	0.18 ±0.005	0.18±0.015
D_7	0.11 ±0.018	0.09±0.002	0.07 ±0.004	0.32 ±0.093	0.04±0.024
D_{14}	0.10 ±0.004	0.15±0.059	0.08±0.001	0.25±0.035	0.07±0.005
D_{21}	0.11±0.011	0.12±0.058	0.07±0.007	0.28±0.035	0.07±0.015
D_{28}	0.11 ±0.056	0.16±0.041	0.08±0.012	0.27 ±0.036	0.06±0.013

Table 8b. Ammonium nitrogen of water (mean ± S.D. in mg/litre) during outdoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	0.121 ±0.039	0.160±0.08	0.078 ±0.023	0.061 ±0.001	0.097 ±0.049
D_{15}	0.464±0.062	0.48±0.038	0.381±0.01	0.371±0.076	0.451 ±0.18
D_{30}	0.807±0.06	0.802±0.146	0.685±0.015	0.697±0.054	0.835±0.129
D_{45}	0.540±0.05	0.577±0.03	0.459 ±0.12	0.475±0.09	0.464±0.008
D_{60}	0.625+0.05	0.553±0.02	0.354 ±0.03	0.370±0.003	0.336±0.009
D_{75}	0.484+0.05	0.467±0.006	0.423 ±0.03	0.442±0.002	0.443±0.09
D_{90}	0.571 ±0.04	0.471±0.03	0.368 ±0.02	0.456±0.03	0.420±0.01

unproductive. In the present investigation, irrespective of treatments, the nitrate nitrogen values varied from 0.002 ± 0.0001 to 0.025 ± 0.008 mg/litre in outdoor experiment (Table 9). This water was not much productive in the experiment. However, nitrate-nitrogen value was slightly more in T_1, the treatment where juice of banana pseudostem was used @ 0.5 ml/litre. The trend

Contents

Table 9. Nitrate nitrogen content of water (mean ± S.D. in mg/litre) during outdoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	0.011 ±0.0067	0.005 ±0.0023	0.005 ±0.0001	0.005±0.0003	0.008 ±0.0012
D_{15}	0.023 ±0.011	0.024 ±0.0011	0.020 ±0.006	0.019±0.0009	0.017 ±0.0014
D_{30}	0.024±0.001	0.025 ±0.0008	0.006 ±0.0009	0.008±0.0021	0.006 ±0.0005
D_{45}	0.011 ±0.0032	0.004 ±0.0003	0.004 ±0.0004	0.005±0.0007	0.004 ±0.0018
D_{60}	0.009 ±0.001	0.002 ±0.0001	0.005 ±0.001	0.004±0.001	0.003 ±0.0019
D_{75}	0.006 ±0.0005	0.003 ±0.000	0.011 ±0.007	0.005±0.001	0.005 ±0.0005
D_{90}	0.005 ±0.002	0.004 ±0.001	0.009 ±0.001	0.006±0.0005	0.006 ±0.001

observed in all the treatment, was the gradual decrease of nitrate nitrogen as the experiment advanced. This might be due to fact that fertilization was done at the beginning of the experiment only.

Plakton growth

It is well known that the structure and biomass of planktonic organisms (both phytoplankton and zooplankton) govern the quality of an aquatic ecosystem. Phytoplankton biomass itself indicates the productivity of a water body (Table 10). In the present outdoor investigation, maximum plankton abundance (both phytoplankton and zooplankton) was recorded in T_1, on 30th day (D_{30}) (505-678/litre). The lowest plankton abundance was recorded in control (T_0) (478-554/litre). It was low in day 0 in all the treatments and gradually increased as the experiment advanced. Similarly the zooplankton abundance was more on day '0' and gradually decreased as the experiment advanced. The plankton variation is directly reflected in the primary production of the water bodies. It was found that the plankton abundance in lime treatments (T_4) and in different concentrations of banana pseudostem juice treatments (T_1 , T_2, T_3) is similar and higher than that of control (T_0), due to good water quality and availability of nutrients.

A remarkable variation in species composition of plankton (both zooplankton and phytoplankton) was recorded during the period of study. In most of the cases the Chlorophyceae group phytoplankton and Rotifer group of zooplankton were the dominant groups in all the treatments.

Growth, survival and production parameters

Growth, survival and production offish (IMC) in a culture system depends on several factors such as water-quality parameters, stocking density, feeding, pond management etc. In the present study growth, survival and production of fish varied in different treatments due to adoption of different methods for water treatments, i.e., lime and juice of banana pseudostem.

Data on average weight of fish in different treatments reveled that growth of fish was fastest in T_4 followed by T_3, T_2, T_1, and T_Q (Table 11a). Higher growth rate in treatments other than that of control indicated that juice of banana pseudostem as well as lime improved the growth. Best growth under lime treatment (T_4) might be due to higher pH value, high alkalinity, high calcium, low turbidity, higher plankton production etc. Banana pseudostem-juice treatments (T_1, T_2, T_3) also resulted in comparatively better growth of fish due to these favourable water parameters.

In indoor experiment, survival rate of mrigal fry was 100%, 90%, 90%, 90% and 80% in T_1, T_4, T_2, T_3 and T. respectively. The highest survival (%) achieved in T indicated that water quality of aquarium after treatment of juice of banana pseudostem @ 0.5 ml/litre were most suitable for fish growth (Table l1b).

Table 10. Variation in different groups of phytoplankton and zooplankton abundance (No. of species/litre) measured monthly for outdoor experiment

Day	T_0 (Control)					Protozoa	Rotefera
	Phytoplankton						
	Chlorophyceae	Cyanophyceae	Bacilariophyceae	Euglenophyceae	Total		
0	203	42	38	32	315	5	97
30	210	77	61	42	390	4	85
60	213	61	48	45	367	10	14
90	200	73	80	35	388	8	28
T_1 (0.5 ml/litre)							
0	231	39	31	25	326	3	101
30	283	83	74	62	502	5	91
60	209	130	88	70	497	6	69
90	275	81	76	54	486	10	32
T_2 (1.0 ml/litre)							
0	242	51	22	29	344	7	85
30	271	92	76	31	470	4	79
60	199	185	82	51	517	12	30
90	208	183	66	43	500	8	36
T_3 (1.5 ml/litre)							
0	219	47	40	23	329	6	89
30	250	102	63	39	454	8	95
60	239	105	68	53	465	10	34
90	263	86	75	51	475	7	44
T_4 (Lime 50 mg/litre)							
0	191	67	59	45	362	5	98
30	266	86	71	59	482	7	81
60	220	110	95	44	469	13	70
90	185	190	69	35	479	10	85

Fish-production rates achieved under this experiment were 28.93 g/m^2, 24.2 g/m^2, 23.72 g/m^2,21.9 g/m^2 and 16.47 g/m^2 in T_4, T_3, T_1, T_2 and T_0 respectively in 28 days. Highest production rate in T_4 was due to better growth as well as survival under this treatment. Lowest production in T_0 was due to lowest survival and slowest growth of fish under die treatment.

Irrespective of treatments, relative growth as well as specific growth rate of fish gradually decreased from the beginning to end of the experiment.

Data on average weight offish during outdoor study in different treatments showed that growth of fish was fastest in T_1, followed by T_2, T_3, T_4 and T_0. Higher growth rate in treatments other than that of control indicated that juice of banana pseudostem as well as lime treatment had beneficial impact in maintaining better quality of water for aquaculture. Best growth under T_1 might be due to higher pH value, high alkalinity, high calcium and better plankton production (Table 12a).

In outdoor experiment the survival rate of mrigal was 100%, 100%, 100%, 93.33% and 86.66% in T_1, T_3, T_4, T_2 and T_O respectively (Table 12b). Highest survival % achieved in T_1, indicates that water quality of cement cistern after treatment

Table 11a. Average weight of mrigal fish (g) in different treatments during indoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	0.034 ±0.006	0.036 ±0.009	0.036 ±0.006	0.035 ±0.011	0.038 ±0.005
D_7	0.087±0.024	0.132±0.064	0.109 ±0.065	0.078 ±0.078	0.099±0.058
D_{14}	0.149±0.031	0.239 ±0.101	0.212±0.032	0.206±0.015	0.236±0.059
D_{21}	0.295±0.026	0.383±0.074	0.422±0.094	0.387±0.097	0.454±0.128
D_{28}	0.342±0.045	0.427±0.087	0.438±0.075	0.484±0.038	0.558±0.099

Table l1b. Survival and production of mrigal fish in indoor experiment under different treatment

	T_0		T_1		T_2		T_3		T_4	
Day	Survival (%)	Production (g/m^2)	Survival (%)	Production (g/m^2)	Survival (%)	Production (g/m^2)	Survival (%)	Production (g/m^2)	Survival (%)	Production (g/m^2)
28	80	16.47	100	23.72	90	21.9	90	24.2	90	28.93

Table 12a. Average weight of mrigal fish (g) in different treatments during outdoor experiment

Day	T_0	T_1	T_2	T_3	T_4
D_0	0.393±0.12	0.430±0.19	0.561±0.1	0.622±0.13	0.491±0.11
D_{15}	0.599±0.15	0.984±0.05	0.891±0.17	1.016±0.14	0.869±0.13
D_{30}	0.602±0.09	1.154±0.14	0.903±0.12	1.125±0.62	0.916±0.15
D_{45}	0.748±0.16	1.30±0.07	1.127±0.26	1.316±0.62	1.073±0.12
D_{60}	0.779±0.17	1.406±0.13	1.213±0.20	1.427±0.63	1.151±0.18
D_{75}	0.904±0.1	1.556±0.14	1.499±0.18	1.583±0.59	1.410±0.16
D_{90}	1.013±0.08	1.612±0.09	1.589±0.11	1.60±0.63	1.575±0.12

Table 12b. Survival and production of mrigal fish in outdoor experiment under different treatment

	T_0		T_1		T_2		T_3		T_4	
Days	Survival (%)	Production (g/m^2)	Survival (%)	Production (g/m^2)	Survival (%)	Production (g/m^2)	Survival (%)	Production (g/m^2)	Survival (%)	Production (g/m^2)
90	86.66	42.21	100	75.56	93.33	69.52	100	75	100	73.83

of banana pseudostem @ 0.5 ml/litre was most suitable for fish growth.

Fish production rates achieved under this experiment were 75.56, 75.00, 73.83, 69.52 and 42.21 g/m^2 respectively in 90 days. Highest production rate in T, was due to better growth as well as survival. Lowest production in T_0 was due to lowest survival and slowest growth of fish.

In this case, it was also found that irrespective of treatments the relative growth as well as

Contents

specific growth rate of fish gradually decreased from the beginning to end of die experiment.

CONCLUSION

Results of the experiments show that juice of banana pseudostem is slightly acidic in nature with high hardness and high alkalinity. It is rich in minerals like Zn, Cu, Ca, Fe, Mg, Mn and phosphate, which slightly increased the pH, hardness and alkalinity of water, helped precipitate the suspended matter in the water and thereby reduce the turbidity. It also increased the plankton production by facilitating the proper sunlight penetration. Fish growth in juice-treated water was higher than the control and similar to that of lime treatment. The ITK may be considered as a substitute for lime treatment for freshwater aquaculture.

□

Code	**416**
Title of the ITK	**Treatment of foot-and-mouth disease in cattle by using *harida (Terminalia chebula)* and *baheda (Terminalia bellirica)***
Description of the ITK	Foot-and-mouth disease (FMD) in cattle is controlled by applying to the affected parts with 500 g each of *harida* and *behada* powder mixed with 2,500 ml water, twice a day, after boiling. It is being used extensively by the cattle-growing farmers in Makarbili village of Nawapada district in Orissa. Foot-and-mouth disease of cattle is a severe problem in village Makarbili. FMD is a deadly viral disease of cattle, causing severe mouth and foot lesions. The oral mucosa and dorsum of the tongue are severely affected and there is sloughing of the mucous layer of oral cavity as well as dorsal aspect of the tongue, for which animal cannot eat. Similarly, development of severe lesions in the interdigital clefts of the four legs are seen, due to which the affected animals cannot walk properly. Ultimately, milk yield in cattle decreases abruptly and the bullocks cannot perform properly. There is severe deterioration of health and body conditions.
Name and address of the discloser :	Ms Bhanumati Behera, Plot No. 64, Surva Nagar, Unit 7, Bhubaneshwar (Orissa)
Location of use of the ITK	Makarbili, Boden, Nawapada (Orissa) 766 107
Experimenters	Birsa Agricultural University (BAU) Dr S. Haque, Head and Dr P. Shekhar, Assistant Professor, Department of Medicine, Ranchi Veterinary College, Ranchi 834 006 (Jharkhand) West Bengal University of Animal and Fishery Sciences (WBUAFS) Dr N.R. Pradhan, Professor and Head and Dr C. Lodh, Lecturer, Department of Medicine, Faculty of Veterinary and Animal Science, Kolkata 700 037 (West Bengal) Orissa University of Agriculture and Technology (OUAT) Dr P.K.Das, Professor and Head, and Dr G.S. Parida, Assistant Professor, Department of Epidemiology and Preventive Medicine, Orissa Veterinary College, Bhubaneswar 751 003 (Orissa)

METHODOLOGY

Experiment *BAU*

The seeds of *harida* and *baheda* were collected locally and crushed to make a powder. Then 250 g of each of *harida* and *baheda* powder mixed with 1 litre of water and boiled to make a good paste. This paste was applied on foot lesions twice daily for 7 days after thorough washing. The experimentation on animals was done on 20 types of wounds. All the wounds were free of maggots (either the maggots were removed earlier or were not found). The wounds are evaluated on days 0, 2, 4, 6, 8, 10, 12 and 14 to see the recovery.

WBUAFS

Clinical trial: The trial was conducted in 10 clinical cases of FMD. The dried fruits of *harida* and *baheda* were crushed thoroughly in a grinding stone separately. Fine powder was prepared and 500 g of each of them was mixed with 2.5 litres water and boiled for 30 min. After boiling, the mixed pasty preparation was kept overnight and allowed to cool. This herbal ITK paste thus prepared was applied on foot lesions @ 20 g twice daily for 6 days.

A group of 12 cattle was treated with the conventional therapy, comprising of an antibiotic (Moxel @ 2-3 g intramuscularly daily for 4 days) and an analgesic (Butagesic @ 10 ml intramuscularly daily for 3 days). The foot-and-mouth lesions were washed with 1% potassium permanganate solution twice daily. Boroglycerine was applied on mouth lesions and Himax ointment was applied on foot lesions after washing.

The healing of lesions was assessed on the basis of colour of wound, quantity and type of exudation and pain on a scale of 0-4.

OUAT

For the management of foot and mouth disease in cattle, 500 g each of *harida* and *baheda* seed powder was mixed with 2.5 lit water and applied twice a day after boiling. Total 12 cattle affected with FMD were randomly selected for the study and divided into 2 groups. The animals of first group were treated with ITK. Animals of second group received conventional allopathic veterinary medicines administered Enrofloxacin (10%) injection after washing the lesions with potassium permanganate or Povidone iodine. Boroglycerine was applied on the mouth lesions in the conventional treatment group.

Table 1. Score obtained on different parameters of recovery from FMD foot lesions by applying *harida+baheda* at BAU

Parameter	Days of observation					
	0	2	4	6	8	10
Quantity of exudation	5	3	0	0	0	0
Peripheral swelling	7	5	3	0	0	0
Warmth	7	5	3	0	0	0
Pain	7	5	3	0	-	-
Colour of swelling	10	5	5	3	0	0
Quality of swelling	7	5	3	0	0	-

RESULTS AND DISCUSSION

The animals treated with *harida* and *baheda* paste, at BAU recovered within 6-7 days (Table 1) but foot lesions took 17-18 days for complete cure. In allopathic treatment the initial improvement was noticed, although the wound

complications persisted. Peripheral swelling, warmness and pain were reduced in 3-4 days in the ITK-treated group. The clinical improvement was markedly significant in ITK treatment in comparison with allopathic treatment. The treatment of FMD foot lesions with *harida-baheda* paste was more cost effective than allopathic treatment. The health improvement was better than in allopathic-treated animals in the later phase of the disease.

At WBUAFS the application of the ITK comprising *harida* and *baheda* resulted in recovery of foot lesions within 12 to 13 days. However, the conventional veterinary treatment resulted in recovery from foot-and-mouth lesions within 6 to 7 days. Wound exudation, pain and lameness decreased in both the treated groups 4 days after treatment (Table 2). The ITK proved effective in management of foot lesions in FMD though at lower efficacy than the conventional treatment.

Histopathological study: This experiment was conducted to find out the cellular evidence of wound healing, which was assessed by histo-pathological studies in 30 rabbits, divided in two groups (Group I and Group II).The wounds of the control group (G I) were washed with normal saline only, and in Gr II, were treated with the pasted of *harida* and *baheda.* The biopsy material was collected from both the groups at 4 day intervals. The samples were preserved in 10% neutral buffer formaline, and routine histological technique was adopted using H &E method.

On day 4, the histological examination in both the groups revealed severe inflammation, marked by presence of severe lymphocytic infiltrations and of sero-fibrinous exudates.

On day 8 the histological examination in the treated group showed some evidence of regenerating epidermis and thin layer of dermis along with randomly arranged fibroblast and neovascularizatin. But in the control group there was no evidence of regeneration of the epidermal layer.

On day 12, the dermis foundation was completed and a thin layer of epidermis with a few epidermal pegs having tendency to move towards the centre was noted. But in the control group the dermal layer was still in the process of regeneration and there was no evidence of epidermis.

On the basis of all the findings of the histo-pathological studies it was concluded that wound healing was accelerated by topical use of *harida* and *baheda* in the treated group.

Results at OUAT showed that in animals treated with powder of *harida* and *baheda* mixed with water, the hoof lesions were cured within 10-11 days. All other parameters were found

Table 2. Wound-healing score of FMD treated with *harida* and *bahera* (ITK) and conventional therapy (CT) at WBUAFS

Parameter	Group	Days of observation			
		0	4	8	12
Quantity of exudation	**ITK**	3.26	1.69	0.32	0.0
	CT	3.33	0.63	0.0	0.0
Colour	ITK	3.52	1.86	0.39	0.0
	CT	3.54	1.72	0.0	0.0
Pain	ITK	3.43	2.13	0.66	0.0
	CT	3.39	1.75	0.0	0.0
Lameness	ITK	3.29	2.38	0.71	0.0
	CT	3.34	2.09	0.52	0.0

Table 3. Observations on performance of *harida* and *baheda* (ITK) and conventional therapy in treatment of FMD lesions at OUAT

Parameter	*Harida* and *baheda*	Conventional therapy
Effectiveness in treatmem :	Moderate	Marked
Recovery period (days)	10-11	5-6
Improvement in milk yield	Moderate	Marked
Improvement of health	Marked	Marked

improved. Animals of Group 2 treated with antibiotic and antiseptic recovered within 5-6 days (Table 3).

CONCLUSION

The ITK consisting of use of paste prepared from seeds of *harida* and *baheda* was validated at Veterinary colleges BAU, WBUAFS and OUAT. The practice proved effective in management of foot lesions in FMD, albeit at lower efficacy than the conventional treatment. Histo-pathological findings showed that wound healing was accelerated by topical use of *harida* and *baheda*, which could be responsible for efficacy of ITK. □

Code	**: 1279**
Title of the ITK	**: Curing lesions of FMD or wounds by applying extract of peach *(Prunus persica)* leaves mixed with fresh milk**
Description of the ITK	: To treat the lesions of mouth and hooves of the animals suffering from FMD, extract of peach leaves mixed with fresh milk is applied three times daily on the lesions of FMD-affected parts of the animals. This is followed in many villages of Budaun, Shahjahanpur and Bareilly districts of Uttar Pradesh.
Name and address of the discloser	Shri Syed Musawwir Ali, mohalla Furshori Tola, Bund Gali, Badaun 243 601 (Uttar Pradesh)
Location of use of the ITK	Farmers in villages of Bareilly and Badaun districts use peach leaves to cure wounds both for family members and animals.
Experimenters	Indian Veterinary Research Institute (IVRI), Izatnagar-243 122 (Uttar Pradesh). Dr D. Swamp, Head, Division of Medicine, Dr A.K. Sharma, Senior Scientist and Dr Naveen Kumar, Senior Scientist, Division of Surgery and Dr Mahesh Chandra, Division of Extension Education. Govind Ballabh Pant University of Agriculture and Technology (GBPUAT), Pantnagar 263 145 (Uttaranchal). Dr Mahesh Kumar, Professor and Head, Department of EPM and Dr Arup Das, Associate Professor, Department of Surgery and Radiology, College of Veterinary Sciences.

METHODOLOGY

The ITK was validated initially at IVRI, Izatnagar and also at GBPUAT, Pantnagar for cross-sectoral revalidation during 2003-04.

Experiment

IVRI

Peach *(Prunus persica)* leaves were evaluated with fresh milk for the treatment of wounds. During the period of investigation of 2004, total 23 maggot wounds were treated with the paste of peach *(Prunus persica)* leaves at Livestock Production Research (Cattle and Buffalo) and at veterinary polyclinics of the Institute. The cases included 17 of bovines and 6 of canines. The paste was applied on the affected part and the wound was bandaged. The wounds were evaluated on days 0,3,7,10,14 and 21 or till the healing based on the evaluation of exudation, quantity of exudates, peripheral swelling, warmth and pain, colour of wounds and granulation tissue.

GBPUAT

Collection and processing of peach leaves: Fresh neat and clean peach leaves were collected from the local areas and grinded to prepare paste in distilled water as and when required.

Experimental animals: Cattle and buffaloes (40) having wounds on various parts of body were selected at IDF, College Veterinary Teaching

Contents

Hospital, and the nearby villages were divided into two groups of maggoted and non-maggoted wounds of 20 animals each. These two groups were further subdivided into 2 subgroups for therapeutic evaluation.

Therapeutic trial: To study the comparative therapeutic efficacy, the subgroups a and b of groups I and II animals were treated as per protocol given below.

Wounded animals (n=40)

Maggoted wounds (n=20)	Non-maggoted wound (n=20)
(a) Standard therapy (n=10)	(a) Standard therapy (n=10)
(Lorexane ointment)	(Betadine dressing + Sulprim bolus)
b. Peach leaves paste (n=10)	b. Peach leaves paste (n=10)

Depending upon clinical recovery, period of medication varied from 14 to 21 days in animals and even within a group. All the affected wounds were evaluated on days 0, 3, 7, 10, 14 and 21 or till healing occurred on the basis of parameter given below.

Exudation: Type of exudates was scored and graded as 0= dry casts; 1= serious; 2= fibrinous; 3= seropurulent and 4= purulent.

Quantity of exudate: Quantity of exudates was scored as 0= none (apparently dry wound); 1 = slight (wound is moist but not oozing on pressing); 2= moderate (wound is moist and slightly oozing on pressing); and 3= extreme (exudate is visible and pressure leads to excessive exudation).

Peripheral swelling: Peripheral swelling was recorded at weekly intervals as- 0= nil; 1 = moderate and 2= marked.

Warmth and pain: Warmth around the affected area was compared with that of the normal area of touching with palm. This was done by the same person at 10.30 a.m. The warmth was graded as per order: 1= normal warmth; 2= mildly warmth; 3= moderately warmth and 4= hot.

Pain on manipulation: The pain of the affected area was recorded as: 0=no pain on extensive mani-pulation; 1= pain on extensive manipulation; 2= pain on moderate manipulation, and 3= pain on slight manipulation.

Colour of wound: It grossly depicts the status of healing and was scored as: 1= pale yellow; 2= pale red and 3= Pink.

Area of wound: Area of wound was recorded at 7 days intervals. Margins of wound, area of granulation and area of epithelization were marked and the percentage of healing was calculated. Finally time taken for complete healing was recorded.

RESULTS AND DISCUSSION

Therapeutic trial: Total 23 maggot wounds (17 bovine and 6 canine) were treated at **IVRI** with the paste of peach *(Prunus persica)* leaves. In bovines 8 cases recovered by day 7 and 6 recovered on day 14. The remaining 3 cases of maggot wounds required 28 days (4 weeks) for

Table 1. Mean scores of different parameters at IVRI

Observations	Days of observation						
	0	3	7	10	14	21	28
Type of exudation	2.8	2.4	1.8	0.6	0.4	0.2	0.0
Quantity of exudation	1.9	1.4	0.8	0.6	0.0	0.0	0.0
Peripheral swelling	**1.4**	0.8	0.4	0.2	0.0	0.0	0.0
Warmth	1.8	1.2	1.0	1.0	1.0	1.0	0.0
Pain	1.8	1.4	0.6	0.4	0.0	0.0	0.0
Colour of wound	2.0	2.4	2.8	3.0	3.0	3.0	0.0

Table 2. Overall efficacy of peach leaves paste at IVRI

Type of wound	Species	No. of animals treated	Recovery period (days)		
			7 day	14 day	28 day
Maggot wounds	Bovines	17	8	6	3
	Canines	6	3	3	
Efficacy (%)			47.82	86.95	100

Table 3. Score sheet of wound healing (Group I) at different days of treatment (mean value) at GBPUAT, Pantnagar

Observation	Subgroup	Days of observation					
		0	3	7	10	14	21
		Maggotted wound					
Type of exudation	a	2.5	2.2	1.4	0.8	0.3	0.0
	b	2.3	2.1	1.1	0.5	0.2	0.0
Quantity of exudation	a	2.0	1.4	0.8	0.5	0.2	0.0
	b	1.9	1.7	0.5	0.3	0.2	0.0
Peripheral swelling	a	1.3	0.8	0.5	0.2	0.0	0.0
	b	1.4	0.9	0.6	0.2	0.0	0.0
Warmth	a	1.8	1.5	1.2	1.0	1.0	1.0
	b	1.9	1.3	1.1	1.0	1.0	1.0
Pain	a	1.8	1.4	0.6	0.4	0.0	0.0
	b	2.1	1.7	1.6	1.1	0.4	0.0
Colour of wound	a	2.0	2.4	2.8	3.0	3.0	0.0
	b	2.1	2.5	2.9	3.0	2.0	0.0
		Non-maggoted wound					
Type of exudation	a	2.5	2.2	1.4	1.0	0.5	0.0
	b	2.2	2.0	1.5	0.8	0.4	0.0
Quantity of exudation	a	1.7	1.4	1.0	0.5	0.2	0.0
	b	1.6	1.3	0.9	0.4	0.3	0.0
Peripheral swelling	a	1.0	0.8	0.7	0.5	0.2	0.0
	b	1.2	0.9	0.6	0.4	0.1	0.0
Warmth	a	1.9	1.4	1.0	1.0	1.0	1.0
	b	1.8	1.3	1.2	1.1	1.0	1.0
Pain	a	1.9	1.5	0.9	0.4	0.2	0.0
	b	2.1	1.7	0.8	0.6	0.4	0.0
Colour of wound	a	2.2	2.3	2.8	3.0	3.0	0.0
	b	2.4	2.5	2.9	2.9	3.0	0.0

complete recovery. It was noticed that the recovery period was longer when the site of wound was such that bandage could not be applied. In canine 3 cases recovered on day 7 but the remaining 3 recovered on day 14.

The paste of peach leaves was found very effective in the treatment of maggot wounds. One or two applications were required to kill the

Fig. 1. Different stages of treatment of maggot wound in dog A. Before treatment B. Application of peach-leaf paste C. Complete healing by day 21

Fig. 2. Different stages of treatment of non-maggot wound in cow
A. Non-maggot vulvar wound before treatment B. Application of peach-leaf paste
C. Complete healing by day 21

maggots. There was reduction in peripheral swelling, decrease in pain and warmth scores following the treatment and the healing progressed (Table 1).

The type and quantity of exudate decreased after 2-3 applications. The wounds appeared dried and the peripheral swelling subsided. There was concomitant decrease in pain and warmth scores. As the healing progressed, the colour of wounds changed from pale red to pink. A majority of the wounds were healed by day 14, whereas 3 wounds required longer period (day 28) for healing. The overall efficacy of the peach-leaf paste in healing the wound was 47.82, 86.95 and 100% on day 7, 14 and 28 respectively (Table 2), which is almost comparable to the efficacy of standard veterinary treatment. The efficacy of peach leaves may be attributable to the presence of phytochemical

ingredients such as flavonoids.

At GBPUAT, a total of 8 cases of maggoted wound out of total 10 got cured by application of fresh paste of peach leaves twice for 14—21 days. However, by the standard therapy, 90% (9/10) of maggot wound were cured in 14 days. The therapeutic efficacy of peach-leaf paste in non-maggot wound was 70% in group Ila compared with 90% in standard therapy group lib. (Table 3).

Identification of maggots: The species of maggots were identified in 3 cases of the wounds at IVRI. The maggots belonged to *Callitroga* species. The average length of maggots was 10 mm.

Ingredient analysis of peach leaves: The peach leaves were subjected to phytochemical testing and the active compounds were identified as flavonoids, alkaloids, steroids and triterpenoids, fixed oils and fats, tannins and phenolic compounds.

CONCLUSION

The peach leaves were found effective for the treatment of maggot wounds. One or two applications were required to kill or expel the maggots. The paste was applied on the affected part and bandaged. After 2-3 applications the type and quantity of exudates decreased. The wounds appeared dried and the peripheral swelling subsided. Healing of the maggot wounds took longer time where bandaging was not possible. The efficacy of ITK may be attributable to presence of active ingredients such as flavonoids, steroids, fixed oils etc. Its efficacy was comparable to that of standard veterinary treatment.

□

Code : **1288**

Title of the ITK **Use of *babool {Acacia nilotica)* and *jamun (Syzygium cumini)* bark extract to cure foot-and-mouth disease in animals**

Description of the ITK : A paste of *babool* bark and *jamun* bark is applied on the hooves of the FMD-affected animal thrice daily, costing Rs 2-5 per animal. In this method the disease is cured up to 70%.

Name and address of the discloser Shri Syed Musawwir Ali, mohalla Furshori Tola, Bund gali, Badaun, district Bareilly

Location of use of the ITK : This is practised in many villages of Baduan and Bareilly districts of Uttar Pradesh.

Experimenters : Indian Veterinary Research Institute (IVRI)

Dr D. Swarup, Principal Scientist and Head, Division of Medicine, IVRI, Izatnagar and Dr T.J. Rasool, Principal Scientist, Dr R.K. Singh, Head, Division of Virology, Dr V Bhanuprakash, Scientist and Dr Ram Naresh, Scientist, IVRI, Mukteswar, Nainital (Uttaranchal)

Birsa Agricultural University (BAU)

Dr S. Haque, Head and Dr P. Shekhar, Assistant Professor, Department of Medicine, Ranchi Veterinary College, Ranchi 834 006 (Jharkhand)

West Bengal University of Animal and Fishery Sciences (WBUAFS),

Dr N.R. Pradhan, Professor and Head and Dr C. Lodh, Lecturer, Department of Medicine, Faculty of Veterinary and Animal Science, Kolkata 700 037 (West Bengal)

METHODOLOGY

Experiment

IVRI

Use of *babool* bark *and jamun* bark decoction was found highly effective in treatment of foot lesions in clinical cases of FMD during 2003. The ITK was found cost effective and had easy accessibility. Therefore it was recommended for *in-vitro* antiviral activity trials.

Preparation of extracts: Aqueous extracts of *babool* and *jamun* bark were prepared as per standard protocol and were put to solubility test. The aqueous extracts of *babool* and *jamun* were readily dissolved in sterile distilled water. A 10 mg/ml stock of extracts was made in sterile distilled water and filtered separately using 0.22 mm filters. The filtrates were used for cytotoxicity in $BHK_{2|}$ and Vero cell lines.

Cytotoxicity study: Initially the following concentrations of the extracts were prepared in GMEM/EMEM with 1 % new born calf serum or

bovine-calf serum from the stock solutions. BHK_{21} or Vero cells were grown to confluence for 48 hr in 24-well plates. Then the monolayers were washed with GMEM/EMEM containing 1 % NBCS/BCS and antibiotics. Later each of the extracts concentrations in GMEM/EMEM with 1% NBCS/BCS in quadruplicates was fed on to the confluent monolayer with appropriate controls. The plates were incubated at 37°C under 5% CO_2 for 96 hr and up to 144 hr. The cells were observed at 24 hr intervals for cytotoxicity and the following changes were noted.

Determination of safe concentrations: Safe concentration of the extracts were determined by using 1, 10, 100, 1,000, 2,000 and 3,000 mg/ml extract of *babool* or *jamun* in BHK_{21} cell monolayer for 96 hr.

Determination of viable cells: The confluent monolayers of both $BHK_{2|}$ and vero cells were treated with different concentrations (as indicated below) with appropriate controls and then incubated in an incubator at 37°C for 72 hr under 5% CO_2. After the incubation period, the cells were treated with trypsin to detach the cells from the surface and then the cells were stained with 0.4% Trypan blue.

Antiviral activity against blue-tongue virus serotype: Initially, the vero cells were put for 24 hr in a 24 well-cell culture plate (Nunc). The cells were washed with 2% EME medium. Then 100 $TCID_{50}$/100 ml BTV serotype 23 was infected in duplicates and allowed to adsorb for 1 hr. The unadsorbed virus was removed by washing the cell monolayers with 2% EME medium. Further the monolayers were fed with different concentrations of *babool* (10, 40, 50 and 100 mg/ml) and *jamun* (10, 100, 800 and 1000 mg/ml) separately with appropriate virus and cell controls. The plates were incubated in a 5% CO_2 incubator at 37°C for 72 hr and the readings were noted.

Antiviral activity against goat-pox virus (GPV): The experiment was conducted as above for GPV, i.e. by using both direct and indirect methods for all the extracts.

RESULTS AND DISCUSSION

Determination of safe concentration showed that 1,000 mg/ml and higher concentrations induced rounding of cells as early as at 24 hr. The rest of the concentrations and BHK_{21} control cells remained normal. Similar results were also noticed with vero cell lines as early as at 24 hr and up to 120 hr.

The total, viable and percentage of viable cells were counted or calculated and the results are given in Table 1.

When tested against blue-tongue virus, cytopathic changes (CP) were observed in all the wells with all the concentrations of *babool* and

Table 1. Total, viable and percentage of viable cells at different concentrations of *babool* and *jamun* extracts at IVRI

Concentrations	10µg/ml	100µg/ml	1000µg/ml	2000µg/ml	3000µg/ml	Control
			Babool			
Total cell count	2.1×10^6/ml	2.9×10^6/ml	3.1×10^6/ml	1.7×10^6/ml	1.1×10^6/ml	1.8×10^6/ml
Viable cells	2.0×10^6/ml	2.6×10^6/ml	1×10^6/ml	0	0	1.7×10^6/ml
Viable cells (%)	95.23	89.65	33.3	0	0	95
			Concentration (µg/ml)			
Total cell count	2.7×10^6/ml	2.3×10^6/ml	2×10^6/ml	1.9×10^6/ml	2.2×10^6/ml	1.8×10^6/ml
Viable cells	2.6×10^6/ml	2.2×10^6/ml	1.9×10^6/ml	1.8×10^6/ml	2.0×10^6/ml	1.7×10^6/ml
Viable cells (%)	96.15	95.65	95	94.73	90.90	95

jamun bark extracts treated except the cell control. This indicates that the aqueous extract of *babool,* at concentration mentioned, does not inhibit blue-tongue virus serotype 23. Further, the titration of the virus was carried out from each concentration in vero cell line. The titre of the virus control and infected cells treated with different concentrations remained 10^6 $^{66}TCID_{50}$/ml. There was no reduction in the titre of the virus compared to that of the virus control. Against GPV there was 4 log inhibition of the titre by *babool* extract at 1/ 100,4/100, 5/100 and 10/lOOpil concentrations both in direct and indirect methods. *Jamun* inhibited at 100/100, 500/100, 1000 u.g/100 M-l. The 10 p.g/100 nl concentration did not show any effect in indirect method but reduced the 2 log titre of the virus in direct method. Further, one step growth studies are required to determine the stage at which these extracts are acting on GPV.

Experiment

BAV

The trial was conducted in 20 clinical cases following outbreak of FMD in Tatisilvy and Jagnnathpur villages of Ranchi district. Most of these cases were 5-7 days old and had severe foot lesions, whereas some cases were in very early stages where only lameness and mouth lesions were observed.

From fresh bark of *jamun* and *babool* the decoction was prepared by boiling 250 g bark of each tree in 1 litre of water till the volume became half. Thereafter, the decoction was filtered through muslin cloth. The foot lesions were washed with decoction and the farmers were advised to repeat the treatment in similar manner twice or thrice daily and restrict the grazing of animals and entry into the muddy places. The animals were examined for healing of the lesion after 7 days. The information to decide the recovery rate was collected from farmers.

WBUAFS

The trial was conducted in 10 clinical cases of FMD. The decoction was prepared by boiling 250 g bark of each of *babool* and *jamun* tree in 1 litre of water and die volume was reduced to half. It was filtered dirough muslin clodi and the foot lesions were washed witii the decoction twice daily for a maximum period of 10-12 days or till recovery.

A group of 12 cattle was treated with the conventional therapy comprising antibiotic (Moxel @ 2-3 g intramuscularly daily for 4 days) and analgesic (Butagesic @ 10 ml intramuscularly daily for 3 days). The lesions were washed witii 1% potassium permanganate solution twice daily. Boroglycerine was applied on mouth lesions and Himax ointment on foot lesions after washing.

The healing of lesions was assessed on die basis of colour of wound, quantity and type of exudation and pain on a scale of 0-4.

RESULTS AND DISCUSSION

At BAU, the ITK, comprising application of *babool* and *jamun* bark on foot lesions dirice daily, showed good efficacy because die lesions healed rapidly witiiout development of maggot in FMD-affected catde and buffaloes. The average duration for the complete recovery was 22.5 days with a range of 7 to 29 days. However, wound healing occurred by day 10 in a majority of the cases (Table 2).

Table 2. Wound-healing score in FMD treated animals (with decoction of *babool* and *jamun* bark) at BAU

Parameter	Days of observation					
	0	2	4	6	8	10
Quantity of exudation	5	5	5	3	3	0
Peripheral swelling	7	5	3	3	0	0
Warmth	7	7	3	0	0	0
Pain	7	5	3	0	-	-
Colour of swelling	10	7	5	3	3	0
Quality of swelling	7	5	3	3	0	-

Table 3. Wound-healing score in animals affected by FMD with decoction of *babool* and *jamun* bark (ITK) and conventional therapy (CT) at WBUAFS

Parameter	Group	Days of observation			
		0	4	8	12
Quantity of exudation	ITK	3.19	1.82	0.69	0.0
	CT	3.33	0.63	0.0	0.0
Colour	ITK	3.49	2.49	0.78	0.00
Pain	CT	3.54	1.72	0.0	0.0
Lameness	ITK	3.46	2.43	1.53	0.52
	CT	3.39	1.75	0.0	0.0
	ITK	3.54	2.67	1.24	0.36
	CT	3.34	2.09	0.52	0.0

At WBUAFS the application of the ITK comprising *babool* and *jamun* bark decoction resulted in recovery of foot lesions within 12 to 13 days. However, the conventional veterinary treatment resulted in recovery from foot-and-mouth lesions within 6 to 7 days. Wound exudation, pain and lameness decreased in both the treated groups after 4 days of treatment (Table 3). The results indicated that ITK was effective in management of foot lesions in FMD though at lower efficacy than the conventional treatment.

CONCLUSION

At BAU, ITK consisting of use of decoction *of jamun* and *babool* bark in FMD lesion was initially validated at IVRI, Izatnagar and was reported to be highly effective in the management of foot lesions in outbreak of FMD. The ITK was cross validated at Ranchi and Kolkata veterinary colleges. The findings from these two centres also confirmed the earlier findings that ITK is effective in management of FMD foot lesions. However, studies conducted at IVRI did not reveal any antiviral activity of either of the bark extracts against blue-tongue virus. *Rut jamun* bark extract had inhibitory effects on goat-pox virus. It can be suggested that ITK had some wound-healing as well as selective anti viral-potential. Further studies are required to establish antiviral activities of these two bark extracts, especially against FMD virus.

Code	**:**	**1588**
Title of the ITK		**Control of FMD in cattle with camphor**
Description of the ITK	:	In February and March, or October and November, nearly 20% cattle and buffaloes suffer from FMD in Jharkhand region. Mouth and hoove wounds are common in cattle and other animals. Farmers of Bagraisai village of Saraikela Kharsawan district in Jharkhand use the following practice for their treatment. 1 .*For hooves:* Cattle are made to walk in sandy soils along die river bed. The coarse sand helps clean the wound by friction. Hooves are washed with hot water. Then 2 pieces of camphor and 10 ml coconut oil mixed together are applied on the wounds, which act as an antiseptic. 2. *For mouth:* Paste of roasted brinjal and pure ghee is scrubbed on the tongue to clean as well as treat the lesions. The cost of these two treatments is quite low; i.e. Rs 3 to 5 per animal, which is successful in more than 95% of cases. All the farmers in the village use these age-old practices.
Name and address of the discloser		Ms Chami Murmu, Sahyogi Mahila, Bagraisai, Govindpur, Rajnagar, Saraikala, Kharsawan 831 002 (Jharkhand)
Location of use of the ITK		Village Bargaisai, block Rajnagar, Saraikela (Jharkhand)
Experimenters		Birsa Agricultural University (BAU) Dr S. Haque, Head and Dr P. Shekhar, Assistant Professor, Department of Medicine, Ranchi Veterinary College, Ranchi 834 006 (Jharkhand) West Bengal University of Animal Sciences and Fishery Sciences (WBUA&FS) Dr N.R. Pradhan, Professor and Head and Dr C. Lodh, Lecturer, Department of Medicine, Faculty of Veterinary and Animal Science, Kolkata-700 037 (West Bengal) Orissa University of Agriculture and Technology (OUAT) Dr P.K. Das, Professor and Head, Dr G.S. Panda, Assistant. Professor, Department of Epidemiology and Preventive Medicine, Orissa Veterinary College, Bhubaneshwar 751003 (Orissa)

Contents

METHODOLOGY

Experiment

BAU

The trial was conducted on 30 clinical cases of FMD, divided in 3 groups. Animals in group I had severe lesions mainly on dorsum of tongue and were treated with roasted brinjal mixed with ghee. Brinjal (100-150 g) was roasted and after removing the superficial peel it was mashed properly, and 25-30 g ghee was added to it. The preparation was applied on tongue after thorough washing twice daily for 4—5 days.

Animals of group II having severe lesions on hooves especially on interdigital spaces were treated by applying a mixture prepared by mixing 4 pieces of camphor in 20 ml coconut oil after thorough washing with plain water for 7 days.

The animals of group III were treated with allopathic medicine, streptopenicillin, @ 10 mg / kg body weight for 3 days.

WBUAFS

The trial was conducted in total 9 clinical cases of FMD. The animals were treated by applying paste prepared by mixing 100 g of roasted brinjal in 50 g ghee on the mouth lesions once daily and 2 pieces of camphor with coconut oil once daily for 10-12 days.

A group of 12 cattle was treated with the conventional therapy comprising antibiotic (Moxel @ 2-3 g intramuscularly daily for 4 days) and analgesic (Butagesic @ 10 ml intramuscularly daily for 3 days). The foot and mouth lesions were washed with 1% potassium permanganate solution twice daily. Boroglycerine was applied on mouth lesions and Himax ointment on foot lesions after washing.

The healing of lesions was assessed on the basis of colour of wound, quantity and type of exudation and pain on a scale of 0-4.

OUAT

The trial was conducted in total 9 clinical cases of FMD. Mouth lesions in 6 animals were treated by applying a paste of roasted brinjal mixed in ghee once daily and 3 foot lesions were treated with coconut oil once daily.

Six animals were given enrofloxacin (10%) intramuscularly and foot lesions were washed with potassium permanganate or Providone iodine. Boroglycerine was applied on the mouth lesions.

The efficacy of treatment was evaluated by healing score of foot and mouth lesions, general clinical improvement, improvement in gait, and appetite.

RESULTS AND DISCUSSION

Tables 1 and 2 than that use of the paste of roasted brinjal and ghee and camphor in coconut oil was 90% effective in the cure of mouth and foot lesions respectively The mouth lesions disappeared after day 3 of the treatment and the

Table 1. Mouth lesion healing score of FMD affected cattle treated with Brinjal+ghee paste at BAU

Parameter	Day of observation			
	0	2	4	6
Quantity of exudation	10	5	0	0
Peripheral swelling	7	5	3	0
Warmth	7	3	0	0
Pain	10	3	0	0
Colour of swelling	10	5	3	0
Quality of swelling	10	3	6	0

Table 2. Healing score of foot lesions in FMD affected cattle treated with camphor+ coconut oil at BAU

Parameter	Day of observation			
	0	2	4	6
Quantity of exudation	5	3	3	0
Peripheral swelling	7		3	0
Warmth	7	5	3	0
Pain	7	5	3	0
Colour of swelling	10	7	5	3
Quality of swelling	7	5	3	3

animal started taking food normally. In comparison, animals treated with allopathic medicine (streptopenicillin) showed only 70 % recovery.

Foot lesions showed recovery by day 7 of ITK treatment. Importantly, no maggots were developed during the course of the treatment with camphor and coconut oil. The foot lesions did not recover fully in the allopathic treatment group probably due to non-application of local antiseptics.

Table 3. Wound healing score in cases of FMD treated with brinjal and ghee (ITK) and conventional therapy (CT) at WBUAFS

Parameter	Group	Day of observation			
		0	4	8	12
Quantity of	ITK	3.24	1.84	0.78	0.0
exudation	CT	3.33	0.63	0.0	0.0
Colour	ITK	3.46	2.32	0.89	0.32
	CT	3.54	1.72	0.0	0.0
Pain	ITK	3.44	2.33	1.44	0.42
	CT	3.39	1.75	0.0	0.0
Lameness	ITK	3.40	2.46	1.31	0.48
	CT	3.34	2.09	0.52	0.0

At WBUAFS, the application of the ITK comprising roasted brinjal in ghee and camphor in coconut oil resulted in recovery of foot lesions within 11 to 13 days. However, the conventional veterinary treatment resulted in recovery from foot and mouth lesions within 6 to 7 days. Wound exudation, pain and lameness decreased in both the treated groups after 4 days of treatment. However, in ITK treatment group, pain on the site of lesions did not subside completely and the gait of animals showed slight lameness till the period of observation (Table 3). The results indicated that ITK was moderately effective in the management of foot lesions in FMD.

Animals treated with roasted brinjal and pure ghee paste at OUAT showed the healing of mouth lesions in 10-11 days. Animals treated with camphor + coconut oil recovered in 8 —10 days, with complete healing of lesions. The recovery period with conventional veterinary treatment was 5-6 days.

CONCLUSION

The ITK consisting of use of roasted brinjal in ghee and camphor in coconut oil for mouth and foot lesion, respectively in FMD was initially validated at veterinary college, BAU and was found effective in curing mouth lesions completely and foot lesions partially in cases of FMD. The ITK was cross-validated at veterinary colleges of BAU, OUAT and WBUFS. The findings from BAU which demonstrated that ITK was highly effective in management of mouth and foot lesions due to FMD. At other two centres the ITK was found moderately effective. In terms of cost, the ITK was highly effective than the allopathic treatment.

Code **1595**

Title of the ITK : **Use of** *bantulsi {Ocimum gratissimum)* **leaf paste for treatment of *khurha* (FMD) in cattle and buffalo**

Description of the ITK : *Bantulsi* has medicinal properties against FMD. Paste of its leaves is prepared after grinding it along with water and is applied on the infected foot of cattle and buffalo at least twice daily for 3-4 days. The practice is prevalent in Barmasa village of Jarmundi block in Dumka district (Jharkhand) and has potential for spread in the areas where *bantulsi* is available. Success has been reported in more than 75% of the cases.

Name and address of the discloser : Shri Varun Lai, C/o Lok Jagriti Kendra, 52 Bigha, Madhupur, Deoghar (Jharkhand)

Location of use of the ITK Barmasa, Jarmundi, Dumka (Jharkhand)

Experimenters Indian Veterinary Research Institute (IVRI)

Dr D. Swarup, Principal Scientist and Head, Division of Medicine, I.V.R.I., Izatnagar; and DrT.J. Rasool, Principal Scientist, Dr R.K. Singh, Head, Division of Virology, Dr V. Bhanuprakash, Scientist and Dr Ram Naresh, Scientist, I.V.R.I., Mukteswar, dist Nainital.

West Bengal University of Animal Sciences and Fishery Sciences (WBUAFS), Kolkata

Dr N.R. Pradhan, Professor and Head and Dr C. Lodh, Lecturer, Department of Medicine, Faculty of Veterinary and Animal Science, Kolkata 700 037 (West Bengal)

METHODOLOGY

Experiment

IVRI

Use of *bantulsi* was found slightly effective in treatment of foot lesions in clinical cases of FMD during the validation trial conducted at Veterinary College, BAU, Ranchi in 2003. Therefore it was recommended for cross-sectoral validation and *in-vitro* antiviral activity trials.

Preparation of extracts: Aqueous and alcoholic extracts of *bantulsi* were prepared as per standard protocol and put to solubility test. Both the extracts readily dissolved in sterile distilled water. A 10 mg/ml stock of extracts was made in sterile distilled water and filtered separately using 0.22 mm filters. The filtrates were used for cytotoxicity in $BHK_{2|}$ and vero cell lines.

Cytotoxicity study: Initially, different concentrations of the extracts were prepared in GMEM/EMEM with 1 % new born calf serum or bovine calf serum from the stock solutions. BHK_{21} or vero cells were grown to confluence for 48 hr in 24-well plates. Then the monolayers were washed with GMEM/EMEM containing 1%

Contents

NBCS/BCS and antibiotics. Later each extract concentrations in GMEM/EMEM with 1% NBCS/BCS in quadruplicates was fed on to the confluent monolayer with appropriate controls. The plates were incubated at 37°C with 5% CO_2 for 96 hr up to 144 hr. The cells were observed at 24 hr intervals for cytotoxicity and the following changes were noted.

Determination of safe concentrations: Safe concentration of the alcoholic and aqueous extracts of *bantulsi* were determined by using 1, 10, 100, 1,000, 2,000, 3,000 and 4,000 mg/ml in BHK_{2l} cell monolayer for 96 hr.

Determination of viable cells: The confluent monolayers of both BHK_{21} and vero cells were treated with different concentrations (indicated below) with appropriate controls and then incubated in an incubator at 37°C for 72 hr under 5% CO_2. After the incubation period, the cells were treated with trypsin to detach the cells from the surface, which were then stained with 0.4% Trypan blue.

Antiviral activity against blue-tongue virus serotype: Preliminarily, the vero cells were put for 24 hr in a 24 well cell culture plate (Nunc). The cells were washed with 2% EME medium. Then 100 $TCID_{5(}$/100 ml of OBTV serotype 23 was infected in duplicates and allowed to adsorb for 1 hr. The unadsorbed virus was removed by washing the cell monolayers with 2% EME medium. Further, the monolayers were fed with different concentrations of *bantulsi* alcoholic and aqueous extracts separately with appropriate virus and cell controls. The plates were incubated in a 5% CO_2 incubator at 37°C for 72 hr and the readings were noted.

Antiviral activity against goat-pox virus: The experiment was conducted as above for GPV, i.e. by using both direct and indirect methods for all the extracts.

RESULTS AND DISCUSSION

Determination of safe concentration showed that 100, 500, and 1000 mg/ml *bantulsi* alcoholic extract did not change the morphology of both $BHK_{,t}$ and vero cells for 96 hr and 120 hr respectively, whereas the concentrations 2,000, 3,000 and 4,000 mg/ml induced rounding and detachment of cells as early as at 24 hr both in BHK_{21} and vero cell lines. Its aqueous extract at 100,500, and 1,000 mg/ml concentrations did not change the morphology of both BHK_{21} and vero cells for 96 and 120 hr respectively, whereas that of 4,000 mg/ml induced rounding and detachment of cells as early as at 24 hr, 3,000 mg/ml after 48 hr and 2,000 mg/ml after 72 hr both in BHK_{2l} and vero cell lines.

The total, viable and percentage of viable cells

Table 1. Total and viable cell count at different concentrations of *bantulsi*

Concentration	Concentration (mg/ml)						
	100	500	1,000	2,000	3,000	4,000	Control
				Alcoholic extract			
Total cell count	2.9×10^6/ml	2.5×10^6/ml	2.5×10^6/ml	2.4×10^6/ml	2.4×10^6/ml	2.5×10^6/ml	2.8×10^6/ml
Viable cells	2.8×10^6/ml	2.3×10^6/ml	2.3×10^6/ml	1×10^6/ml	0.4×10^6/ml	0	2.7×10^6/ml
Viable cells (%)	96.55	92	92	41.16	16.66	0	96.42
				Aqueous extract			
Total cell count	2.6×10^6/ml	2.5×10^6/ml	2.6×10^6/ml	2.4×10^6/ml	2.7×10^6/ml	2.6×10^6/ml	2.8×10^6/ml
Viable cells	2.5×10^6/ml	2.4×10^6/ml	2.4×10^6/ml	0.9×10^6/ml	0.5×10^6/ml	0	2.7×10^6/ml
Viable cells (%)	96.15	96	92.3	37.5	18.5	0	96.42

were counted or calculated and the results are given in Table 1.

Antiviral activity: Bantulsi aqueous extract at different concentrations was found non-inhibitory to blue-tongue and GPV, because virus titres remained the same in treated as well as control wells.

Experiment

WBUAFS

The trial was conducted in total 11 clinical cases of FMD. The paste from leaves of *bantulsi* was prepared by using an electric grinder. The paste was applied on the foot lesions twice daily for a maximum period of 10-12 days or till recovery was noticed.

A group of 12 cattle was treated with the conventional therapy comprising an antibiotic (Moxel @ 2-3 g intramuscularly daily for 4 days) and an analgesic (Butagesic @ 10 ml intramuscularly daily for 3 days). The foot and mouth lesions were washed with 1% potassium permanganate solution twice daily. Boroglycerine was applied on mouth lesions and Himax ointment was applied on foot lesions after washing.

The healing of lesions was assessed on the basis of colour of wound, quantity and type of exudation and pain on a scale of 0-4.

RESULTS AND DISCUSSION

The application of the ITK comprising *bantulsi* leaf paste resulted in recovery of foot lesions within 14 to 15 days. However the conventional veterinary treatment resulted in recovery from foot and mouth lesions within 6 to 7 days. Wound exudation, pain and lameness decreased in both the treated groups after 4 days of treatment. However, in ITK treatment group, the healing of wound lesions remained incomplete and the gait of animals showed slight lameness till the period of observation (Table 2). The results indicated that ITK was moderately effective in the management of foot lesions in FMD.

Table 2. Wound healing score in cases of FMD treated with paste of *bantulsi* leaves (ITK) and conventional therapy (CT)

Parameter	Group	Day of observation			
		0	4	8	12
Quantity of	ITK	3.42	1.96	1.03	0.48
exudation	CT	3.33	0.63	0.0	0.0
Colour	ITK	3.32	2.58	0.92	0.46
	CT	3.54	1.72	0.0	0.0
Pain	ITK	3.27	2.54	1.64	0.81
	CT	3.39	1.75	0.0	0.0
Lameness	ITK	3.26	2.84	1.58	0.59
	CT	3.34	2.09	0.52	0.0

Farmers were advised to repeat the treatment in similar manner twice or thrice daily and to restrict the grazing of animals and entry into the muddy places. The animals were examined for healing of the lesion after 7 days. The information to decide the recovery rate was collected from farmers.

CONCLUSION

The ITK consisting of the use *bantulsi* was moderately effective in the management of foot lesions in FMD affected animals. The extract of *bantulsi* also did not reveal antiviral activity against blue-tongue and goat-pox viruses.

□

Code	**:**	**1280**
Title of the ITK	**:**	**Use of stone apple *(bael)* to check diarrhoea in animals**
Description of ITK	:	Stone apple *(bael)* might have anti-diarrhoea ingredient. Its juice is mixed with water and drenched to the animals suffering from diarrhoea, 2-3-times a day. Treatment per animal costs Rs 15 to 20. The animal is cured in 2-3 days. This practice is in use in many villages of Budaun, Shahjahanpur and Bareiily in Uttar Pradesh.
Name and address of the discloser :		Ms Husan Afjal, Primary School Teacher, C/o late Ilyas Fatima, mohalla Vedon Tola, Bund gali, Baduan (Uttar Pradesh)
Location of use of ITK with full address and geo indicators		Animal owners of many villages in Budaun, Shahjahanpur and Bareiily
Experimenters		Indian Veterinary Research Institute (IVRI)
		Dr D Swarup, Head, Dr N.N. Pandey, Principal Scientist and Dr D.B. Mondal, Senior Scientist, Division of Medicine, IVRI, Izatnagar 243 122 (U.P.)
		Govind Ballabh Pant University of Agriculture and Technology (GBPUAT)
		Dr Mahesh Kumar, Professor and Head, Department of EPM and Dr J. L. Singh, Associate Professor, Clinical Medicine, College of Veterinary Sciences, Pantnagar, dist. U.S. Nagar (Uttaranchal) 263 145.
		Maharashtra Animal Science & Fisheries Sciences University (MASFSU)
		Dr N. K. Dakshinkar, Associate Professor, Dr G. B. Shrikhande, Assistant Professor and Dr D. B. Sarode, Professor and Head, Department of Clinical Medicine, College of Veterinary Sciences, Nagpur 44006 (Maharashtra)

METHODOLOGY

Experiment

IVRI

Therapeutic trials: *Bael* powder @ 24 g/100 kg body weight for 3 days was given orally to 25 clinical cases of animals suffering from neonatal diarrhoea (Gr II). The animals of Gr I (5) receiving standard treatment served as the control.

Evaluation of therapy: The diarrhoeic animals were kept under close observations and the treatment success in the two groups was evaluated on the basis of clinical and hemato-biochemical improvement.

Contents

Table 1. Experimental design

Therapeutic agents	Group	Dose regimen
Standard therapy (Cotrimazine)	I (n=5)	15 mg/kg body wt bid for 3 days
Standard therapy* + *bael* fruit powder	II (n=25)	15 mg/kg body wt + 24 g/100 kg body wt bid for 3 days

*Cotrimazine contains trimethprim and sulfadiazine.

Table 2. Grading for clinical score

Clinical score	Interpretations		
	Faecal consistency score	*Depression score*	*Dehydration score*
0	Normal (well-formed faeces)	Normal (fully alert and responsive)	Normal (bright eyes and pliable skin)
1	Pasty faeces	Mild depression, calf suckles but not vigorously	Mild dehydration, slight loss of skin elasticity, skin tents < sec., eyes do not recess into orbit
2	Semi-liquid faeces, still with a solid component	Moderate depression, calf able to stand, suckling is weak or disorganized	Moderate dehydration, skin tents > 3 seconds but <10 sec., eyes slightly recessed into orbit
3	Watery faeces	Severe depression, unable to stand or suckle	Severe dehydration, skin tents >10 sec., eyes markedly recessed into orbit

Clinical profile: The clinical scores (0-3 basis) for faecal consistency (FC), dehydration and depression were recorded on day 0 (before therapy) and days 3 and 7 after therapy as per the following criteria suggested by Walker *et al.* (1998).

Haemato-biochemical profile: The blood samples were collected before (day 0) and after administration of the treatment (days 3 and 7) and analysed for different haemato-biochemical parameters, viz. packed cell volume (PCV), glucose, protein, albumin (A) and globulin (G) ratio (A:G ratio), sodium (Na), potassium (K) and chloride (Cl) following standard methods.

GBPUAT

Therapeutic trials: Calves (30) suffering from diarrhoea were divided randomly into three equal groups. The animals of group I were given standard treatment in the form of Cflox-T_z bolus (ciprofloxacin + tinidazole) @ one bolus per 100 kg body weight twice a day for 3 days. The animals of group II were treated with *bael* powder juice @ 24 g/100 kg body weight twice a day for 3 days. The animals of group **111** received Cflox-T_z @ one bolus/100 kg body weight twice a day and *bael* powder juice @ 24 g/100 kg body weight twice a day for 3 days.

Evaluation of therapy: The animals were observed closely and therapeutic efficacy of different treatments was evaluated on the basis of clinical profile and haemato-biochemical changes

Clinical profile: To study the clinical profile of diarrhoeic calves, a clinical scores (0-3 basis) for faecal consistency, dehydration and depression was recorded on day 0 (before treatment) and days 3 and 7 after therapy.

Fig. 1. Powdered bael fruit

Fig. 2. Polypacked powder

Hemato-biochemical study: Major clinical manifestations including general appearance, status of dehydration, posture, temperature, pulse, respiration, heart rate etc. were recorded in all affected calves and the blood samples were collected for blood bio-chemicals analysis before (day 0) and after (days 3 and 7) the treatment.

Phytochemical study: The matured unripe *bael* fruits of medium size were procured from in and around Pantnagar. Its hard covering removed and fruit was sliced and shade dried. Subsequently the dried slices were powdered and 24 g each was stored in polythene packets till use. Aqueous, methanolic and hexane extracts of *bael* powder were prepared and subjected to chemical analysis and through HPTLC for active ingredient analysis.

Anti-microbial activity assessment: Agar well method was used to study antimicrobial activity of *bael* powder. A concentration of 500 mg/ml extract of *bael* powder was prepared in different solvents. An amount of 150 ul/well of this concentration was used for antimicrobial assessment.

Etiological investigation: To know the frequency distribution of various etiological agents, faecal samples of all the diarrhoeic calves were examined microscopically and for microbial culture and antibiotic sensitivity.

MASFSU

Therapeutic trial: The study was conducted on goats presented to Veterinary College Hospital, Nagpur with a history of diarrhoea or dysentery. These goats were subjected to detailed clinical and parasitological examinations and were sub-divided into parasitic and non-parasitic groups. These animals were randomly assigned to two treatments within each broad groups (parasitic and non-parasitic) comprising 6 goats irrespective of their age and sex.

Medium-sized unripe *bael (Aegle marmelos)* fruit was sliced, dried and grinded to powder. The bael-fruit powder was given orally @ 1.6 g/10 kg body weight twice a day to the goats suffering from parasitic and non-parasitic diarrhoea

Faecal sample examination: Faecal samples of goats suffering with diarrhoea were collected per-ractal in clean sterile glass vials before treatment and thereafter on day 6 of the treatment. The samples were examined by sedimentation technique immediately after collection.

Efficacy of treatment: Efficacy of the drugs was evaluated on the basis of eggs per gram faeces (EPG) determined by modified Stoll's dilution technique on days 0 and 6 after treatment.

Clinical examination: Clinical signs such as dehydration score and faecal consistency were recorded.

Table 3. Results of etiological investigation at GBPUAT

Causative agent	No. of calves affected out of total 46	Frequency distribution (%)
Toxocariasis	10	21.73
Coccidiosis	09	19.56
Colibacilosis *(E. coli)*	17	36.95
Nutritional scour/diarrhoea	04	08.69
Miscellaneous	06	13.04

Haemato-biochemical profile: Packed cell volume (PCV), serum total protein, albumin (A), globulin (G), A: G ratio, chloride, sodium and potassium were estimated from the blood samples collected on days 0 and 6 post treatment.

RESULTS AND DISCUSSION

Etiology of diarrhoea: For etiology of diarrhoea at IVRI, *E. coli* was isolated from 69% of faecal samples. The rest cases of diarrhoea could be attributable to other bacterial, viruses and non-infectious causes in the absence of specific tests. None of the calves was found to suffer from parasitic diarrhoea due to routine deworming programme at the farm.

Results of etiological investigation conducted at GBPUAT are given in Table 3. *E. coli* followed by toxocariasis were the predominant causes.

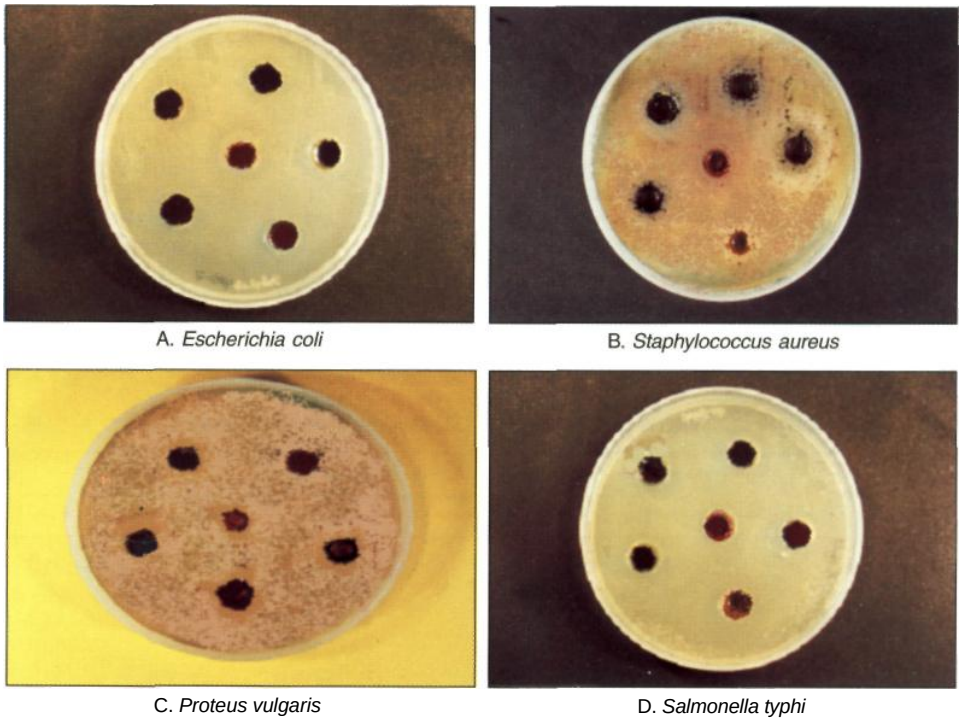


Fig. 3. *In vitro* antimicrobial profile against
(Clock-wise) 1. Methanolic extract of *Aegle marmelos;* 2. Hexane extract of *Aegle marmelos;* 3. Aqueous extract of *Aegle marmelos;* 4. Hexane extract of *Dalbergia sisoo;* 5. Methanolic extract of *Dalbergia sisoo;* 6. Centre aqueous extract of *Dalbergia sisoo*

Antimicrobial activity assessment: The bacteria for which antimicrobial assessment was made were: *Proteus vulgaris, Staphyloccus aueus, Escherichia coli* and *Salmonella typhi.* In this study only mild anti-microbial activity against *Staph, aureus* could be recorded. No antimicrobial activity was recorded against other bacteria.

Therapeutic efficacy of bael fruit: Results of experiments conducted at IVRI are presented in Tables 4-6.

The diarrhoeic calves of Gr II that received *bael-fruit* powder (ITK) together with standard antibiotic treatment showed better improvement than those of Gr I (without ITK) in terms of faecal consistency, depression and dehydration (based on clinical assessment and PCV). The result showed that the values of different haemato-biochemical parameters improved markedly to almost normal level by day 3 in animals of Gr II, whereas the animals of Gr I still continued to pass loose faeces and had mild depression and dehydration by day 3. Thus, the calves of Gr II had a faster recovery than those of Gr I, indicating significant supportive therapeutic effect of *bael* powder in diarrhoea. These results are in conformity with those of the previous year.

Antimicrobial activity assessment: The than those of Gr I (without ITK) in terms of faecal bacteria for which antimicrobial assessment was consistency, depression and dehydration (based made were: *Proteus vulgaris,Staphyloccusaueus,* on clinical assessment and PCV). The result *Escherichia coli* and *Salmonella typhi.* In this showed that the values of different haemato-study only mild anti-microbial activity against biochemical parameters improved markedly to *Staph. aureus* could be recorded. No antimicrobial almost normal level by day 3 in animals of Gr II, activity was recorded against other bacteria. whereas the animals of Gr I still continued to pass

Therapeutic efficacy of bael fruit: Results of loose faeces and had mild depression and experiments conducted at IVRI are presented in dehydration by day 3. Thus, the calves of Gr II Tables 4-6. had a faster recovery than those of Gr I, indicating

The diarrhoeic calves of Gr II that received significant supportive therapeutic effect of *bael bael-ivuii* powder (ITK) together with standard powder in diarrhoea. These results are in antibiotic treatment showed better improvement conformity with those of the previous year.

Table 4. Clinical score of diarrhoeic calves following treatment (mean ± SE) at IVRI

Table 4. Clinical score of diarrhoeic calves following treatment (mean ± SE) at IVRI

Parameter	Group I			Group II		
	DayO	Day 3	Day 7	DayO	Day 3	Day 7
Temperature (°F)	100.72 ±0.10	100.76 ±0.12	100.64 ±0.070	101.480 ±0.350	101.240 ±0.231	101.240 ±0.231
FCS (0-3)	2.20 ±0.20	1.000 ±0.316**	0.000 ±0.000**	2.000 ±0.316	0.000 ±0.000**	0.000 ±0.000**
Depression score (0-3)	1.800 ±0.200	0.800 ±0.200*	0.400 ±0.245**	1.400 ±0.245	0.400 ±0.245**	0.000 ±0.000**
Dehydration score (0-3)	1.400 ±0.245	0.800 ±0.490	0.400 ±0.245**	1.400 ±0.245	0.200 ±0.200**	0.000 ±0.000**
PCV (%)	44.8 ±1.020	42.4 ±1.327**	38.4 ±0.748**	44.0 ±1.41	37.6x ±0.75**	34.8 ±0.49**

*P<0.05; **P<0.01. Day 0: before therapy; days 3 and 7, after therapy day

Table 5. Mean haemato-biochemical profiles of group I (Cotrimazine) diarrhoeic calves (mean ±SE) at IVRI

Parameter	Group I (n=5)		
	Day 0	Day 3	Day 7
PCV (%) Glucose	44.80 ±1.02	42.40 ±1.33**	38.40±0.75**
(mg/dl) Total protein	44.22 ± 1.42	46.14±1.46**	51.06±0.83**
(g/dl) Albumin (g/dl)	6.97 ±0.13	6.51 ±0.14*	6.26±0.16**
A:G ratio	3.15 ±0.08	2.90 ±0.08*	2.76±0.09**
Sodium (mmol/litre)	0.82 ±0.01	0.79 ±0.01*	0.78±0.01**
Potassium (mmol/litre)	115.20 ±2.13	120.40 ±1.36**	123.20±1.07**
Chloride (mmol/litre)	5.44 ±0.18	5.22 ±0.18	4.76±0.17*
	96.91 ±0.75	98.42 ±0.54**	99.54±0.36**

*P<0.05; **P<0.01; Day 0: before therapy; Day 3: after therapy

Contents

Table 6. Mean haemato-biochemical profile of group II (Cotrimazine + *bael* fruit powder diarrhoeic calves (mean ± SE) at IVRI

Parameters	Group V (n=30)		
	DayO	Day 3	Day 7
PCV (%)	42.00±1.41	35.60x±0.75**	36.80±0.49**
Glucose (mg/dl)	46.74±2.02	57.14+1.49**	60.47±0.79**
Total protein (g/dl)	7.14±0.21	6.39+0.19*	6.17±0.05*
Albumin (g/dl)	3.22±0.14	2.86±0.03*	2.70±0.06**
A:G ratio	0.81±0.00	0.80±0.01	0.77±0.02

*P<0.05; **P<0.01; DayO . Before therapy; Day 3. Three post therapy day; Day 7: Seven post therapy day

Table 7. Pre- and post-treatment clinical profile of diarrhoeic calves (mean±SE) at GBPUAT

Parameter	Group	DayO	Day 3	Day 7
Faecal consistency score	I	2.30±0.3	1.20±0.24**	0.20±0.0**
	II	2.20±0.20	1.40±0.22*	0.40±0.0*
	III	2.40±0.40	0.80±0.20*	0.10±0.0**
Depression scores	I	1.90±0.20	1.20±0.34*	0.50±0.0**
	II	2.20±0.0	1.40+0.44*	0.60±0.20**
	III	2.50±0.40	1.00±0.32**	0.20±0.30**
Dehydration score	I	2.00±0.32	1.00±0.40*	0.40±0.20**
	II	2.40±0.41	1.20±0.42*	0.60±0.24**
	III	2.20±0.22	1.35±0.46*	0.30±0.20**

*P<0.05; **P<0.01; Day 0: before therapy; Day 3: after therapy

Table 8. Pre- and post-treatment values of haemato-biochemical profiles of group 1 (Cflox T) diarrhoeic calves (mean ± SE) at GBPUAT

Parameter	Group I (n=5)		
	DayO	Day 3	Day 7
PCV (%)	45.80±1.04	41.35±1.01*	37.42±1.04**
Glucose (mg/dl)	43.24±1.50	47.14±1.50*	52.08+1.25**
Total protein (g/dl)	6.90±0.54	6.50±0.16*	6.27±0.18**
Albumin (g/dl)	3.25+0.09	3.07±0.05*	2.80±0.09**
A:G ratio	0.84±0.02	0.81+0.01*	0.80±0.02*
Sodium (m mol/litre)	114.30+2.51	119.20±1.36*	124.62+1.56**
Potassium (m mol/litre)	5.30±0.20	5.12+0.17	4.80±0.14*
Chloride (m mol/litre)	94.81±0.60	99.22±0.52**	100.24±0.38**

*P<0.05; **P<0.01; Day 0: before therapy; Days 3 and 7, after therapy

Contents

Table 9. Pre- and post-treatment values of haemato-biochemical profiles of group II *(bael* fruit powder) diarrhoeic calves (mean±lSE) at IVRI

Parameter	Groupl I (n=10)		
	DayO	Day 3	Day 7
PCV (%)	48.50±3.55	42.34±2.44**	36.40±1.84**
Glucose (mg/dl)	46.25±2.62	52.58±3.84**	57.04±2.40**
Total protein (g/dl)	6.84+0.40	6.56±0.32*	6.24±0.28*
Albumin (g/dl)	3.12+0.18	3.04±14*	2.85±0.08**
A:G ratio	0.87±0.02	0.83±0.02	0.78±0.01*
Sodium (m mol/litre)	112.40±2.24	118.7+3.37*	124.35±4.26**
Potassium (m mol/litre)	5.91+0.20	4.95±0.06**	4.25±0.14**
Chloride (m mol/litre)	93.25±1.14	98.85±0.94*	100.04±1.56**

*P<0.05; **P<0.01; Day 0: before therapy; Days 3 and 7, after therapy

Table 8. Pre- and post-treatment of haemato-biochemical profiles of group III (Cflox T_z+ *bael* fruit powder @ 24 g/100 kg body weight) diarrhoeic calves (mean±lSE) at GBPUAT

Parameter	Group III (n= 10)		
	DayO	Day 3	Day 7
PCV (%)	48.44+2.42	44.12±2.20*	36.72±1.92**
Glucose (mg/dl)	42.72+3.40	51.32±2.84*	56.54±2.72**
Total protein (g/dl)	7.20+0.40	6.60±0.50*	6.20±0.22*
Albumin (g/dl)	3.24±0.12	3.10±0.18	2.76±0.12**
A:G ratio	0.86+0.02	0.83±0.01	0.78±0.02*
Sodium (m mol/litre)	112.24±1.44	116.80+1.18	123.80±2.72**
Potassium (m mol/litre)	5.48±0.25	4.94±0.14**	4.60±0.12**
Chloride (m mol/litre)	92.41+2.65	96.52±1.78*	99.82±2.44**

*P<0.05; **P<0.01

The results pertaining to therapeutic efficacy of ITK at GBPUAT are given in Tables 7-10. Clinical profile of all diarrhoeic calves revealed significant decline in scores for faecal consistency, dehydration and depression by days 3 and 7 of post-medication values. A majority of the affected calves in different groups showed normalcy in respect to clinical profile after 7 days of medication. However, compared with groups I and II, clinical recovery was more pronounced in group III calves that received Cflox-T_z bolus together with ITK (bael powder).

Haemato-biochemical parameters revealed significant decline in the value of PCV, serum total protein, albumin, A.G ratio and potassium, and significant increase in the values of serum glucose, sodium and chloride by day 7 (post-therapy) in all diarrhoeic calves compared with the respective day 0 values (Tables 8-10). No significant difference was noticed between groups at different days.

The therapeutic efficacy of *bael* powder juice alone was 60% in diarrhoeic calves. However, its efficacy in combination with standard therapy

Table 11. Clinical profile and EPG in different groups before (day)) and after (day 6) treatments at MASFSU

Parameter	parasitic				Non-parasitic			
	Bael		Standard therapy*		*Bael*		Standard therapy**	
	0 day	6 day	0 day	6 day	0 day	6 day	0 day	6 day
Dehydration score	5.16 ±0.3	4.16 ±0.16	5.33 ±0.33	4.16 ±0.16	5.16 ±0.3	5.83 ±0.16	5.00 ±0.25	4.16 ±0.16
Faecal consistency	1.83 ±0.3	0.16 ±0.16	2.33 ±0.33	0.50 ±0.22	2.16 ±0.4	0.33 ±0.21	1.83 ±0.3	0.33 ±0.21
EPG	1133.3 ±205.1	1021.68 ±202.5	1545.0 ±319.8	0.00 ±0.00	ND	ND	ND	ND
Average recovery period	3.83		1.5		4.83		5.66	

*Standard therapy: Fenbendazole tab @ 10 mg/kg body weight orally
**Standard therapy: Astringent mixture (kaolin, creta, catechue) 30 g twice a day orally

Table 10. Haemato-biochemical changes in parasitic and non- parasitic diarrhoea before and after the treatment at MASFSU

Parameter	*Parasitic diarrhoea*															
Group	PCV		Serum total Protein		Serum albumin		Serum globulin		A: G ratio		Serum sodium		Serum potassium		Serum chlorides	
	0 day	6 day	0 day	6 day	0 day	6 day	0 day	6 day	0 day	6 day	0 day	6 day	0 day	6 day	0 day	6 day
								Bael								
	32.33 ±2.38	29.35 ±2.48	5.18 ±0.2	4.72 ±0.27	2.68 ±0.18	2.42 ±0.14	2.5 ±0.27	2.3 ±0.35	0.148 ±0.16	1.223 ±0.23	110.37 ±4.06	122.60 ±3.72	6.65 ±0.22	5.26 ±0.23	94.36 ±6.85	100.98 ±5.01
ST	27.7 ±3.54	27.7 ±3.54	5.51 ±0.17	6.4 ±0.3	2.72 ±0.19	2.88 ±0.11	2.79 ±0.11	3.51 ±0.21	0.992 ±0.09	0.827 ±0.03	113.28 ±6.70	124.65 ±6.62	6.12 ±0.16	5.29 ±0.23	95.15 ±2.39	113.71 ±1.28
								Non-parasitic diarrhoea								
Bael	25.16 ±3.53	23.13 ±3.3	4.92 ±0.28	4.93 ±0.24	2.81 ±0.25	3 ±0.29	2.11 ±0.35	1.92 ±0.34	1.656 ±0.57	1.85 ±0.41	113.28 ±6.7	124.65 ±6.62	6.12 ±0.16	5.29 ±0.23	85.61 ±3.59	98.72 ±3.63
ST	3.3 ±2.1	33.4 ±2.48	5.78 ±2.02	6.53 ±0.29	3.16 ±0.16	3.4 ±0.67	2.59 ±0.17	3.12 ±0.38	1.128 ±0.236	1.201 ±0.19	144.13 ±6.94	124.52 ±6.96	6.13 ±0.3	5.14 ±0.29	86.06 ±3.37	107.53 ±3.65

Table 13. Phytochemical testing results of *Aegle marmelos* (bael fruits) at GBPUAT

Particulars	Methanol extract	Hexane extract	Aqueous extract
Alkaloids	+	+	+
Anthroaquinonen	-	-	-
Flavonoids	+	-	-
Saponins	+	+	-
Tannins	+	-	-
Sterols	+	+	-
Reducing sugars	-	-	-
Glycosides	+	-	-
Resins	+	+	+
Triterpenes	+	-	+
Proteins	+	-	+
Coumarins	-	+	+

was 90%. The standard therapy alone was responsible for 80% recovery in diarrhoea in calves.

Results obtained for treatment of diarrhoea using *bael* powder at Nagpur Veterinary College are presented in Tables 11 and 12. In parasitic diarrhoeic animals, faecal examination revealed mixed infestation of *Trichuris, Strongale* and *Moneizia* spp. Complete recovery in parasitic diarrhoea was achieved with standard therapy on an average of 1.5 days. The EPG was reduced from 1545 to 0 level in this group by day 6. Though ITK, i.e. use *of bael* powder, reduced the dehydration score and faecal consistency score, it had little effect on parasitic load. In non-parasitic diarrhoea, the *bael* powder could reduce the faecal consistency score. However, clinical recovery was more pronounced in standard therapy group. Haemato-biochemical parameters also simulated the clinical recovery.lt was observed that Bael powder had an astringent property and could be used as an adjunct therapy in diarrhoea for speedy recovery.

Phytochemical analysis of bael *fruit (Aegle marmelos):* Methanol extract of *Aegle marmelos* fruit revealed the presence of alkaloids, flavonoids, saponins, tannins, sterols, glycosides, resins, triterpenes and proteins on preliminary investigation. Its hexane extract had alkaloids, saponins, sterols, resins and coumarins, whereas aqueous extract had alkaloids, resins, triterpenes, proteins and coumarins (Table 13).

CONCLUSION

The study was conducted to validate the use of *bael* fruit powder in diarrhea. The initial validation was done at IVRI, where the *bael* powder given @ 24 g/100 kg body weight orally was found to hasten the recovery in calves suffering from *E. coli* diarrhoea. The *bael* powder was of particular use as a supportive therapy. The cross-sectoral validation study done at Veterinary College, GBPUAT and Veterinary College, MASFSU, Nagpur confirmed these findings. The *bael* powder also showed mild anthelmintic effects and was useful in parasitic diarrhoea as well. The active ingredient study revealed the presence of alkaloids, tannins, flavonoids, saponons and triterpenes, which may be responsible for ameliorative potential of *bael* in diarrhoea.

□

Code : **1287**

Title of the ITK **Control of diarrhoea in cattle and buffalo by a paste made from leaves of** *shisham (Dalbergia sissoo)*

Description of ITK *: Dulbergia sissoo* leaves might be having anti-diarrhoea medicinal value. This ITK is highly compatible with the existing resources. About 500 g of *shisham* leaves are ground into paste and are mixed with 1 litre water and drenched 2-3 times a day per adult cow or buffalo. It costs Rs 1-2 per animal. The animal is cured in 2-3 days. This is in vougue in many villages of Shahjhanpur, Bulandshar and Bareilly districts of Uttar Pradesh.

Name and address of the discloser : Shri Syed Musawir Ali, Mohalla - Furshoori Tola, Bund Gali, Baduan, Bareilly (Uttar Pradesh)

Location of use of ITK : Villages in the district of Shahjahanpur, Bulandshahar and Bareilly (U.P)

Experimenters : Indian Veterinary Research Institute (IVRI)

Dr D Swarup, Head, Dr N.N. Pandey, Principal Scientist, Dr D.B. Mondal, Senior Scientist, Division of Medicine, IVRI, Izatnagar 243 122 (U.P.)

Gobind Ballabh Pant University of Agriculture and Technology (GBPUAT)

Dr Mahesh Kumar, Professor and Head, Department of EPM and Dr Dr J. L. Singh, Associate Professor, Clinical Medicine, College of Veterinary Sciences, Pantnagar, dist. U.S. Nagar 263 145 (Uttaranchal)

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Dr N. K. Dakshinkar, Associate Professor, Dr G. B. Shrikhande, Assistant Professor, Dr D. B. Sarode, Professor and Head, Department of Clinical Medicine, College of Veterinary Sciences, Nagpur 440006 (Maharashtra)

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Contents

METHODOLOGY

Experiment *IVRI*

Therapeutic trials: *Shisham* leaf powder @ 105 g/100 kg body weight orally twice a day for 3 days was given to 25 clinical cases of animals suffering from neonatal diarrhoea (Gr II). Animals of Gr I (5) receiving standard treatment served as the control.

Evaluation of therapy: The diarrhoeic animals were kept under close observation and the treatment success in the two groups was evaluated on the basis of clinical and haemato-biochemical improvement.

Clinical profile: The clinical scores (0-3 basis) for faecal consistency (FCS), dehydration and depression were recorded on day 0 (before therapy) and on days 3 and 7 post-therapy as per the criteria suggested by Walker *et al*. (1998).

Haemato-biochemical profile*:* The blood samples were collected before (day 0) and after administration of the treatment (days 3 and 7) and analysed for different haemato-biochemical parameters, viz. packed cell volume (PCV), glucose, protein, albumin (A) and globulin (G) ratio (A:G ratio) sodium (Na), potassium (K) and chloride (Cl) following standard methods.

Experiment

GBPUAT

Therapeutic trials: *A* total 30 clinical cases of diarrhoea were divided randomly into three equal groups. The animals of group I were given

Table 1. Experimental design

Therapeutic agent	Group	Dose regimen
Standard therapy (Cotrimazine)	I (n=5)	15 mg/kg body wt bid for 3 days 15 mg/kg body
Standard therapy* + *shisham* leaf powder	II (n=25)	wt + 105 g/100 kg body wt twice a for 3 days
day		

*Cotrimazine contains trimethprim and sulfadiazine

Table 2. Grading for clinical score

Clinical score	Interpretations		
	Faecal consistency score	depression score	Dehydration score
0	Normal (well-formed faeces)	Normal (fully alert and responsive)	Normal (bright eyes and pliable skin)
1	Pasty faeces	Mild depression, calf suckles but not vigorously	Mild dehydration, slight loss of skin elasticity, skin tents < sec, eyes do not recess into orbit
2	Semi-liquid faeces still with a solid component	Moderate depression, calf able to stand, suckling is weak or disorganized	Moderate dehydration, skin tents > 3 seconds but <10 sec, eyes slightly recessed into orbit
3	Watery faeces	Severe depression, unable to stand or suckle	Severe dehydration, skin tents >10 sec, eyes markedly recessed into orbit

standard treatment in the form of Cflox-T_z bolus (ciprofloxacin + tinidazole) @ 1 bolus per 100 kg body weight twice a day for 3 days. The animals of group II were treated with *shisham* leaves powder @ 105 g/100 kg body weight twice a day for 3 days. The animals of group **III** received Cflox-T_z bolus @ 1 bolus per 100 kg body weight twice a day and *shisham* leaves powder @ 105 g/ 100 kg body weight twice a day for 3 days.

Evaluation of therapy: The animals were observed closely and therapeutic efficacy of different treatments was evaluated on the basis of clinical profile and haemato-biochemical changes.

Clinical profile: To study the clinical profile of diarrhoeic calves, a clinical score (0-3 basis) for faecal consistency, dehydration and depression was recorded on day 0 (before treatment) and days 3 and 7 post-therapy, as suggested by Walker *et al*. (1998) and described in the report of IVRI. Major clinical manifestation, viz. general appearance, status of dehydration, posture, temperature, pulse, respiration and heart rate were recorded in all affected calves before and after treatment.

Hemato-biochemical study: Blood samples from all affected calves were collected before and after treatment for blood bio-chemical parameters including PCV, glucose, total protein, albumin (A), globulin (G), A:G ratio, serum sodium, potassium and chloride.

Phytochemical analysis of shisham leaves: Cold methanolic, hexane and aqueous extracts of *shisham* leaves were prepared after soaking the powder in these solvents for 24 hr. Phytochemical analysis of these extracts was done for the presence of alkaloids, anthraquinones, flavonoids, saponins, tannins, sterols, reducing sugars, glycosides, resins, triterpenes, proteins and coumarins by the standard methods.

Antimicrobial activity assessment: Antimicrobial activity assessment of *shisham* leaf-powder extracts was assessed against commonly prevalent bacteria of enterobacteriacae using standard methods of agar wells. A concentration of 500 mg /ml extract of *shisham* leaves powder was prepared in different solvents. An amount of 150 ul/well of the above concentration was used for antimicrobial assessment.

Etiological distribution: Faecal examination of 52 calves of various age groups (1 week to 6 months) was done by standard techniques to determine the etiological agent (s) associated with the diarrhoea. The faecal samples that were negative for parasitic eggs were subjected to microbial investigation and antibiotic sensitivity tests.

MASFSU

Therapeutic trial: The study was conducted on goats presented to Veterinary College Hospital, Nagpur with a history of diarrhoea or dysentery. These goats were subjected to detailed clinical and parasitological examination and were subdivided into parasitic and non-parasitic groups. These animals were randomly assigned to two treatments within each broad groups (parasitic and non-parasitic) comprising 6 goats irrespective of their age and sex.

Freshly collected *shisham* leaves were minced in a mixer and the paste was administered orally @ 25 g twice a day to goats suffering from parasitic and non-parasitic diarrhoea.

Faecal sample examination: Faecal samples from goats suffering with diarrhoea were collected per-ractal in clean sterile glass vials before treatment and thereafter on day 6 of the treatment. The samples were examined by sedimentation technique immedietly after the collection.

Efficacy of treatment: Efficacy of the drugs was evaluated on the basis of eggs per gram faeces (EPG) determined by the modified Stoll's dilution technique on days 0 and 6 post- treatment.

Clinical examination: Clinical signs such as dehydration score and faecal consistency were recorded.

Haemato-biochemical profile: Packed cell

Table 3. Clinical score of diarrhoeic calves following treatment at IVRI

Parameter	Group I			Group II		
	Day 0	Day 3	Day 7	Day 0	Day 3	Day 7
Temperature (^{O}F)	100.72±0.10	100.76±0.12	100.64±0.07	100.72±0.24	101.40+0.13	101.56±0.25
FCS (0-3)	2.20±0.20	1.00±0.32**	0.00±0.00**	2.60±0.24	0.00±0.00**	0.00±0.00**
Depression score (0-3)	1.80±0.20	0.80±0.20*	0.40±0.24**	2.00±0.00	0.20±0.20**	0.00±0.00**
Dehydration score (0-3)	1.40±0.24	0.80+0.49	0.40±0.24**	1.40±0.24	0.20±0.20**	0.00±0.00**
PCV(%)	44.80 ±1.02	42.40±1.33**	38.40±0.75**	46.00±1.09	38.00±0.63**	35.20±0.49**

*P<0.05; **P<0.01. Day 0: before therapy; Days 3 and 7, after therapy

Table 4. Haemato-biochemical profiles of group I (Cotrimazine) diarrhoeic calves (mean ±SE) at IVRI

Parameter	Group I (n=5)		
	DayO	Day 3	Day 7
PCV (%)	44.80 ±1.02	42.40+1.33**	38.40±0.75**
Glucose (mg/dl)	44.22±1.42	46.136±1.455**	51.058+0.831**
Total protein (g/dl)	6.97±0.13	6.52±0.14*	6.27 ±0.17**
Albumin (g/dl)	3.15±0.08	2.90±0.08*	2.75±0.09**
A:G ratio	0.82±0.01	0.79±0.01*	0.78±0.01**
Sodium (mmol/litre)	115.20+2.13	120.40+1.36**	123.20±1.07**
Potassium (mmol/litre)	5.44±0.18	5.22±0.18	4.76±0.17*
Chloride (mmol/litre)	96.91±0.75	98.42±0.54**	99.54±0.36**

*P<0.05; **P<0.01; Day 0: before therapy; Days 3 and 7, after therapy

Table 5. Haemato-biochemical profile of group II

(Cotrimazine + *shisham* leaf powder @ 105 g/100 kg body weight) diarrhoeic calves (mean ±SE) at IVRI

Parameters	Group V (n=30)		
	Day 0	Day 3	Day 7
PCV (%)	44.00±1.19	37.32±0.54**	34.19±0.24**
Glucose (mg/dl)	45.87±3.43	53.32±3.39**	55.79±3.46**
Total protein (g/dl)	6.33±0.19	5.91±0.22**	5.69±0.19**
Albumin (g/dl)	2.88+0.11	2.62±0.12**	2.52±0.11**
A:G ratio	0.83±0.02	0.79±0.02*	0.79±0.02*

*P<0.05; ** P<0.01; Day 0; before therapy; Days 3 and 7, after therapy

Contents

Table 6. Pre- and post-treatment clinical profile value of diarrhoea calves (mean±SE) at GBPUAT

Parameter	Group	DayO	Day 3	Day 7
Faecal consistency score	I	2.40±0.30	1.15±0.40**	0.00±0.0**
	II	2.10±0.40	1.00±0.50**	0.00+0.0**
	III	2.60±0.20	0.50±0.20**	0.00±0.0**
Depression score	I	1.70±0.30	0.90+0.40*	0.30±0.20**
	II	1.90±0.50	1.20+0.25*	0.80±0.30**
	III	2.40±0.22	1.00±0.20*	0.50±0.30**
Dehydration score	I	1.60±0.10	0.90±0.30	0.50±0.40*
	II	2.22±0.30	1.30±0.40*	0.60±0.20**
	III	2.10±0.10	1.00±0.20*	0.30±0.40**

Table 7. Haemato-biochemical profiles of group 1 (Cflox- T_z) diarrhoeic calves before and after treatment (mean±lSE) at GBPUAT

Parameter	Group (n=5)		
	DayO	Day 3	Day 7
PCV (%)	45.20±2.40	41.30*1.88*	38.50±1.24**
Glucose (mg/dl)	46.62±4.54	50.36±2.72**	53.82±2.20**
Total protein (g/dl)	6.98±0.24	6.51±0.20*	6.26±0.19**
Albumin (g/dl)	3.23±0.09	2.85±0.07*	2.74 ±0.08*
A:G ratio	0.84±0.02	0.80±0.03*	0.76±0.02**
Sodium (m mol/litre)	112.90±4.50	121.24±2.45*	125.67±3.25**
Potassium (m mol/litre)	5.75±0.28	5.25±0.22	4.80±0.28*
Chloride (m mol/litre)	94.82±2.74	99.42±2.66*	99.80±2.54*

*P<0.05; **P<0.01; Day 0: before therapy; Days 3 and 7, after therapy

Table 8. Haemato-biochemical profiles of group II *{shisham* leaf powder @ 105 g/100 kg body weight) diarrhoeic calves before and after treatment (mean±lSE) at GBPUAT

Parameter	Group (n=10)		
	Day 0	Day 3	Day 7
PCV (%)	45.50±1.75	43.40±1.46	40.70±2.20*
Glucose (mg/dl)	45.41±3.45	46.80±3.52	50.97±5.42*
Total protein (g/dl)	6.95±0.18	6.75±0.25	6.36±0.24*
Albumin (g/dl)	3.34±0.08	3.04±0.09	2.92±0.07*
A:G ratio	0.94±0.02	0.88±0.03*	0.85±0.04**
Sodium (m mol/litre)	112.00±1.20	115.9+1.44	122.60+5.40**
Potassium (m mol/litre)	6.42±0.22	6.06±0.32	5.56±0.16*
Chloride (m mol/litre)	87.86±1.96	92.64±3.12*	97.44±2.36**

*P<0.05; **P<0.01; Day 0: before therapy; Days 3 and 7, after therapy

Contents

volume (PCV), serum total protein, albumin (A), globulin (G), A: G ratio, chloride, sodium and potassium were estimated from the blood samples collected on days 0 and 6 post-treatment.

BAU

Therapeutic trials: The clinical trial was conducted in 30 goats having parasitic and non-parasitic diarrhoea. These were divided into 3 different treatment groups, each consisting of 10 animals. Group I (non-parasitic diarrhoea) was given *shisham* leaf paste orally 30 g twice daily for 3 days. Group II (parasitic diarrhoea) received Fazole – $^{1}/_{2}$ bolous twice a day for 3 days and Panacur @ 5 mg/kg body weight single dose. Group III (parasitic diarrhea) received *shisham* leaf paste orally @ 30 g twice daily and Panacur 5 mg/kgbody weight single dose. In severely dehydrated cases 5% dextrose was also infused.

RESULTS AND DISCUSSION

Therapeutic efficacy: At IVRI, the trial was conducted in 30 young calves (<2 months old). The fecal examination revealed no parasitic

Table 9. Haemato-biochemical profiles of group III (Cflox- T_z+ *shisham* leaf powder @ 105 g/100 kg body weight) diarrhoeic calves before and after treatment (mean±lSE) at GBPUAT

Parameter	Group (n=10)		
	DayO	Day 3	Day 7
POCV (%)	47.50±2.75	40.40±2.12*	37.44±2.75**
Glucose (mg/dl)	44.56±3.44	49.23±3.53*	54.31 ±2.84**
Total protein (g/dl)	6.78±0.24	6.42±0.18*	5.85±0.20**
Albumin (g/dl)	3.98+0.15	2.75±0.14	2.66±0.1i**
A:G ratio	0.78±0.02	0.76±0.02	0.83±0.04*
Sodium (m mol/litre)	110.40±1.22	116.76±2.33*	123.10±3.50**
Potassium (m mol/litre)	6.24±0.36	5.80±0.44*	5.42±0.33**
Chloride (m mol/litre)	92.92±1.44	95.04±1.29*	99.64±2.14**

***P<0.05;** **P<0.01 Table 10. Clinical profile and EPG in different groups before (day 0) and after (day 6) treatments at MASFSU

Parameter	Parasitic				Non-parasitic			
	Shisham		Standard	therapy*	*Shisham*		Standard therapy**	
	Day 0	Day 6	DayO	Day 6	Day 0	Day 6	Day 0	Day 6
Dehydration score	4.5±0.22	4.00±0.0	5.33±0.33	4.16±0.16	5.33±0.33	4.16±0.55	5.00±0.25	4.16±0.16
Faecal consistency	1.50±0.22	0.00±0.00	2.33±0.33	0.50±0.22	1.66±0.21	0.66±0.33	1.83±0.3	0.33±0.21
EPG	1682.5 ±254.8	1986.67 ±276.19	1545.0 ±319.8	0.00	ND	ND	ND	ND
Average recovery period	6.5		1.5		4.5		5.66	

*Standard therapy: Fenbendazole tab @ 10 mg/ kg body weight orally; "Standard therapy: Astringent mixture (kaolin, creta, catechu) 30 g twice a day orally

Table 11. Hemato-biochemical changes in parasitic and non- parasitic diarrhea before and after the treatment-MASFU

Parameter / Group	PCV		Serum total protein		Serum albumin		Serum globulin		A: G ratio		Serum sodium		Serum potassium		Serum chlorides	
	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6
Parasitic diarrhoea																
Shisham	29.03 ±1.78	28.86 ±1.55	5.33 ±0.24	5.13 ±0.08	2.19 ±0.16	1.81 ±0.19	3.14 ±032	3.91 ±0.75	0.712 ±0.15	0.475 ±0.06	112.17 ±7.44	123.15 ±7.53	5.78 ±0.46	5.02 ±0.4	103.4 ±10.3	111.58 ±9.41
ST	27.7 ±3.54	27.7 ±3.54	5.51 ±0.17	6.4 ±0.3	2.72 ±0.19	2.88 ±0.11	2.79 ±0.11	3.51 ±0.21	0.992 ±0.09	0.827 ±0.03	113.28 ±6.70	124.65 ±6.62	6.12 ±0.16	5.29 ±0.23	95.15 ±2.39	113.71 ±1.28
Non-Parasitic diarrhoea																
Shisham	32.25 ±2.49	29.35 ±2.57	5.15 ±0.21	5.43 ±0.24	2.06 ±0.21	2.95 ±0.3	3.09 ±0.34	2.47 ±0.5	0.757 ±0.5	1.74 ±0.6	113.61 ±7.48	125.04 ±7.21	6.27 ±0.34	5.35 ±0.32	88.33 ±6.01	96.5 ±3.83
ST	3.3 ±2.1	33.4 ±2.48	5.78 ±2.02	6.53 ±0.29	3.16 ±0.16	3.4 ±0.67	2.59 ±0.17	3.12 ±0.38	1.128 ±0.236	1.201 ±0.19	144.13 ±6.94	124.52 ±6.96	6.13 ±0.3	5.14 ±0.29	86.06 ±3.37	107.53 ±3.65

infestation, majority of these calves were positive for *E. coli* on bacteriological examination. As such, the antibiotic was included in therapeutic regimen either alone or in combination with ITK. The results are presented in Tables 3-5.

E. coli was isolated in 69% of the faecal samples and the rest cases of diarrhoea could be

Table 12. Clinical recovery in goats of different groups at BAU

Group	Average recovery (days)	Faecal consistency score	Efficacy (%)
I	7	Solid	60
II	4	Semi-solid	80
III	3–5	Solid and palleted	85

Table 13. Phytochemical testing results of *shisham* (*Dalbergia sisoo*) leaf powder at GBPUAT

Particular	Methanol extract	Hexane extract	Aqueous extract
Alkaloid	+	-	-
Anthroaquinonens	-	-	-
Flavonoids	-	-	-
Saponins	+	-	+
Tannins	+	-	-
Sterols	+	+	-
Reducing sugars	-	-	-
Glycosides	-	-	-
Resins	-	-	-
Triterpenes	-	-	-
Proteins	-	-	-
Coumarins	+	+	+

Table 14. Etiological distribution in calves at GBPUAT

Etiological agent isolated	No. of calves affected (out of total 52)	Frequency distribution
Toxocariasis	12	23.07%
Coccidiosis	07	13.46%
Colibaccilosis (*E. coli*)	22	42.30%
Nutritional scour/diarrhoea	06	11.53%
Miscellaneous	05	09.61%

attributable to other bacterial, viruses and non-infectious causes in the absence of specific tests. None of the calves were found positive for parasitic infestation due to routine deworming programme at the farm.

The diarrhoeic calves of Gr. II (with ITK) had better improvement than animals of Gr. I (without ITK) in terms of faecal consistency, depression and dehydration. No parasitic eggs were found in faeces negating the parasitic infesttaion. On bacteriological examination, majority of the affected calves were found positive for entero-pathogenic *E coli* infection causing diarrhoea. *In vitro* drug sensitivity test revealed that Cotrimazine (trimethoprim + sulfadiazine) was highly (++++) effective against the causative bacteria. The result showed that almost normal level was noted in group II by day 3, whereas in the animals of GI continued to pass loose motion till day 3 and had mild to moderate depression and dehydration even by day 7. It was thus evident that calves of Gr II had a faster recovery as compared to those of Gr I, indicating significant supportive therapeutic effect of *shisham* leaf paste in diarrhoea. The non-occurrence of parasitic diarrhoea in the present study may be due to regular deworming programme being followed at the organized dairy herd, where the present study was carried out. *E. coli* was found to be the cause of diarrhoea in 69% of calves which is known to be the commonest cause for diarrhoea. The results of clinical trial conducted at Veterinary College, GBPUAT Pantnagar are given in Tables 6-9. The clinical scores of all the groups

Fig. 1. *Proteus vulgaris*

Fig. 2. *Salmonella typhi*

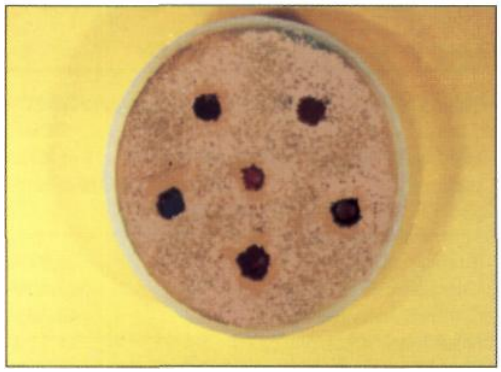

Fig. 3. *In vitro* antimicrobial profile against *Pr. vulgaris*

Fig. 4. *In vitro* antimicrobial profile against S. *typhi*

of diarrhoeic calves revealed mild to moderate diarrhea on day 0. After 3 days of medication the clinical scores in all affected groups was > 1 and after day 7 it was 0 (normal) for faecal consistency and below 1 for depression and dehydration.

Haemato-biochemical profile in different groups of diarrhoeic calves before medication (zero days) demonstrated significant increase in values of PCV, serum total protein, albumin, A:G ratio and potassium, and significant decrease in the values of serum glucose, sodium and chloride as compared to day 7 post-therapy values.

The therapeutic efficacy of *shisham* leaf powder paste was 60% in diarrhoeic calves. However, therapeutic efficacy of *shisham* leaf powder paste in combination with standard therapy was 80%. The standard therapy alone was responsible for 70% recovery.

Results obtained for treatment of diarrhoea using *shisham* leaf paste at Nagpur Veterinary College MASFSU are presented in Tables 10 and 11 faecal examination revealed mixed infestation of *Trichuris*, *Strongale* and *Moneizia* spp. in parasitic diarrhoeic animlas. Complete recovery in this group was achieved with standard therapy with an average of 1.5 days. EPG was reduced from 1545 to 0 in this group by day 6. However, in animals treated with *shisham* leaf paste, EPG was found slightly elevated on day 6. But the treatment with ITK reduced the dehydration score and faecal consistency score, The clinical recovery was more pronounced in standard therapy group. Hemato-biochemical parameters also simulated the pattern observed on clinical recovery. It was noted that the Shisham leaf paste had an ameliorative potential especially in non-parasitic diarrhoea.

Results pertaining to clinical recovery in different groups are given in Table 13 recorded in goats at BAU. ITK alone could bring 60% recovery in non-parasitic diarrhoea. The average recovery period in this group was 7 days. Goats of group II suffering from parasitic diarrhoea and receiving standard anthelmintic treatment together with antimicrobial recorded 80% recovery with average recovery period of 4 days, Maximum recovery was noted in group III, which received ITK together with standard anthelmintic treatment. The average recovery period in this group was 3-5 day with 85% efficacy. This indicated that use of *shisham* leaves with panacure was highly effective in parasitic diarrhoea.

Phyto-chemical analysis of shisham leaves: Methanol extract of *shisham* revealed the presence of alkaloids, saponins, tannins, sterols and coumarins. Its hexane extract showed presence of sterols and coumarins only, in the aqueous extract saponins and coumarins were present.

Etiological investigation: The details of etiological status of 52 calves are presented in Table 8. About 42.3% cases revealed presence of *E.coli* while in 23.07% cases toxocariasis was recorded. Evaluation of therapy Maximum frequency distribution of etiological agents in diarrhoea was in order: *E. coli* > Toxocariasis > Coccidiosis > Nutritional scour and the Miscellaneous agent.

Anti-microbial assessment: The bacteria against which anti microbial activity was assessed were *Proteus vulgaris, Staph, aureus, E. coli* and *Salmonella typhi.* In this study, no antimicrobial activity could be recorded against these bacteria.

CONCLUSION

Use of *shisham* leaf paste in treatment of diarrhoea was validated initially at IVRI. It was found that *shisham* leaf paste given @ 105 g could enhance the recovery in *E. coli* diarrhoea. Further studies at IVRI and cross-validation at three different centers also confirmed the ameliorative potential of *shisham* leaves in different types of parasitic and non-parasitic diarrhoea. *In-vitro* testing revealed no antibacterial activity in aqueous extract of *shisham* leaves. The presence of alkaloids, saponins and tannins may be responsible for antidiarrheal activity of *shisham* leaves. □

Code : **1585**

Title of ITK **Treatment of diarrhoea by juices of *urhul (Hibiscus rosa-sinensis)* flowers in goats**

Description of the ITK : Diarrhoea is common in goats in Samtoli village of Simdega district in Jharkhand and is controlled by extract of *urhul* flower. Juice of *urhul* flowers (2-3 flowers) is orally administered twice a day for 3 days. The cost of the treatment is Rs 30 per animal. A majority of the farmers use this ITK in this village. About 20% goats suffer from diarrhoea, and 50% are treated by the reported ITK.

Name and address of the discloser : **Shri Babulal Horo, Pathalkudwam, Church Lane, Ranchi (Jharkhand) 834 001**

Location of use of the ITK : Samtoli, Simdega, Simdega (Jharkhand)

Geographical indicators : An evergreen, woody, glabrous, showy shrub, 5-8 feet high. The flowers solitary, axillary and bell shaped. It is native of China. It is grown as an ornamental plant in gardens throughout India and often planted as hedge or fence plant

Experimenters : Maharashtra Animal Science and Fisheries Sciences University (MASFSU)

Dr N. K. Dakshinkar, Associate Professor, Dr G. B. Shrikhande, Assistant Professor, Dr D. B. Sarode, Professor and Head, Department of Clinical Medicine, College of Veterinary Sciences, Nagpur 440006 (Maharashtra).

Central Institute for Research on Goats (CIRG)

Dr V.S. Vihan, Principal Scientist and Head, Dr Ashok Kumar, Senior Scientist and Dr Rajneesh Rana Scientist (Senior Scale), Animal Health Division, Makhdoom 281 122, Mathura (U.P.).

METHODOLOGY

Experiment

MASFSU

The study was conducted on goats presented to Veterinary College Hospital, Nagpur with the history of diarrhoea or dysentery. These goats were subjected to detailed clinical and parasitological examination and were sub-divided into parasitic and non-parasitic groups and were randomly assigned to two treatments within each broad groups (parasitic and non-parasitic) comprising 6 goats irrespective of their age and sex. Another group consisting of 6 goats was kept as the standard treatment.

Fresh flowers of *Hibiscus rosa-sinensis* were collected in the morning and minced in a mixer to make a homogeneous juice. The juice was strained through a sieve and was drenched @ 15 ml twice a day to goats suffering from parasitic

and non-parasitic diarrhoea.

Faecal sample examination: Faecal sample of goats suffering with diarrhoea were collected per-rectal in clean sterile glass vials before treatment and thereafter on day 6 of the treatment. The samples were examined by sedimentation technique immediately after collection.

Therapeutic efficacy: The therapeutic efficacy of the drugs was evaluated on the basis of eggs per gram faeces (EPG) determined by modified Stall's dilution technique on day 0 and 6 after-treatment.

Clinical examination: Clinical signs such as dehydration score and faecal consistency were recorded

Haemato-biochemical profile: Packed cell volume (PCV), serum total protein, albumin (A), globulin (G), A: G ratio, chloride, sodium and potassium were estimated from the blood samples collected on day 0 and 6 after treatment.

CIRG

Therapeutic trial: Clinical trial was conducted on 15 goats suffering with diarrhoea. Only the animals found negative for endoparasitic infestation were selected. Bacteriological examination of faecal sample from representative clinical cases showed predominantly *Escherichia coli*. All the animals were given methanolic extract of *urhul* flowers @ 50-mg/kg body weight after preparing suspension in gum acacia (5%). This preparation was administrated once daily for 3 consecutive days. The assessment of clinical efficacy was based on revival of appetite, faecal consistency and dehydration status.

Haemato-biochemical estimation: Standard methods were used to estimate glucose, albumin, globulin, A:G ratio, aspartate amino transferase activity and creatinin, sodium, potassium and chloride concentrations in the serum samples collected before and 3 days after the treatment.

Phyto-chemical analysis: Urhul flowers were collected from local area of Mathura district of Uttar Pradesh and taxonomically identified as *Hibiscus rosa-sinensis.* After drying the flowers at room temperature, methanolic extract was prepared by Soxhlet assembly as per the standards techniques and concentrated by rotary evaporator.

In-vitro antimicrobial activity of juice: Antibiogram study was conducted against *E. coli* isolated from clinical cases by using different concentrations (1, 2, 4, 8, 16 mg/disc) of *urhal* extract. The sterile disc (Hi-media) was loaded with these dilutions individually. Control disc, loaded with solvent base was prepared separately. To compare the antimicrobial properties of

Table 1. Clinical recovery and average recovery duration in different groups MASFSU

Parameter	Parasitic				Non-parasitic			
	Urhul		Standard	therapy*	*Urhul*		Standard	therapy**
	Oday	6 day	Oday	6 day	Oday	6 day	Oday	6 day
Dehydration score	5.5	4.83	5.33	4.16	5.33	4.5	5.00	4.16
	±0.22	±0.16	±0.33	±0.16	±0.33	±0.22	±0.25	±0.16
Faecal consistency	2.5	0.50	2.33	0.50	2.66	0.50+	1.83	0.33
	±0.22	±0.22	±0.33	±0.22	±0.21	0.22	±0.3	±0.21
EPG	1488.3	1333.3	1545.0	0.00	ND	ND	ND	ND
	±204.6	±189.83	±319.8	±0.00				
Average recovery period	4.83		1.5		5.33		5.66	

*Standard therapy: Fenbendazole tab @ 10 mg/ kg body weight orally; ** Standard therapy: astringent mixture (kaolin, creta, catechu) 30 g twice a day orally

various extract with commonly practiced antibiotics, antibiogram profile against 12 known antibiotics was also conducted under similar conditions using the same isolates.

RESULTS AND DISCUSSION

Therapeutic efficacy

Results obtained for treatment of diarrhoea using *urhul-flower* juice at Nagpur Veterinary College are presented in Table 1.

Mixed infestation of *Trichuris, Strongyle* and *Moneizia* spp. was the cause of parasitic diarrhea. Complete recovery in the parasitic diarrhea group was achieved with standard therapy wirhin an average period of 1.5 days. The EPG was reduced from 1545 to 0 level in this group by day 6. Administration of urhul-flower juice reduced the dehydration and faecal consistency scores in both parasitic and non-parasitic diarrhoeic goats. However, there was no significant reduction in EPG count in parasitic diarrhoea following treatment with *urhul* flower. The results indicated that *urhul* flower juice has astingent effect and can be used as supportive therapy.

Table 2. Therapeutic efficacy of *Urhul* flowers extract in clinical cases of diarrhoea in goats

Parameter	Clinical parameter			
	Pretreatment	Post treatment		
		Day 1	Day 2	Day 3
Appetite score*	**1.15*0.15**	l.l±0.105	1.02+0.2	1.0+0.0
Faecal score**	1.8+0.141	1.8+0.141	2.3+0.49	3.0±0.27
Temperature	102.2±0.22	102.2±0.2	102.5±0.23	102.17±0.2
Dehydration score***	1.13±0.15	1.13+0.23	1.13+0.20	0.0±0.0
Recovery score****		1.5±0.324	**1.1+0.105**	3.0+0.27
Efficacy (%)	No. of animals 15	Animals recovered 10	Efficacy (%) 66.7	

*Good 1, low 2, no appetite 3; **watery 1, semi-solid 2, loose ball 3, normal 4; *** +1, +2, +3, +4; ****poor 1, partial 2, moderate 3, complete

Table 3. Serum biochemistry in treatment trial of *urhul* flower extract in clinical cases of diarrhoea in goats at CIRG

Parameter	Pretreatment	Post-treatment
Glucose (mg%)	41.09±2.680	45.78±3.20
Total protein (g %)	5.32±0.216	5.36±0.25
Albumin (g %)	3.01±0.090	3.13±0.10
Globulin (g %)	2.32±0.165	2.23±0.27
AG Ratio	1.36±0.105	1.65±0.26
AST (u/ml)	69.40±7.71	78.60±5.68
Creatinine (m mol/l)	73.2±0.110	59.6±0.06*
Sodium (m mol/l)	142.5±2.36	152.37±3.08*
Potassium (m mol/l)	4.12±0.219	4.78±0.13
Chloride (m mol/l)	78.61±4.190	92.11±3.53*

* P>0.05

At CIRG, Makhdoom the clinical efficacy was assessed on the basis of revival of appetite, faecal consistency, dehydration status and changes in serum biochemical parameters. Overall therapeutic efficacy of the ITK was 66.7%. It was noted that the flower juice was moderately effective in bacterial diarrhoea in goats (Tables 2 and 3). Serum glucose and the sodium and potassium levels increased slightly after the treatment. Apparently the drug did not show any untoward effect, which was supported by biochemical parameters, viz. total protein, albumin, globulin, AST and creatinin concentration in serum (Table 4).

Chemical analysis, yield (%) and physical

Table 4. Haemato-biochemical changes in parasitic and non-parasitic diarrhea before and after the treatment (at Nagpur; MASFU)

Parameter / Group	PCV		Serum total protein		Serum albumin		Serum globulin		A: G ratio		Serum sodium		Serum potassium		Serum chlorides	
	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6
Parasitic diarrhoea																
Urhul	28.85 ±1.9	29.15 ±1.97	5.08 ±0.17	4.83 ±0.08	2.21 ±0.28	2.13 ±0.22	2.86 ±0.27	2.56 ±0.25	0.858 ±0.18	0.894 ±0.14	108.74 ±5.98	120.00 ±6.35	5.84 ±0.26	5.18 ±0.35	92.96 ±6.61	102.55 ±3.8
ST	27.7 ±3.54	27.7 ±3.54	5.51 ±0.17	6.4 ±0.3	2.72 ±0.19	2.88 ±0.11	2.79 ±0.11	3.51 ±0.21	0.992 ±0.09	0.827 ±0.03	113.28 ±6.70	124.65 ±6.62	6.12 ±0.16	5.29 ±0.23	95.15 ±2.39	113.71 ±1.28
Non-Parasitic diarrhoea																
Urhul	30.53 ±2.29	31.00 ±2.54	5.76 ±0.14	5.89 ±0.2	2.66 ±0.17	3.2 ±0.2	3.01 ±0.06	3.01 ±0.06	0.991 ±0.07	1.27 ±0.17	115.44 ±12.94	126.44 ±12.37	6.12 ±0.29	5.05 ±0.32	87.16 ±7.91	102.21 ±5.2
ST	3.3 ±2.1	33.4 ±2.48	5.78 ±2.02	6.53 ±0.29	3.16 ±0.16	3.4 ±0.67	2.59 ±0.17	3.12 ±0.38	1.128 ±0.236	1.201 ±0.19	144.13 ±6.94	124.52 ±6.96	6.13 ±0.3	5.14 ±0.29	86.06 ±3.37	107.53 ±3.65

Table 5. Yield and physical characteristics of *urhul* extract at CIRG

Parameters	*Urhul* flower extract
Yield (%)	20.5%
Colour	Light brown
Smell	Pungent
Nature	Oily
Solubility	Methyl alcohol

Table 6. Chemical analysis of *urhul* flowers methanolic extract at CIRG

Chemical constituents	Reaction
Flavonoids	+
Glycosides	+
Steroids	-
Tannins	+
Coumarins	-
Alkaloids	+
Saponins	-
Proteins	-
Fat and oils	-
Carbohydrates	+

Table 7. Antibiogram of *urhul* flower extract at CIRG

Test compound	Zone of inhibition (mm)		
	Trial I	Trial II	Mean
Standard antibiotics			
Gentamycin	8(R)		8
Kanamycin	15(1)		15
Ampicloxacilln	8(R)		8
Enrofloxacin	0(R)		0
Lincomycin	0(R)		0
Cefuroxime	10 (R)		10
Tobramycin	15 (S)		15
Amikacin	17 (S)		17
Cephadroxil	10 (R)		10
Amoxycillin	7(R)		7
Cephatrioxone	10 (R)		10
Norfloxacin	0(R)		0
Urhal-flower extract (cone/disc)			
Control	0	0	0
16 mg	0	0	0
8mg	0	0	0
4mg	0	0	0
2mg	0	0	0
1 mg	0	0	0

characteristic of extract were studied (Table 5). Qualitative analysis of extract revealed the presence of flavonoids, glycosides, tannin, alkaloids and carbohydrates (Table 6).

In-vitro antibiogram study: No zone of inhibition was observed in the disc impregnated with different concentrations of *urhal* extract (Fig. 1, Table 7), indicating that it has no antimicrobial effect. However, this effect may be exhibited at much higher concentration. Of the standard antimicrobial drugs, only amikacin and tobramycin were found sensitive.

CONCLUSION

The initial validation study using ITK (flower juice of *urhul)* for treatment of diarrhoea was conducted at Veterinary College, BAU, Ranchi. The use of *urhul*-flower juice proved effective in treatment of diarrhoea in goats. But recovery period following treatment by the ITK was more than that by the standard veterinary therapy. Further trial for cross-sectoral validation was done at Veterinary College, MASFSU Nagpur and CIRG, Makhdoom. Both studies recorded moderate degree of effectiveness of the ITK against parasitic and *E.coli* diarrhoea in goats. However, the juice did not reveal any antibacterial activity. Presence of flavonoids, tannins and alkaloids may be responsible for the efficacy of the ITK in diarrhoea.

□

Code : **1589**

Title of ITK : **Treatment of diarrhoea in animals (goats and sheep)**

Description of the ITK : Goat and sheep suffering from diarrhoea are treated with *pojo (Litsaea anthapoly)* plant. Paste is prepared by crushing the *pojo* plant. It is and fed to animal @ *Vi* cup of *pojo* paste daily for 3 days. Villagers believe *that pojo* plant has medicinal value, controls diarrhoea and prevents dehydration. This wisdom is being used for the ancient times without modification. About 40% goats suffer from diarrhoea in the village from where the ITK is reported. Out of these, 30% cases of diarrhoea are treated by the method of ITK, 5% remains untreated and 5% are treated by some other medicines.

Name and address of the discloser Shri Veeresh Kumar, Department of Extension Education, Birsa Agricultural University, Kanke, Ranchi (Jharkhand)

Location of use of the ITK

Experimenters : Sose, Kanke, Ranchi (Jharkhand) :

Birsa Agricultural University (BAU)

Dr S. Haque, Head, Dr P. Shekhar, Assistant Professor, Department of Clinical Medicine, Ranchi Veterinary College and Dr R.P. Singh 'Ratan', BAU, Ranchi 834 006 (Jharkhand).

Central Institute of Research on Goats (CIRG)

Dr VS. Vihan, Principal Scientist and Head, Dr Ashok Kumar, Senior Scientist and Dr Rajneesh Rana, Scientist (Senior Scale), Animal Health Division, CIRG, Makhdoom, Mathura, 281 122 (U.P.)

METHODOLOGY

Experiment

BAU

Pojo plant bark was collected, dried and powdered by using an electrical grinder. The powder was sieved before use. The clinical trial was conducted in 30 goats having parasitic and non-parasitic diarrhoea, which were divided into 3 different treatment groups, each consisting of 10 animals. Group I (non- parasitic diarrhoea) was given *pojo* bark powder orally @ 40 g twice daily for 3 days in the form of paste. Group II (parasitic diarrhoea) received Fazole- *Vi* bolus twice a day for 3 days and Panacur @ 5 mg/kg body weight single dose. Group III (parasitic diarrhoea) received *pojo* paste orally @40 g twice daily and Panacur 5 mg/kg body weight single dose.

CIRG

Therapeutic trial: In-vivo study was carried out in 15 goats suffering from non-parasitic diarrhoea. Bacteriological examination of faecal sample from representative clinical cases showed predominance of *Escherichia coli.* Goats were given extract of *pojo* bark at the dose rate of 20 mg/kg body weight. The suspension of extract was prepared in

gum acacia (5%) for oral preparation, which was drenched once daily for three consecutive days. The assessment of clinical efficacy was based on revival of appetite, faecal consistency, dehydration status and changes in serum biochemical parameters, before and after treatment.

Hemato-biochemical estimation: Standard methods were used to estimate glucose, albumin, globulin, A:G ratio, aspartate amino transferase activity, creatinin, sodium, potassium and chloride concentrations in serum samples collected before and 3 days after the treatment.

Chemical analysis: Pojo bark was collected from Ranchi (Jharkhand), from where this indigenous technology has been reported. The bark was completely dried, powdered and its methanolic extract was prepared with Soxhlet assembly and was subjected to phytochemical analysis.

In vitro *antimicrobial activity of juice:* Antibiogram study was conducted against *E. coli* isolated from clinical cases of diarrhoea in goats using different concentrations (1, 2, 4, 8, 16 mg/ disc) of extract of *pojo* bark juice.

RESULTS AND DISCUSSION

Clinical efficacy

Results pertaining to clinical recovery in different groups obtained at BAU are given in

Table 1. Clinical recovery in goats of different groups at BAU

Group	Average recovery (days)	Faecal consistency score	Efficacy (%)
I	3	Solid	90
II	4	Semi-solid	80
III	2	Solid and palleted	100

Table 1. Treatment with ITK alone resulted in 90% recovery in non-parasitic diarrhoea. The average recovery period in this group was 3 days. Goats of group II suffering from parasitic diarrhoea and receiving standard anthelmintic and antimicrobial treatment recorded 80% recovery with average recovery period of 4 days. Maximum recovery was noted in group III, which received ITK together with standard anthelmintic treatment. The average recovery period in this group was 2 days with 100% efficacy. The results indicated that use of pojo bark alone was effective in non-parasitic diarrhoea and it improved the efficacy of specific anthelmintic Panacure in parasitic diarrhoea.

The clinical efficacy at CIRG was assessed on the basis of revival of appetite, fecal consistency, dehydration status, which was categorized on

Table 2. Therapeutic efficacy of *Pojo* bark extract in clinical cases of diarrhea in goats (CIRG)

Parameter	Clinical parameter			
	Pretreatment	Post treatment		
		Day 1	Day 2	Day 3
Appetite score*	1.66±0.19	1.56±0.18	1.44±0.17	1.20±0.0
Faecal score**	1.25±0.15	1.22+0.15	2.62±0.17	3.34±0.34
Temperature	101.8+0.13	101.3+0.17	102.2*0.17	101.44+0.20
Dehydration score***	1.23*0.25	1.13+0.23	1.13+0.23	0.0±0.0
Recovery score****	-	1.11+0.17	1.22±.05	3.38±0.15
Efficacy (%)	No. of animals 15	Animals recovered 11		Efficacy (%)

*Good 1, low 2, no appetite 3; **watery 1, semi-solid 2, loose ball 3, normal 4; *** +1, +2, +3, +4; ****poor 1, partial 2, moderate 3, complete 4.

scoring basis and changes in serum biochemical parameters. The result of therapeutic efficacy suggested that drug in the given concentration was very effective in bacteria origin diarrhea in goats (Table 2 and 3). Overall efficacy was 73.3 %. Marginal increment was observed in serum glucose, sodium and potassium levels in post treatment. Drug was considered to be safe, as there were no untoward reactions during treatment No significant changes were noted in biochemical parameters viz, total protein, albumin, globulin, AST, and creatinine, supporting the safety of the ITK.

Chemical analysis

Yield (%), physical characteristic and qualitative analysis revealed the presence of glycosides, alkaloids, saponins and carbohydrate (Tables 3 and 4).

Table 3. Serum biochemistry in treatment trial of *pojo-bark* extract in clinical cases of diarrhoea in goats at Makhdoom

Parameters	Pretreatment	Post-treatment
Glucose (mg %)	29.16±2.44	39.52+2.42
Total protein (g %)	6.09+0.22	5.72±0.26
Albumin (g %)	2.76+0.10	2.75±0.07
Globulin (g %)	3.33+0.18	2.96±0.26
AG ratio	0.385±0.05	0.98±O.O8
AST (U/ml)	80.0+5.82	81.88±4.14
Creatinine (m mol/litre)	70.2+0.08	75.2±0.02
Sodium (m mol/litre)	129.33±0.18	144.78±3.28*
Potassium (m mol/litre)	3.93+0.18	4.23±0.14
Chloride (m mol/litre)	102.0±5.04	105.40±15.90

* P>0.05.

Table 4. Yield (%) and physical characteristics of pcyo-bark extract at Makhdoom

Parameter	Po/'o-bark extract
Percent yield	23.5% on as such basis
Colour	Brown
smell	Agreeable
Nature	Sticky
Solubility	Methyl alcohol, ethyl acohol

Tabl 5. Chemical analysis of methanolic extract of *pojo-bark.* at Makhdoom

Chemical constituent	Reaction
Flavonoids	–
Glycosides	+
Steroids	-
Tannins	-
Coumarins	-
Alkaloids	+
Saponins	+
Proteins	-
Fat and oils	-
Carbohydrates	+

Table 6. Antibiogram profile of *pojo* (tree bark) extract against *E.coli* isolates at Makhdoom

Test compound	Zone of inhibition (mm)		
	Trial I	Trial II	Mean
Standard antibiotics			
Gentamicin	8(R)	-	8
Kanamycin	15(1)	-	15
Ampicloxacilln	8(R)	-	8
Enrofloxacin	0(R)	-	0
Lincomycin	0(R)	-	0
Cefuroxime	10 (R)	-	10
Tobramycin	15 (S)	-	15
Amikacin	17 (S)	-	17
Cephadroxil	10 (R)	-	10
Amoxycillin	7(R)	-	7
Cephatrioxone	10 (R)	-	10
Norfloxacin	0(R)	-	0
Pojo *tree bark extract* ' *(conc./disc)*			
Control	0	0	0
16 mg	12	14	13
8 mg	9	13	11
4mg	8	10	9
2mg	0	0	0
1 mg	0	0	0

***In vitro* antibiogram**

The results showed 8-14 mm zone of inhibition at 4, 8, 16 mg/disc concentration. It indicated that *pojo* bark extract in these concentrations had antibacterial property against

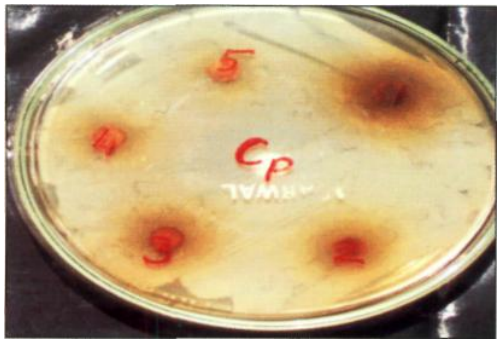

Fig. 1. Antibiogram of *Pojo tree bark* extract

E.coli, a most common entero-pathogen causing diarrhoea in goats (Table 6).

CONCLUSION

The ITK, i.e. use of *pojo* bark paste in diarrhoea, was initially validated at Veterinary College, BAU, Ranchi. The study concluded with the findings that the paste of *pojo* bark was beneficial in the treatment of non-parasitic diarrhoea in goats. Present trial at the same centre by other scientific team reported 90% efficacy of ITK when used alone and 100% efficacy when combined with anthelmintic. The average recovery period with the ITK treatment was 3-5 days and in combination treatment 2 days. Cross-sectoral validation studies conducted at CIRG also substantiated the previous report. It was concluded that the bark of *pojo (Litsaea anthapoly)* plants had strong potential as an antidiarrhoeal herb in goats. This property may be attributed to its antibacterial activity against *E.coli* and possibly potentiated by its astringent action by the presence of glycosides, alkaloids and saponins.

□

Code	:	**1967**
Title of ITK		**Curing of diarrhoea in goats by using *takala {Cassia tora)* flower juice**
Description of the ITK	:	Diarrhoea is a commonly observed health disorder in goats. The reason may be eating of tender grasses in rainy season, and the excess intake of tubers and grains. To control diarrhoea, *takala* flower juice and *Vi* cup tea are orally administered to the goat for 2-3 days. Farmers of Solapur district in Maharashtra are adopting this practice since several years.
Name and address of the discloser	:	Shri B.B. Khatal, Solapur (Maharashtra)
Location of the use of the ITK	:	Solapur, parts of Sangli, Ahmednagar and Pune (Maharashtra)
Geographical indicators	:	Botanical name : *Cassia tora* Local name : *Takala* Family : Leguminoseae A small weed plant, an annual herb 30-90 cm high. It is widely spread, growing on dry soil. It occurs in wasteland during rainy season. Leaves and seeds of *takala* are laxative, antipyretic, anthelmintic, ophthalmic and expectorant. The leaves and seeds are useful in cough, constipation and stomach disorder.
Experimenters	:	Maharashtra Animal Science and Fisheries Science University (MASFSU) Dr N. K. Dakshinkar, Associate Professor, Dr G. B. Shrikhande, Assistant Professor, Dr D. B. Sarode, Professor and Head, Department of Clinical Medicine, College of Veterinary Sciences, Nagpur 440 006 (Maharashtra). Central Institute for Research on Goats (CIRG) Dr V.S. Vihan, Principal Scientist and Head, Dr Ashok Kumar, Senior Scientist and Dr Rajneesh Rana, Scientist (Senior Scale), Animal Health Division CIRG, Makhdoom-281122, Mathura (U.P.)

Contents

METHODOLOGY

Experiment

MASFSU

Therapeutic trial: The study was conducted on goats presented to Veterinary College Hospital, Nagpur with the history of diarrhoea or dysentery. These goats were subjected to detailed clinical and parasitological examinations and were sub-divided into parasitic and non-parasitic groups and were randomly assigned to two treatments within each broad group (parasitic and non-parasitic) comprising 6 goats irrespective of their age and sex. Another group consisting of 6 goats was kept as standard treatment.

Flower juice of *takala {Cassia tora)* was prepared by mincing freshly collected flowers of *Cassia tora* in the morning hours. The juice was strained through a sieve and was drenched @ 15 ml twice a day to goats suffering from parasitic and non-parasitic diarrhoea.

Faecal sample examination: Faecal sample of goats suffering with diarrhoea was collected per-rectal in clean sterile glass vials before treatment and thereafter on day 6 of treatment. The samples were examined by sedimentation technique immediately after collection.

Therapeutic efficacy of the drugs: It was evaluated on the basis of eggs per gram faeces (EPG) determined by modified Stoll's dilution technique (Soulsby, 1982) on days 0 and 6 after-treatment.

Clinical examination: Clinical signs such as dehydration score and faecal consistency were recorded

Haemato-biochemical profile: Packed cell volume (PCV), serum total protein, albumin (A), globulin (G), A: G ratio, chloride, sodium and potassium were estimated from the blood samples collected on days 0 and 6 after-treatment.

CIRG

Therapeutic trial: Therapeutic efficacy of *takala* leaf extract was carried out in 15 diarrhoeic goats. Bacteriological examination of faecal sample from representative clinical cases (10) showed predominantly *Escherichia coli*. The suspension of methanolic extract of *takala* leaves was prepared in gum acacia (5%) for oral administration and was given @ 30 mg/kg body weight, once daily for 3 consecutive days.

Haemato-biochemical estimations: Standard

Table 1. Clinical changes in parasitic and non-parasitic diarrhoea before and after the treatment at MASFU

Parameter	Parasitic				Non-parasitic			
	Takala		Standard therapy*		*Takala*		Standard therapy**	
	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6
Dehydration score	6.5 ±0.42	4.33 ±0.33	5.33 ±0.33	4.16 ±0.16	6.33 ±0.55	4.00 ±0.36	5.00 ±0.25	4.16 ±0.16
Faecal consistency	2.66 ±0.21	0.51 ±0.22	2.33 ±0.33	0.50 ±0.22	2.00 ±0.36	0.50 ±0.22	1.83 ±0.3	0.33 ±0.21
EPG	1158.3 ±247.8	966.66 ±212.79	319.8 1545.0±	0.00 ±0.00	ND	ND	ND	ND
Average recovery period (days)	4.33		1.5		6.5		5.66	

♦Standard therapy: Fenbendazole tab @ 10 mg/ kg body weight orally; ** Standard therapy: astringent mixture (kaolin, creta, catechue) 30 g twice a day orally

Table 2. Hemato-biochemical changes in parasitic and non- parasitic diarrhoea before and after the treatment at Nagpur

Parameter / Group	PCV		Serum total protein		Serum albumin		Serum globulin		A: G ratio		Serum sodium		Serum potassium		Serum chlorides	
	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6	Day 0	Day 6
Parasitic diarrhoea																
Takala	29.5. ±2.32	30.13 ±1.88	5.01 ±0.14	5.31 ±0.15	2.14 ±0.23	2.38 ±0.25	3.03 ±0.28	2.95 ±0.23	0.854 ±0.18	0.775 ±0.09	114.47 ±46.95	122.85 ±7.18	6.12 ±0.34	5.13 ±0.24	92.52 ±2.97	
ST	27.7 ±3.54	27.7 ±3.54	5.51 ±0.17	6.4 ±0.3	2.72 ±0.19	2.88 ±0.11	2.79 ±0.11	3.51 ±0.21	0.992 ±0.09	0.827 ±0.03	113.28 ±6.70	124.65 ±6.62	6.12 ±0.16	5.29 ±0.23	95.15 ±2.39	
Non-parasitic diarrhoea																
Takala	33.9 ±3.01	33.53 ±2.75	5.58 ±0.19	5.84 ±0.21	2.71 ±0.25	2.82 ±0.22	2.87 ±0.11	3.08 ±0.11	0.968 ±0.13	0.948 ±0.09	114.26 ±9.42	124.98 ±9.6	5.97 ±0.22	5.22 ±0.23	97.96 ±3.48	
ST	3.3 ±2.1	33.4 ±2.48	5.78 ±2.02	6.53 ±0.29	3.16 ±0.16	3.4 ±0.67	2.59 ±0.17	3.12 ±0.38	1.128 ±0.236	1.201 ±0.19	144.13 ±6.94	124.52 ±6.96	6.13 ±0.3	5.14 ±0.29	86.06 ±3.37	

methods were used to estimate serum glucose, albumin, globulin, A:G ratio, aspartate amino transferase activity, creatinin, sodium, potassium and chloride concentrations in serum samples collected before and 3 days after the treatment.

Phyto-biochemical analysis: Cassia tora plant (leaves) was procured from Banagalore. After complete drying at room temperature, it was powdered and methanolic extract was prepared with Soxhlet assembly.

In-vitro *antimicrobial activity of juice:* Antibiogram of Takala leaves juice was determined against *E. coli* isolated from clinical cases of diarrhea in goats using different concentration (1, 2, 4, 8, 16 mg per disc).

RESULTS AND DISCUSSION

Therapeutic efficacy

Results obtained for treatment of diarrhoea using *takala* flower juice at MASFSU are presented in Tables 1 and 2.

In parasitic diarrhoeic animals, faecal examination revealed mixed infestation of *Trichuris, Strongale* and *Moneizia* spp. Complete recovery in parasitic diarrhea was achieved with standard therapy on an average of 1.5 days. The EPG was reduced from 1545 to 0 level in this group by day 6. Administration of *takala* flower juice significantly reduced the dehydration score and faecal consistency score by day 6, particularly in cases of non-parasitic diarrhoea. The average recovery period in ITK treated groups was 4.55 and 6.5 days in parasitic and non-parasitic diarrhoea respectively. The standard treatment, however, brought about clinical recovery within 1.5 and 5.66 days respectively. The flower juice also reduced EPG in parasitic diarrhoea from 0 day values of 1158.3+247.8 to 966.66 ±212.79. This indicated possible anthelmintic activity of the flower juice of *takala (Cassia tora).* The changes in hematobiochemical paramaters simulated the clinical recovery profile.

At CIRG the clinical efficacy was assessed, on the basis of revival of appetite, faecal

Contents

Table 3. Therapeutic efficacy of *Cassia tora* leaf extract in clinical cases of diarrhoea in goats at CIRG

Parameter	Pre-treatment	Post-treatment (Mean ± SE)		
	(Mean ±SE)	Day 1	Day 2	Day 3
Appetite score*	1.76±0.29	**1.66+0.18**	**1.44+0.17**	1.20±0.2
Faecal score**	1.25+0.15	1.22+0.15	2.62±0.17	3.24±0.34
Temperature	101.8+0.17	**101.3+0.17**	101.2+0.17	101.44±0.20
Dehydration score***	1.24+0.35	1.13+0.13	1.13±0.32	0.0±0.0
Recovery score****	-	**1.11+0.17**	1.32±.O5	2.88±0.16
Efficacy (%)	No. of animals 15	Recovered 9	Efficacy (%) (60.0)	

*Good 1, low 2, no appetite 3; **watery 1, semi-solid 2, loose ball 3, normal 4; *** +1, +2, +3, +4; ****poor 1, partial 2, moderate 3, complete 4

Table 4. Serum biochemistry in treatment trial of *Cassia tora* leaf extract in clinical cases of diarrhoea in goats at CIRG

Parameter	Pretreatment	Post-treatment
Glucose (mg %)	40.15±3.24	41.065+2.5
Totol protein (g %)	6.15+0.15	6.17±0.55
Albumin (g %)	3.00±0.15	2.94±0.14
Globulin (g %)	3.16+0.12	3.23±0.68
AG ratio	0.96±0.06	1.05±0.24
AST** (u/ml)	89.25+6.20	69.74±2.14
Creatinine (m mol/litre)	115.2±0.04	91.2±0.09*
Sodium (m mol/litre)	132.4±4.9	140.3±.04
Potassium (m mol/litre)	3.33±1.01	4.91±0.25
Chloride (m mol/litre)	102.5+1.32	104.89±2.83

*P<0.05; **AST, Aspartate amino transferase

Table 5. Yield and physical characteristics of *Cassia tora* leaf extract at CIRG

Parameter	*Cassia tora* extract
Yield (%)	20.5
Colour	Dark green
Smell	sweet
Nature	Oily
Solubility	Methyl alcohol, ethyl alcohol

Table 6. Chemical analysis of methanolic extract of *Cassia tora* leaves at CIRG

Chemical constituents	Reaction
Flavonoids	+
Glycosides	+
Steroids	-
Tannins	+
Coumarins	-
Alkaloids	-
Saponins	+
Proteins	-
Fat and oils	-
Carbohydrates	+

consistency and dehydration status, which were categorized on scoring basis and changes in serum biochemical parameters. Overall therapeutic efficacy of *takala* leaf juice was 60%, which suggested that the juice of *takala* leaves at the tested concentration was moderately effective in bacterial diarrhoea in goats (Tables 3 and 4). No untoward reaction was noticed during treatment and serum biochemical parameters did not indicate toxicity of ITK (Table 4).

Phyto-chemical analysis

Yield (%), physical characteristic and qualitative analysis revealed the presence of flavinoids, glycosides, tannin, saponins and carbohydrate (Tables 5 and 6).

Table 7. Antobiogram of *Cassia tora* leaf extract at Makhdoom

Test compound	Zone of inhibition (mm)		
	Trial I	Trial II	Mean
Standard antibiotics			
Gentamicin	8(R)	-	8
Kanamycin	15(1)	-	15
Ampicloxacillin	8(R)	-	8
Enrofloxacin	0(R)	-	0
Lincomycin	0(R)	-	0
Cefuroxime	10 (R)	-	10
Tobramycin	15 (S)	-	15
Amikacin	17 (S)	-	17
Cephadroxil	10 (R)	-	10
Amoxycillin	7(R)	-	7
Cephatrioxone	10 (R)	-	10
Norfloxacin	0(R)	-	0
Cassia tora *extract (conc./disc)*			
Control	0	0	0
16 mg	9	8	8.5
8mg	0	0	0
4mg	0	0	0
2 mg	0	0	0
1 mg	0	0	0

In-vitro antibiogram

The only zone of inhibition (8.5 mm) was exhibited in the disc of highest concentration (16 mg). Rest of the entire disc did not reveal any zone of inhibition (Fig. 1). It indicated that *Cassia tora* extract had antibacterial property against *E.coli* at higher concentration only (Table 7).

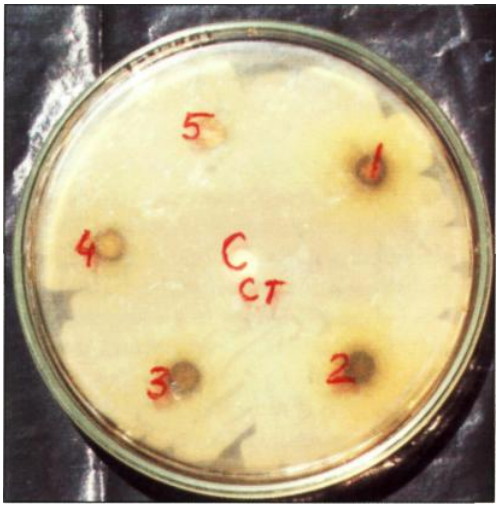

Fig. 1. Antobiogram of *Cassia tora* leaf extract

CONCLUSION

The initial validation study using ITK (flower juice of *takala* in treatment of diarrhoea was conducted at Veterinary College, MASFSU, Nagpur. The findings recorded moderate degree of effectiveness of the ITK against parasitic diarrhoea in goats. Further trial at the same centre substantiated the previous year's results with additional finding on the moderate efficacy of the **ITK** in non- parasitic diarrhoea. Considering non-availability of flowers in different seasons, *takala (Cassia tora)* plant leaves were assessed for their efficacy against *E. coli* diarrhoea at CIRG, Makhdoom. The leaf extract showed enough potential as an antidiarhoeal therapy in management of diarrhoea in goats. This may be due to its moderate antibacterial property against *E. coli* and its astringent action due to presence of tannins and saponins besides flavonoids. □

Code : **1968**

Title of the ITK **Wound management in animals by use of leaf extract of ridge gourd *(Luffa acutangula)* or ekdandi *(Tridex procumbens)***

Description of the ITK : This practice is followed by the farmers of semi-arid tract of western Maharashtra especially in parts of Pune, Satara, Solapur and Ahmednagar districts. Ridge gourd or *ekdandi* leaves are ground and the juice is extracted. The extracted juice is smeared over the wounds of the animal. This practice effectively controls wound in animals due to antiseptic lotion present in ridge gourd and *ekdandi* leaves.

Name and address of the discloser : Shri B.B. Khutal, Solapur (Maharashtra)

Location of use of the ITK : The practice is found in semi-arid tract of western Maharashtra especifically in parts of Pune, Satara, Solapur and Ahmednagar districts.

Experimenters : Maharashtra Animal Science and Fishery Sciences University (MASFSU)

Dr S.N. Patil, Associate Professor, Dr V.S. Panchbhai, Professor, Dr M.S. Dhakate, Associate Professor, Dr B.M. Gahlod, Assistant Professor and Dr S.V. Upadhye, Assistant Professor, Department of Surgery; and Dr A.G. Bhandarkar, Associate Professor, Department of Pathology, Nagpur Veterinary College, Nagppur 440 006 (Maharashtra).

Ch. Sarwan Kumar, Krishi Vishwavidyalaya (CSKHPKV)

Dr A.C. Varshney, Professor and Head, Dr S.P. Tyagi, Assistant Professor and Dr M.S. Kanwar, Associate Professor, Department of Surgery and Radiology, College of Veterinary and Animal Sciences, Palampur 176 062 (Himachal Pradesh)

METHODOLOGY

Experiment

MASFSU

Preparation of juice: The fresh leaves of ridge gourd and *ekdandi* were collected from the vicinity of Cattle Breeding Farm, Nagpur and adjoining villages of Nagpur district. The leaves of both the plants were washed with distilled water 2 to 3 times and triturated in grinder-cum-mixer separately to form a paste. The paste was squeezed with muslin cloth to obtain juice extract.

Preparation of aqueous extract: The fresh leaves of each herb were washed with 0.2% mercuric chloride in distilled water for 2 min. followed by five to six washings with distilled water. Fresh leaf extract, viz. cold water extract of fresh leaves, hot water extract of fresh leaves, cold water extract of dried leaves and hot water extract of dried leaves of ridge gourd and *ekdandi*, were

Contents

Table 1. Plan of the experiment

Group	Number of wounds	Treatment
A	10	Leaf extract of ridge gourd leaves
B	10	Leaf extract of *ekdandi* leaves
C	10	Veterinary medicine: Neosporin ointment (control)

prepared as per the standard method prescribed by Omoregbe *etal*. (1996) to evaluate the *in-vitro* antibacterial activity.

Total 30 clinical cases of wounds in buffaloes of either sex and in the age group of 1 to 3 years were randomly subjected to the following three treatment groups consisting of 10 wounds in each group (Table 1). The wounds were treated at the door step of farmers in Nagpur and adjoining areas. All the wounds were cleaned with moist sterile gauze before application of respective medicament. A sterile gauze soaked in juice was placed on the wounds after gentle squeezing in order to keep the juice in contact with tissue of wound. The juice of ridge gourd and *ekdandi* leaves and Neosporin ointment were applied once a day to treat the wound till healing.

Clinical observation: The wounds in each treatment group were subjected for gross examination (type of wound: fresh or contaminated, presence of discharges like blood, exudates, pus), appearance of granulation tissue, wound contraction (the percentage of wound contraction was calculated at days 0, 3, 6, 9, 12, 15,18 and 21), number of days required for healing and extent of cicatrisation (the cicatrix contraction was assessed on the basis of size of wound on 0 day and then subsequently on every third day up to complete cicatrix formation). The mapping of wound was done with the help of filter-paper by pressing over the wound and moist-area impression was measured by using vernier calipers. The data pertaining to wound size in all the treatment groups at different period intervals were statistically analysed by two-way analysis with multiple observations.

Histomophological study: The biopsy sample of the tissues was collected on days 7, 14 and 21 after-treatment and subjected to standard procedure of fixing and staining the tissue for recording the histo-morphological changes during the process of wound healing.

In vitro evaluation of antibacterial activity: Various extracts were evaluated for their antibacterial spectrum against indicator organisms such as *Staphyolococcus aureus*, *Statphylococcus epidermidis*, *Streptococcus spp.*, *Pseudomonas aeruginosa*, *Proteus* spp. and *E. coli* using diffusion assay method.

CSKHPKV

The study was conducted during 2004 on 10-12 months old healthy male calves (9) that were acclimatized to college animal shed for at least 21 days before start of trials. All the animals were subjected to routine clinical, haematological and faecal examinations to ensure their health status. The animals were dewormed with bolus Fentas (fenbendazole) @ 7.5 mg/kg body weight 15 days prior to start of experiment. All the animals were kept in similar managemental conditions throughout the study. The animals were divided into 3 equal groups, viz. groups A, B and C, for conducting wound-healing study. For creation of wounds, thoraco-lumbar region of each animal was prepared for aseptic surgery. Six equidimensional (3 cm x 3 cm), full-thickness excisional cutaneous wounds, 3 on either side of the vertebral column and 3 cm apart on the dorsal aspect of thoracolumbar region were created under local infiltration anaesthesia (Fig. 1). The animals of group A served as negative control, in which the wounds were dressed with normal saline-soaked gauze. The animals of group B served as positive control, in which 5% Povidone iodine suspension was used

as a dressing agent. The wounds of group C animals were treated with topical application of fresh juice of ridge gourd leaves extracted immediately before each application (Fig. 1). The wounds were dressed daily for 14 days and on alternate days subsequently.

Evaluation of healing of wound: Heart rate, rectal temperature and respiration rate were recorded on days 3, 7, 14, 21 and 28 post-operatively and compared within and between the groups. The wounds were also examined to record the degree of inflammation, exudation, underlying tissue-healing changes, granulation tissue formation and percentage of wound contraction. The percentage wound contraction was measured using the formula:

$$\text{Wound contraction}\,(\%) = \frac{A - B}{A} \times 100$$

where,

A = is area (cm^2) of the wound at day 0.

B = area (cm^2) of the wound at day 3, 7, 14,21 and 28.

RESULTS AND DISCUSSION

Out of the 10 clinical cases of wounds treated at MASFSU, four wounds were fresh, covered with blood clots, whereas six were contaminated with dirt and foreign material. In treatment group of juice of *ekdandi*, wounds were fresh showing discharge of exudate, and seven were contaminated; whereas in Neosporin treatment group the four wounds were fresh covered with clotted blood, and six were contaminated with mud and foreign particles. The gross visual examination of wound showed the presence of granulation tissues and wound contraction on day 7. The evaluation of wound on day 14 revealed epithelization and wound contraction, whereas on day 21 the wounds in all the three treatment groups showed complete healing. None of the wounds showed suppuration till complete healing in all the three treatment groups. The results indicated that these herbs possessed anti-bacterial activity. The wounds treated with juice of ridge gourd leaves showed the appearance of granulation tissue on day 6 after-treatment, whereas it was observed on day 5 after-treatment in those treated with juice of *ekdandi* leaves. In Neosporin treatment group the granulation tissue was apparent on day 4 after-treatment. The results revealed the formation of granulation tissue in all the treated groups. In all the treatment groups the progressive reduction in size of wound was found highly significant at $P<0.01$ at interval of different days. On day 0 the size of the wound treated with juice of ridge gourd leaves was 4.04± 0.06 cm^2, which showed progressive reduction to 0.83 ±.0.02 cm^2 by day 18 after-treatment, whereas it was 4.01 ± 0.02 cm^2 and 0.80 ± 0.0.01 cm^2 on day 0 and 18 after-treatment respectively in the wounds treated with juice of *ekdandi* leaves. In Neosporin-treatment group, the size of the wound was 4.00 ± 0.01 cm^2 and 0.86 ±.0.01 cm^2 on days 0 and 18 after-treatment respectively (Table 2).

The contraction of wound is a normal physiological phenomenon, indicating the process of healing. The percentage of wound contraction (%) was more evident up to day 9 after treatment in groups A and B compared with group C (Table 3). The subsequent observation on days 12,15,18 and 21 in all the treatment groups showed linear increasing trend in percentage of wound contraction and total contraction, of the wound (%) was observed on day 21 in all the groups (Graph 1).

The mean and standard error of days required for complete healing of wounds were 19.9±0.02, 19.7±0.03 days respectively for the wounds treated with juice of ridge gourd and *ekdandi* leaves respectively, whereas it was 20.00±0.06 days in Neosporin-treatment group. The result are indicative of better healing ability of these herbs comparable to Neosporin ointment.

At CSKHPKV, the wounds treated with ridge gourd extract (group C) were relatively drier when compared with other two groups on day 3 after operation. The wounds in this group were covered

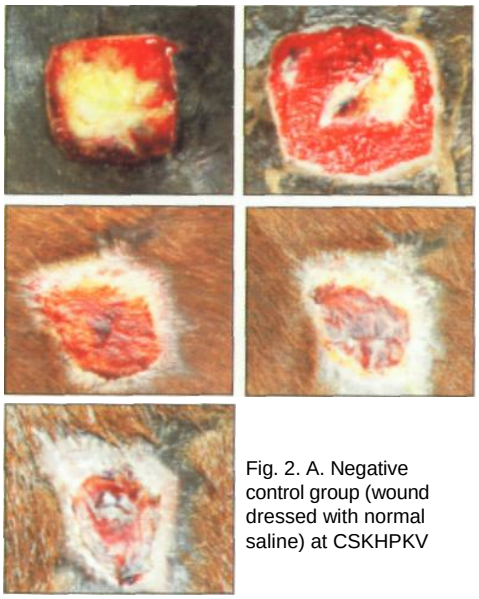

Fig. 2. A. Negative control group (wound dressed with normal saline) at CSKHPKV

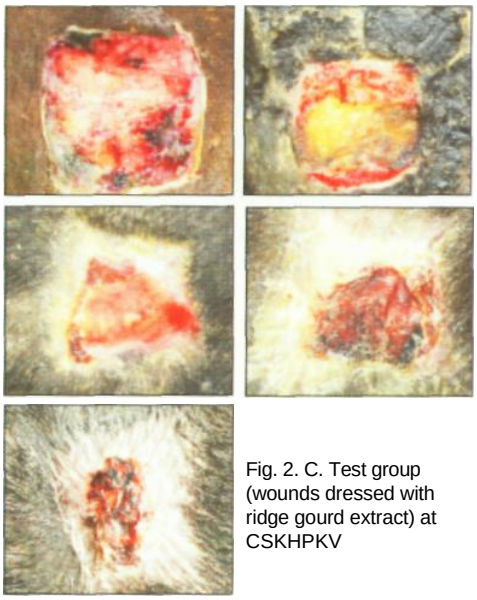

Fig. 2. C. Test group (wounds dressed with ridge gourd extract) at CSKHPKV

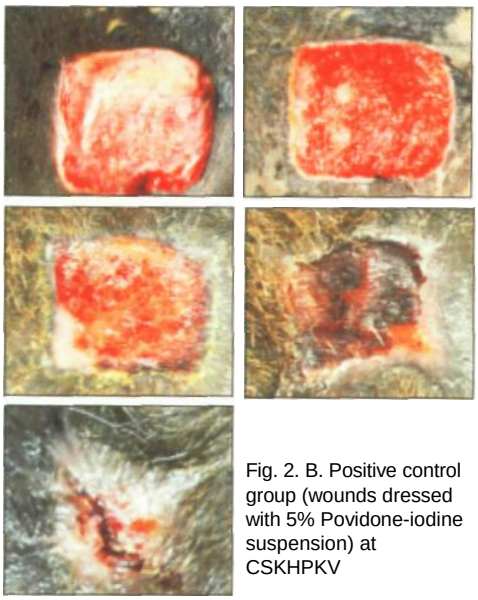

Fig. 2. B. Positive control group (wounds dressed with 5% Povidone-iodine suspension) at CSKHPKV

with a relatively stronger transparent scab; whereas the wound covering in other two groups were too fragile which readily peeled off during dressing change-over (Fig. 2 Cl). The wound edges were quite raw with fragile vascular bed in group A, which bled easily during even a slight manipulation (Fig. 2 Al). In group B, though the bleeding tendency was not as marked as in group A, they still showed intermittent raw patches over wound surfaces (Fig. 2 Bl). Exudation and inflammatory changes of wounds were also least in group C and almost comparable in other two group at this stage. The wound contraction (%) was minimal and comparable between the groups (Table 4).

On day after operation, the wounds in all the three groups exhibited development of healthy granulation tissue, which was covered with blackish yellow to transparent scab (Fig 2 A2, B2 and C2). Again, the scab covering was stronger in group C and fragile in the other two groups. The wound exudation was reduced markedly in

Table 2. Mean and standard error (mean ± SE) for reduction in size of wounds (cm^2) in different treatment groups at different intervals at MASFSU

Treatment	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18
Juice of ridge gourd	4.04 ±0.06	3.43 ±0.02	3.18 ±0.01	3.04+0.01	1.68 ±0.02	1.21 ±0.04	0.83± 0.02
Juice of ***ekdandi***	4.01 ±0.02	3.66 ±0.02	3.33±0.04	2.83+0.01	2.60 ±0.03	1.11 ±0.02	0.80 ±0.01
Neosporin ointment	4.00+0.01	3.91 ±0.06	3.84 ±0.02	3.70+0.01	3.26 ±0.02	1.74 ±0.05	0.86 ±0.01

Table 3. The percentage (%) of wound size and wound contraction at different intervals in days in three groups at MASFSU

Intervals (days)	Group A (ridgegourd)		Group B *(ekdandi)*		Group C (Neosporin)	
	Wound area	Wound contraction (%)	Wound area	Wound contraction (%)	Wound area	Wound contraction (%)
0	100	0	100	0	100	0
3	85.75	14.25	91.50	8.5	97.75	2.25
6	79.50	20.50	83.25	16.75	96.00	4.00
9	76.00	24.00	70.75	29.25	92.50	7.50
12	67.00	33.00	65.75	34.25	81.50	18.50
15	30.25	69.75	27.75	72.25	36.80	63.20
18	20.75	79.25	20.00	80.00	21.50	78.50
21	0	100	0	100	0	100

all the three groups and the dressing gauze was found strictly adhering to the wound surfaces. The fragile scab came off almost completely in groups A and B during dressing change-over, whereas in group C the central portion of almost all the wounds was seen still covered with this scab even after dressing change-over. The extent of inflammation and swelling was least in group C wounds and the animals of this group exhibited lesser pain reactions to palpation when compared with other two groups. The wound contraction (%) was significantly greater in group C when compared with other groups (Table 4).

On day 14 after operation the wounds were seen covered with thick and strong scab in groups A and C (Fig. 2 A3 and C3). The margins of wounds of these groups showed complete healing of underlying tissue. The extent of healing was more widespread in group C wounds as evidenced by the presence of whitish new replacement tissue all around the wound margins, whereas in group A it was restricted mainly to one or two margins only. The extent of healing of underlying tissue was least in group B; its scab was also least firm at this stage (Fig. 2 B3). The inflammation and swelling at the wound margins were however absent in all the groups at this stage; but mild exudation was seen in some of the wounds of group B. The pain response to palpation in all the groups was also almost negligible. The wound contraction (%) was greatest in group C which was slightly greater than in group A and significantly greater than in group B wounds.

On day 21, all the wounds irrespective of the group were devoid of any gross exudate and covered with dry and firm scab (Fig. 2 A4, B4 and

C4). A majority of the portion of the scab in group C was shed at this stage, revealing filling of underlying wound gap by newly formed replacement of proper tissue. The healing changes were relatively comparable in group A, whereas the margins of group B wounds still did not reveal shedding tendency of scab and therefore exact evaluation of underlying tissue healing was not possible. In general the wound contraction was again greatest in group C and least in group B (Table 4).

On day 28 after operation, the gross appearance of wounds in groups A and B was almost comparable to the gross appearance of group C wounds on day 21. Their marginal wound scabs were shed, underlying tissue healing was visible and the wound margins were showing moderate contraction (Fig. 2 A5 and B5). The wounds in group C were exhibiting far more advanced healing changes with even more extensive wound contraction and only very little amount of residual dry scab in the wound centres (Fig. 2 C5, Table 4).

The rectal temperature, respiration rate and heart rate in the animals of both the groups remained within the normal physiological range and did not show any significant change during the entire course of study (Table 4). Feed intake was also normal in all the animals of both groups throughout the period of study.

Histo-morpholigical observations: On day 7, the section of wound treated with juice of ridge gourd (Fig. 3A), *ekdandi* (Fig. 3B) and Neosporin ointment (Fig. 3C) on day 7 showed oedema, haemorrhage and leucocytic infiltration, indicating active inflammatory process.

The section of wound on day 14 revealed haemorrhage, neutrophilic infiltration and proliferation of fibroblast with budding capillaries in the wound treated with Juice of ridge gourd

Table 4. Effect on wound contraction (%), rectal temperature (^{c}), respiration rate/minute and heart rate/ minute following different treatments in aseptic excisional cutaneous wounds in calves (mean±SE) at CSKHPKV

Group	Post-operative interval (days)					
	3	7	14	21	28	
			Wound contraction (%)			
A	1.18+0.14	5.18±1.18	46.57±4.56	59.86+4.22	81.71 ±6.68	
B	1.68±0.22	4.68±0.82	33.96±3.88	48.66±4.06	74.38±5.36	
C	1.78±0.42	9.58±2.14	49.48±4.35	66.26±5.28	83.96±6.44	
			Heart rate/minute (")			
A	101.2±0.36	102.33±0.57	102.0+0.44	102+0.57	101.4±0.32	100.4±0.48
B	102±0.54	102.4+0.30	102.6+0.84	101.63±0.58	101.6±0.30	100.33±1.0
C	101.8±0.64	102.33±1.2	102.2+0.56	101.8±0.42	101.3±0.84	101.4±0.88
			Respiration rate/minute			
A	26.66±2.40	28.0±3.20	29.33+3.42	28.6±2.28	29.33±4.18	28.33±3.35
B	31.2±2.64	30.6±3.65	31.66+2.45	30.33±8.60	32.0±5.42	31.6±5.30
C	27.0±2.64	29.33±5.36	29.6±5.86	28.0±4.80	30.33±4.96	30.6±4.80
			Heart rate/minute			
A	68.6±2.80	69.6±5.22	71.3+2.30	73.4±4.17	64.3±3.28	66.6±4.26
B	67.6±3.80	70.0+6.48	69.6±4.28	69.8±1.52	71±8.26	68.4±2.84
C	69.0±4.04	68.6±3.40	67.0+2.40	68.6±3.81	67.8±5.64	71 ±6.26

Table 5. Anti-bacterial activity of juice and aqueous extract of *Luffa acutangula* Roxb. (ridge gourd) and *Tridax procumbens (ekdandi)* at MASFU

Extract	Zone of inhibition (mm)					
	Staphylococcus aureus	*Staphylococcus epidermidis*	*Streptococcus* spp.	*Pseudomonas aeruginosa*	*Proteus* spp.	*E. coli*
Ridge gourd						
Juice of fresh leaves	-	-	-	10	-	-
Cold-water extract of fresh leaves	11	11	-	-		12
Hot-water extract of fresh leaves	15	16	-	-		15
Cold-water extract of dried leaves	-	-	-	-	-	
Hot-water extract of dried leaves	-	-	-	-	-	
Neosporin	16	16	-	-		14
Ekdandi						
Juice of fresh leaves	5	-	-	7	-	-
Cold-water extract of fresh leaves	-	-	-	-	-	-
Hot-water extract of fresh leaves	-	-	-	-	-	-
Cold-water extract of dried leaves	-	-	-	-	-	
Hot-water extract of dried leaves	-	-	-	-	-	-
Neosporin	18	-	-	-		12

(Plate 4) whereas in *ekdandi* group it showed presence of healthy granulation tissue with presence of fibroblast and proliferation of dermoid epithelium (Fig. 3 D &E).

In Neosporin treatment group it showed the presence of inflammatory cells, juvenile capillaries and proliferation of fibroblast, indicative of formation of granulation tissue (Fig. 3 F&G).

On day 21 the section of wound showed well-organized keratinized epithelium covering the granulation tissue in the wound treated with juice of ridge gourd (Fig. 3H) and *ekdandi* (Fig. 31). But granulation tissue covered with germinal epithelium and the keratinization of dermis was not evident in Neosporin treatment group (Fig. 3J)

The overall result of histomorphological findings revealed early keratinization of epithelium of the wounds treated with juice of ridge gourd and *ekdandi* leaves and were comparable with Neosporin-treatment group, indicating better healing property of these herbs.

In-vitro *anti-bacterial activity:* The juice of fresh leaves of *Luffa acutangula* Roxb i.e. ridge gourd (10 mm) and *Tridax procumbens*, i.e. *ekdandi* (7 mm) showed moderate anti-bacterial activity against *Pseudomonas aeruginosa* that marked antibacterial activity against *Staphylococcus aureus, Staphylococcus epidermidis* and *E. coli* was observed in cold (11, 11 and 12 mm) and hot (15,16 and 15 mm) aqueous extract of fresh leaves of ridge gourd against above indicator organisms respectively (Table 5). The juice of fresh leaves of *ekdandi* also showed antibacterial activity (5 mm) against

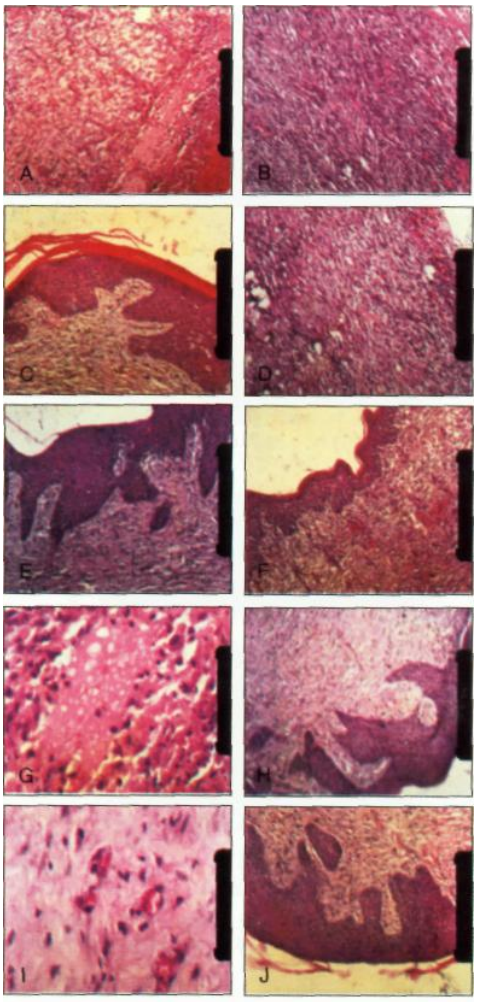

Fig. 3. A. Ridge gourd (day 7); B. *Ekdandi* (day 7); C. Neosporin (day 7); D&E. Ridge gourd (day 14); F&G. Neosporin (day 14); H. Ridge gourd (day 21); I. *Ekdandi* (day 21); J. Neosporin (day 21)

Staphylococcus aureus.

The juice of ridge gourd and *ekdandi* leaves as well as aqueous cold and hot water extracts of fresh leaves of ridge gourd showing anti-bacterial potential were further tested at monthly interval. However, a month-old juice and aqueous extract did not show any anti-bacterial activity. These findings suggest that juice and aqueous extracts should be used immediately after its preparation in order to control the infection from the wounds.

CONCLUSION

The percentage of wound contraction was more than 32% on day 12 after treatment in the wounds treated with juice of ridge gourd and *ekdandi* leaves compared with only 18.50% in Neosporin-treatment group, indicating early process of wound healing. The histo-morphological findings revealed early keratinization of dermal epithelium in both the groups of wounds treated with juice of ridge gourd and *ekdandi* leaves on day 21 after treatment. However, the keratinization of dermis was not evident of the wounds treated with Neosporin ointment, which indicated better healing property of these herbs. The juice of ridge gourd and *ekdandi* fresh leaves as well as cold and hot water extracts of fresh leaves of ridge gourd possessed anti-bacterial activity. It was concluded that ridge gourd can be used effectively for treating the wounds contaminated by *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa* and *E. coli.* The use of ridge gourd *(Luffa acutangula)* extract was also found safe for topical application on cutaneous wounds and was useful in the treatment of excisional cutaneous wounds in animals.

Code	**:**	**1966**
Title of the ITK		**Use of *bhangariya (Eclipta alba)* to cure** blain **in animals**
Description of the ITK	:	To cure the animals from blain, farmers of Sonapur village in Azamgarh district of Uttar Pradesh use paste of *bhangariya.* About 200-250 g of *bhangariya* plant (leaf and stem) is collected from the field and washed before crushing. The paste is fried in 50-60 ml mustard oil. The fried paste is divided into three parts, which are used in 3 days after changing the old doses. By this practice, 80-90% of the problem is controlled for cattle, buffaloes and goats. Out of 1,200 farmers, 400-500 farmers follow this practice.
Name and address of the discloser		Shri Ranjay Kumar Singh, S/o Shri Haribansh Singh, village Sonapur, P.O. Sewta, Azamgarh (Uttar Pradesh) 276 128
Location of use of the ITK		Sonapur, Johanaganj, Azamgarh (Uttar Pradesh) 276 128
Experimenters	:	Maharashtra Animal Sciences and Fishery Sciences University (MASFSU) Dr C.R. Jangde, Associate Professor, Department of Pharmacology, Nagpur Veterinary College, Nagpur 440 006 (Maharashtra) Tamil Nadu Veterinary and Animal Sciences University (TANUVAS) Dr Capt. G. Dhanan Jaya Rao, Associate Professor, Department of Surgery and Dr S. Prathaban, Professor and Head, Department of Clinics, Madras Veterinary College, Chennai 600 007 (Tamil Nadu)

METHODOLOGY

Experiment

MASFSU

Preparation of poultice: The fresh leaves and stem part of *bhangariya* plant was triturated in the mortar. The poultice so obtained was fried with mustard oil and stored in bottle and was used for application on local inflammatory swellings as and when required.

Treatment with poultice: Thirty cases of local inflammatory swellings on any part of body irrespective of species were identified. Their initial inflammation was recorded with the help of vernier calipers. The poultice of *bhangariya* prepared earlier (approximately 250 g) kept on cotton, was applied on the inflammatory swellings in 20 cases. The bandage was applied on the affected part. The poultice of *bhangariya* was kept in contact with the affected part for 5 days and maximum up

Contents

Fig. 1. Efficacy of *bhangariya (E. alba)* poultice on inflammatory swellings before and after treatmentat MASFSU

Fig 2. Efficacy of iodine ointment on inflammatory swelling before and after treatment at MASFSU

Fig. 3. Effect of *bhangariya* poultice and iodine ointment on inflammatory swellings in buffaloes at MASFU

to 9 days or till the inflammatory swelling subsided. After removal of poultice, the diameter of inflammatory swelling was again measured with vernier calipers. The difference in the diameter of inflammation before and after treatment was recorded and the data were analysed statistically by Students' 't' test to test the level of significance. The remaining 10 cases of inflammatory swelling were treated with iodine ointment as standard veterinary ointment and same procedure was repeated. The difference in diameter of inflammation observed in two different treatments, i.e. *bhangariya* poultice and iodine ointment, were compared with each other for their efficacy and analysed by Students 't' test.

TANUVAS

To study the effect of *bhangariya (Eclipta alba)* on blain in animals, 22 cases were selected for the study. These animals included 2 calves, 7 horses, 3 bullocks, 2 cows, 4 buffaloes and 4 goats. The cases were of joint swelling, yoke swelling, swelling of neck region, polyarthritis, thelitis, capped knee, saddle gall, polyarthritis without navel ill, contusion pelvis and orchitis. The inflammatory signs like rubor, callor, dollor, tumour and functionalasia were studied before the start of the treatment and periodically during the treatment. They were graded as normal, mild, moderate and severe and very severe; each grade was scored as 0, 1, 2, 3 and 4 respectively.

RESULTS AND DISCUSSION

Results of studies conducted at MASFSU are given in Table 1 and Fig 1-5. It was observed that the difference in the diameter of inflammation before and after treatment with poultice and iodine ointment differ significantly within group analysis

 Table

1. Comparative efficacy of ITK and conventional veterinary drug treatment in blain cases at MASFSU

Group	Inflammatory swelling (cm)		Average recovery period (days)
	Before treatment	After treatment	
ITK treatment (n=20)	13.36	3.57*	6.8 (5-9)
Conventional veterinary drug (n=10)	16.57	4.80*	5.9 (4-8)

Mean values between two periods differ signifcantly ($p<0.01$) in both groups.
No significant difference in recovery period or post-treatment inflammatory swelling in two groups.
Values in parentheses indicate the range of recovery period.

Fig. 4. Treatment of inflammation with *bhanganya* poultice in buffalo at MASFSU.
A. Swelling; B. Poultice applied; C. Swelling subsided

Contents

Fig. 5. Treatment of inflammation with iodine in buffalo at MASFSU. A. Swelling; B. Poultice applied; C. Swelling subsided

and was found significant at 1% level. The difference in the diameter of inflammation in the poultice-treated group was compared with the difference in the diameter of the inflammation observed in iodine ointment treated group. In ITK group, inflammatory swelling was 13.36 cm, which decreased to 3.57 after treatment. The average recovery period in this group was 6.8 days; it

Table 2. Score (Mean±SE) of the inflammatory signs before (day 0) and after (day 3, 6) of the treatment at TANUVAS

	Swelling			Redness			Functionalasia			Warmth			Pain		
	0	3	6	0	3	6	0	3	6	0	3	6	0	3	6
Mean	3.86	2.45	0.72	3.86	2.36	0.31	3.90	2.45	0.5	3.81	2.09	0.31	3.90	3.81	1.45
SE	0.82	0.52	0.15	0.82	0.50	0.06	0.83	0.52	0.10	0.81	0.44	0.06	0.83	0.81	0.30

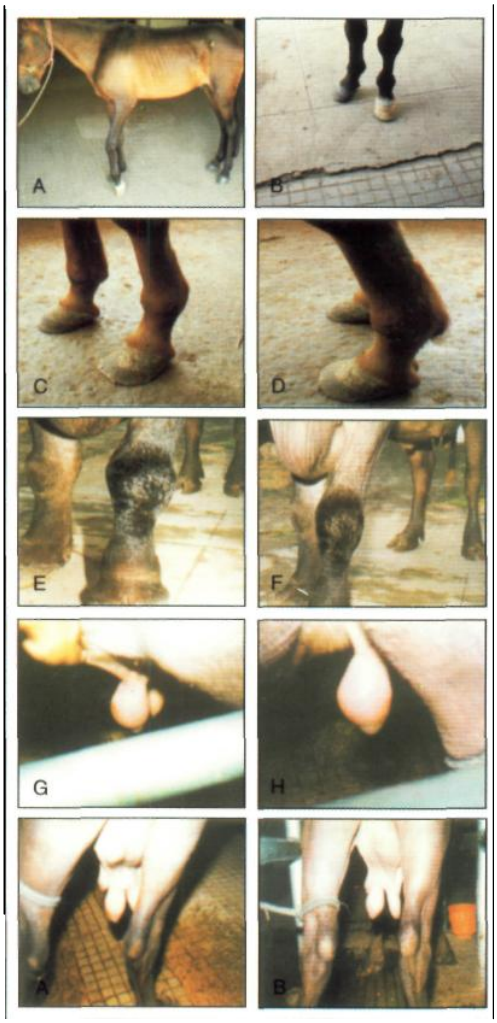

Fig. 6. Different cases of swelling before and after the treatment at TANUVAS
A. Inflammation of the suspensory ligament; B. After treatment; C. Left fetlock joint swelling; D. After treatment; E. Left fetlock joint swelling; F. After treatment; G. Inflammation of the suspensory ligament; H. After treatment; I. Left fetlock joint swelling; J. After treatment

differed non-significantly with the group treated with iodine ointment (Table 1). It indicates that the treatment with *bhangariya* poultice was equally effective to that of iodine-ointment treatment.

The observations recorded at TANUVAS before and after application of ITK are given in Table 2 and Fig. 6 (A-J).

Rubor: The redness of the affected area was visually observed and the grading revealed on day 0 was 3.81 + 0.82. Application of the medicament redness on day 3 decreased to 2.45 ± 0.52 and on day 6 it further decreased to 0.72 ±0.15. The parameter studied revealed that the medicament induced beneficial effect by virtue of its property to provide local hypothermic effect (Fig. 7).

Callor: Warmth of the inflammatory swelling was studied by physical assessment. Of the 22 cases, increase in local temperature on day 0 was 3.86 ± 0.82 and during the treatment it decreased to 2.36 ± 0.50 on day 6 and to 0.31 ± 0.06 on day 3, perhaps due to the hypothermic effect. (Fig.8)

Dallor: Pain on the affected area was assessed by visual analogue systemic changes. The study revealed that pain analogue was 3.90 ± 0.83 on day 0 and decreased to 2.45 ± 0.52 on day 3 and further decreased to 0.5 ± 0.10 on day 6 after the application of the medicament, which could be attributed to the anodyne effect of the medicament. (Fig. 9)

Tumour: Tumour indicates the swelling of the affected area and on day 0 the grading was 3.81 ± 0.81 and on day 3 it decreased to 2.09 ± 0.44 and further decreased to 0.31 ± 0.06 on day 6 (Fig. 10)

In clinical practice, swelling must be reduced at the earliest, otherwise it may lead to compartmental syndrome that interferes with circulation as well as with the conduction of nerve impulses. *Eclipta alba* paste counteracts the compartmental syndrome, revealing that it has astringent effect.

Functionalasia: The functional property could not be assessed because rubor and callor are concomitant factors associated with functionalasia (Fig. 11). The functionalasia study statistically revealed the following results: on day

Fig. 9. Dallor

Fig. 10. Tumor

Fig. 11. Functionalasia

0 the grading was 3.90 ± 0.83; on day 3 it was 3.81 ± 0.81 and on day 6 it was 1.45 ± 0.30.

The medicament has anti-inflammatory property, which has diminishing effect on rubor, callor, dollar and tumour with promotional effect on function. The present study revealed that the paste of *Eclipta alba* has hypothermic, nodyne and astringent effects.

CONCLUSION

Results obtained at MASFSU indicated that the leaves and stem of *bhangariya* plant possess some active principles (ecliptene, wedelollactone and sterols, reported earlier) which is anti-inflammatory in nature. Hence, the poultice of leaves and stem of *bhangariya* plant fried in mustard oil were effective to manage the blain in buffaloes. The *bhangariya* poultice was equally effective to that of iodine ointment to manage the blain in farm animals.

The paste of *Eclipta alba* is effective in muscular and not in skeletal affections, as found from the results obtained at TANUVAS. The results further revealed its positive effect in soft tissue swellings, especially in cases of thelitis in buffaloes, which has economical consequences if treatment is delayed. The paste of *Eclipta alba* is cost effective compared with conventional therapy. It was inferred that the paste of *Eclipta alba* was effective in the management of soft tissue swelling in animals in a cost-effective manner.

Code : **1284**

Title of the ITK **Determination of efficacy of pigeon waste in showing oestrus symptoms in heifers**

Description of the ITK : To induce oestrus and for showing heat symptoms in heifers, pigeon waste, mixed with jaggery, is fed to heifers 2-3 times a day. The disease is cured up to 60%. Treatment cost per animal is Rs 10-15. This is practised by the farmers of many villages in Badaun and Bareilly districts of Uttar Pradesh.

Name and address of the discloser : Dr (Ms) Shagufta Jamal, Department of Adult and Continuing Education, Jamia Millia Islamia, Jamia Nagar, New Delhi 110 025

Location of use of the ITK : The ITK is being used in many parts of Bareilly and Budaun districts of Uttar Pradesh.

Experimenters

Indian Veterinary Research Institute (IVRI)

Dr D. Swarup, Head, Division of Medicine, Dr Satish Kumar, Senior Scientist, Animal Reproduction Division and Dr Mahesh Chander, Senior Scientist, Extension Division, Indian Veterinary Research Institute, Izatnagar-243 122 (Uttar Pradesh)

Govind Ballabh Pant University of Agriculture and Technology (GBPUAT)

Dr Mahesh Kumar, Professor and Head, Department of Epidermiology and Preventive Medicine and Dr J.K. Prasad, Assistant Professor, Animal Reproduction, Gynaecology and Obstetrics, College of Veterinary Sciences, Pantnagar, dist. U.S. Nagar 263 145 (Uttaranchal).

METHODOLOGY

The ITK was validated initially at IVRI, Izatnagar and was included for GBPUAT, Pantnagar for cross-sectoral revalidation.

Experiment

IVRI

During 2002-2004 of study, clinical trial was conducted on 30 anoestrous heifers. Of these, 22 animals were given pigeon waste @ 100 g orally for 3 consecutive days and eight heifers received standard allopathic treatment consisting of hormonal injection and mineral mixture. The animals were observed for heat and conception status.

The pigeon waste collected from different localities was processed for analysis of minerals using atomic absorption spectrophotometer (AAS).

Contents

GBPUAT

Pigeon waste was collected from the local areas of district Rampur. It was cleaned from debris (like sand, feathers and stone particles), dried and powdered. A dose of 100 g was prepared and packaged in polythene bags.

Mineral analysis of pigeon waste: Concentration of minerals (calcium, magnesium, iron, copper, cobalt, zinc and manganese) in the grinded pigeon waste was estimated using atomic absorption spectrophotometer.

Effect of pigeon waste on anoestrus animals: Forty animals were selected for the study and divided in two groups having 20 animals each. Group 1 was given pigeon waste 100 g, orally for 3 days, however, group 2 animals were treated with Receptol, 5 ml, I/M as a single injection.

Effect of pigeon waste on reproductive organs of prepubertal female Swiss mice: Prepubertal female Swiss mice (n=50) were procured from IVRI, Izatnagar. The age of all the mice was 20 days. The reproductive cycles were also assessed by vaginal cytology, which confirmed the non-cyclic stage of the mice.

All the mice were randomly divided into 3 groups, each having 16 mice. Group 1 was given normal feed, group 2 was given normal feed plus pigeon waste in the ratio of 1: 0.5, and group 3 was given normal feed and pigeon waste in the ratio of 1:1. All feeds were given *ad lib* for 8 days.

Vaginal cytology was also observed for the diagnosis of the stage of oestrous cycle, if cycle started. Blood was collected directly from heart after administering anesthesia using anesthetic ether to all the mice and plasma was harvested for the estimation of estradiol and progesterone. Mice from all the groups were sacrificed, and their genital organs were collected and weighed to observe the difference in weights in relation to control group.

RESULTS AND DISCUSSION

Effect of pigeon waste on anoestrus animals

At **IVRI,** of the 22 animals that were given pigeon waste, 11 came in heat and 6 conceived, whereas 3 of the 8 animals receiving allopathic medicine came in heat and 2 conceived (Table 1). At GBPUAT, 7 out of 20 animals (35%) in group 1 and 10 out of 20 animals (50%) in group 2 showed signs of oestrus. Different animals showed oestrus behaviour from 4 to 10 days (av. 6.71 days) after the start of treatment with pigeon waste. All the animals in oestrus were inseminated and 5 animals in group 1, and 7 in group 2 conceived (Table 2).

Table 1. Effect of pigeon waste and allopathic medicine on oestrus and conception rate at IVRI

Group treated	Animals	Animals came in heat	Animals conceived
ITK (pigeon waste)	22	11	6
Allopathic medicine	8	3	2

Table 2. Effect of pigeon waste and allopathic medicine on oestrus and conception rate at GBPUAT

Group treated	Animals came in heat	Animals	Animals conceived
ITK (pigeon waste)	20	7	5 7
Receptol (standard therapy)	20	10	

Mineral analysis of pigeon waste: The results at **IVRI** indicated presence of high concentrations of essential micro-minerals in the pigeon waste,

Table 3. Values of different minerals in pigeon waste at **IVRI**

Parameter	Value (ug/g)
Calcium	839.20
Magnesium	516.07
Iron	1426.60
Copper	44.90
Cobalt	11.03
Zinc	140.85
Manganese	31.83

Fig. 1. Unprocessed pigeon waste at GBPUAT

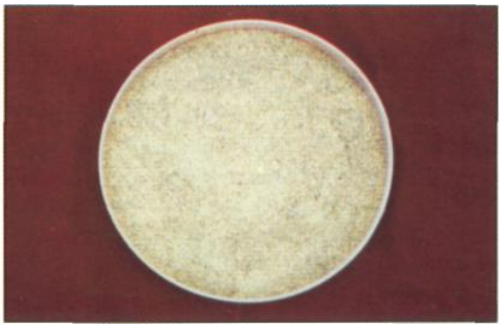

Fig. 2. Processed pigeon waste at GBPUAT

which could be responsible for compensating the deficiency of these nutrients in heifers, leading to estrus symptoms.

At GBPUAT, the pigeon waste revealed high concentration of iron, copper and zinc (Tables 3 and 4).

The mineral composition of pigeon waste in 100 g was almost same (Table 5) as observed in the commonly used 30 g mineral supplements (recommended normal dose of mineral mixture).

Table 4. Concentration of trace minerals in pigeon waste at GBPUAT

Parameter	No of observations	Range (|ig/g)	Mean±SE (ng/g)
Calcium	15	1.98-4.73	3.12±0.18
Phosphorus	15	0.47-3.27	1.57±0.15
Zinc	21	35.04-295.46	82.24±11.43
Iron	12	264-6571.45	836.68±39.45
Copper	12	6.60-19.01	16.21±6.56
Fluorine	1	167.5	-
Magnesium	13	0.60-7.50	2.96±0.58
Cadmium	21	0.06-1.00	0.62±0.07
Lead	11	4.36-9.6	5.27±0.53
Cobalt	13	1.46-5.28	2.96±0.19

Table 5. Comparative estimate of mineral content of pigeon waste and mineral mixture at GBPUAT

Paramete	Pigeon waste		Agrimin mineral mixture	
	Values (Hg/g)	mg/ 100 g	mg/ 100 g	mg/ 30 g
Ca	839.20	83.92	24(g)	7-2 (g)
Mg	516.07	51.60	211	63.3
Fe	1426.60	142.7	98	29.4
Cu	44.90	4.5	31.2	9.36
Co	11.03	1.1	4.5	1.35
Zn	140.85	14.1	21	6.3
Mn	31.83	3.18	-	4.0*

*(Minal forte, Alembic Ltd.)

Table 6. Weight (g) of mice at day 20 (before treatment) and day 28 (after treatment) at GBPUAT

Parameter	Group I (Control)		Group II		Group III	
	Day 20	Day 28	Day 20	Day 28	Day 20	Day 28
Average weight (g)	17.518	19.375	18.950	20.956	20.468	22.434
SE	0.7341	0.9356	0.4816	0.5852	0.6197	0.7075
Increase in weight (g)		1.8563		2.0062		1.9656
Increase in weight (%)		10.5961		10.5868		9.6029

Fig. 3. Final packaging of pigeon waste in 100 g poly packs at GBPUAT

Table 7. Weight (g) of female genital organs in mice at day 28 (after treatment) at GBPUAT

Parameter	Group I	Group II	Group III
Average weight (in g)	0.0480	0.0886	0.0725
SE	0.0025	0.0282	0.0137
Increase in weight (in g)		0.0406	0.025
% increase in	gbt	84.58	52.08

Effect of pigeon waste on reproductive organs of prepubertal female Swiss mice: The weight gain in mice was 10.60,10.58 and 9.60% in group 1, 2 and 3 respectively (Table 6).

There was significant increase in the average weight of female genital organs of mice that received pigeon waste (Table 7, Fig. 4).

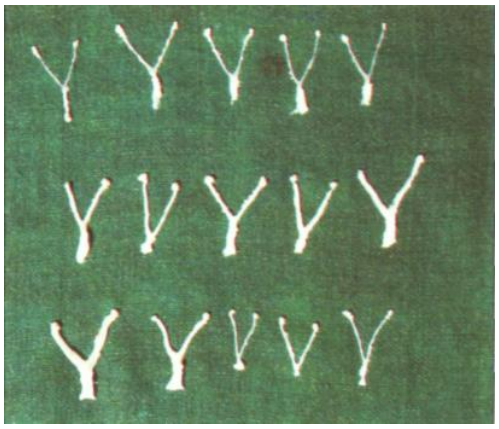

Fig. 4. Comparative growth and development of female genital organs at GBPUAT

CONCLUSION

The findings of IVRI, Izatnagar (during 2002-2004) and GBPUAT, Pantnagar (during 2004) were almost similar and pigeon waste was found useful in bringing to anoestrus heifers to normal cyclicity and conception. The conception rate using this ITK was similar to that of standard hormonal treatment. However, the cost of treatment using ITK was much cheaper than that of standard veterinary treatment. Its mineral composition is almost similar to the commercially available mineral supplements. Experimental studies have suggested that ITK has beneficial effect on the development of reproductive organs and attaining puberty age early in the mice.

□

Code : **1272**

Title of the ITK **Treatment of swelling of shoulders in bullocks or bulls**

Description of the ITK : When shoulders are swollen, bullocks are unable to do work. A mixture of *geru* (30 g) and snail shell or *sipi* (50 g) is boiled in castor oil. *Alua* (20 g) and *kudru* or *sahjan* gum (50 g) are mixed to it. This paste under warm condition is applied on the affected swollen neck of the animal. This is practised by the villagers of Nayabas Kutubpur in Bulandshahr district of Uttar Pradesh.

Name and address of the discloser : Shri Prem Pal Singh Arya, C/o Shri Daal Chand, House No. 38, Purva Ahiram Indra chowk, Meerut (Uttar Pradesh)

Location of use of the ITK : This condition is generally seen in draught animals. The bullocks are generally affected and the condition is known as yoke gall. The cases are generally seen in areas where bullock carts are used for transportation of goods. Continuous chronic irritation results in painful swelling and wounds at shoulder. As shown in Fig. 1, inappropriate size of animals in a pair used for draught or agricultural operations also leads to this disease. The ITK is practised in several villages in Bulandshahar district, particularly where bullock carts are used extensively for rural transport and agriculture is dependent on bullocks.

Experimenters : Indian Veterinary Research Institute (IVRI)

Dr D Swarup, Head, Division of Medicine, Dr A.K. Sharma, Senior Scientist and Dr Naveen Kumar, Senior Scientist, Division of Surgery and Dr H. P. S. Arya, Joint Director (Extension Education), Indian Veterinary Research Institute, Izatnagar (Uttar Pradesh) 243 122

Maharashtra Animal Science and Fishery Sciences University (MASFSU)

Dr M.S. Dhakate, Associate Professor, Dr VS. Panchbhai, Professor, Dr S.N. Patil, Associate Professor, Dr B.M. Gahlod, Assistant Professor and Dr S.V. Upadhye, Assistant Professor, Department of Surgery and Radiology, Nagpur Veterinary College Nagpur (Maharashtra) 440 006

Fig. 1. Paste of *geru,* snail shell, *alua (Aloe vera)* and *sahjan* gum

METHODOLOGY

The ITK was validated at IVRI, Izatnagar and at MASFSU, Nagpur for cross-sectoral revalidation during 2004.

Experiment

IVRI

During 2004, 16 clinical cases which included 6 bovines (shoulder swelling 1, joint and limb

Contents

swellings 5) and 10 equines (joint and limb swellings 10) were used. Of 5 bovine cases of joint and limb swelling, 3 were of calves having swelling at carpal joint of these, 2 cases had hard and painful swelling. X-ray examination revealed osteoarthritis and animals showed severe lameness. In one calf the swelling was soft with mild pain. The remaining 2 bovines were adult. One animal was buffalo bullock having severe lameness and swelling at fetlock. Treated horses had swelling at elbow, fetlock, chronic tendo-synovitis and arthritis of fetlock and carpal joint. A mixture of powder of snail skull 10 g, *alua* 10 g, *sahjan gum* 10 g and *geru* 30 g was mixed in 150 g castor oil. This paste was heated and after cooling at warm stage was applied on the affected part twice or thrice a day. For shoulder swelling, swelling, pain by pressing at the site and side effects, if any, on days 0, 7, 14, 21 and 30 were recorded, whereas for joints and limb swelling, swelling, pain at the site, weight bearing in standing position, weight bearing in motion and side effects, if any, were recorded on days 0, 7, 14 and 21.

MASFSU

The field trials were carried out on clinical cases of bullocks suffering with swelling of shoulder region and swelling of limb or joint. These clinical cases were randomly divided into four groups consisting of 10 animals in each group. The site of swelling in the neck, shoulder region and limb or joint was thoroughly scrubbed and washed with soap and water, and mopped with cloth before application of medicament in groups I, II, III and IV respectively. Clinical observations pertaining to pain and swelling were recorded on day 0 before the application of ointment and subsequently on days 7, 14, 21 and 30.

The observation pertaining to swelling was recorded by measuring with vernier calipers and graded as 0= no swelling, 1= mild swelling, 2= moderate swelling and 3= severe swelling. The pain sensation was judged on the basis of pressing of the swelling site with thumb and finger and was graded as 0= no pain, 1= mild pain, *2*-moderate pain and 3= severe pain on days 0, 7, 14, 21 and 30. The observations regarding the weight bearing in standing position was recorded in groups **III** and IV and graded as 0= no weight bearing, 1= toe touching the ground, 2= moderate weight bearing and 3=full weight bearing. Weight bearing in motion was assessed in groups **III** and IV and graded as 0= support the limb on the ground and put less weight, 1= moderate weight bearing with limping, 2=full weight bearing but apparently lame and 3=full weight bearing without lameness.

RESULTS AND DISCUSSION

Swelling of shoulder

There was significant reduction in the swelling as well as pain in shoulder in all the animals and the swelling score became 1 on day 7 and 0 on day 21, but it decreased to 1 on day 7 and 0 on day 14 (Table 1).

Table 1. Score sheet for shoulder swelling at IVRI

Parameter	Day				
	0	7	14	21	30
Swelling (score)	2	1	1	-	-
Pain (score)	2	1	0		

Swelling of shoulder region

Ten cases of swelling of neck were assessed, which showed moderate to severe inflammation in group I. The average score was 2.1 ± 0.13 on day 0. Application of ITK ointment revealed reduction in swelling and mean score on days 7, 14, 21 and 30 as 1.3+0.13, 1.0+0.16, 0.6 and 0.5+0.2 respectively. Statistically the treatment revealed linearly declined trend, and on day 30 the inflammation at the site was minimum. However, in the animals of group II, which were treated with iodine ointment, swelling score was

Table 2. Score sheet for swelling after application of ITK ointment and iodine ointment over swelling of shoulder at MASFU

Treatment	Days of observation				
	0	7	14	21	30
ITK ointment	2.1+0.13	1.3±0.13	1+0.16	0.6	0.5±0.20
Iodine ointment	2.2±0.11	1.4+0.21	0.8±0.16	0.6±0.3	0.4±0.25

2.2±0.18 on day 0. There was linear regular decline in trend of swelling on days 7, 14, 21 and 30 (Tables 2 and 3, Fig. 2).

Swellings of joints and limbs

A reduction in mean scores of swelling of joints and limbs was observed. The mean scores of pain decreased after the application of ITK on the affected part. The pain score that was 2.0 on day 0 decreased to 0 on day 21 after treatment (Table 3). There was gradual improvement in weight-bearing scores, and on day 21 after treatment it was 2.86. The treated animals also revealed gradual improvement in weight-bearing scores, and on day 21 after treatment it was 3.4 (Table 4). Overall, 16 animals were treated and 8 animals recovered up to a period of 28 days. Of all the recovered animals, 3 recovered within 2 weeks and 2 within 3 weeks (Table 3).

The results of treatment of joint, limbs or shoulder swellings observed at MASFU are presented in Tables **5—11.** The pain sensation in animals was evaluated by palpation with thumb and index finger at the site of inflammation. On day 0, the pain score was 2.6±0.13 and showed regular undulating trend. On days 7, 14, 21 and 30, it became 1.3+0.15, 0.5±0.25, 0.2 and 0.2

Fig. 2. Subsided swelling after application of ointment

respectively, which showed decreasing trend of reduction in pain. The animals of group II treated with iodine ointment revealed pain score 2.5±0.16 on day 0, which declined regularly and linearly (Tables 2 and 5).

Iodine ointment is a proven mild counter-irritant and strong antiseptic, having ability to dilate the superficial blood vessels with enhancing phagocytosis, which literally helps dilute and drain the inflammatory fluid through lymphatic and thereby reduce the inflammation of the part. During the phase of drainage of inflammatory fluids, the chemical mediators of inflammation, i.e. cytokinine, bradykinine, alphaprostaglandin

Table 3. Score sheet for pain after application of ITK and iodine ointments over swelling of shoulder at MASFSU

Treatment	Days of observation				
	0	7	14	21	30
I T K ointment	2.6+0.13	1.3+0.15	0.5+0.25	0.2	0.2
Iodine ointment	2.5±0.16	1.3+018	0.6±0.20	0.5	0.4

Table 4. Score sheet for joints and limb swelling of calves at IVRI

Parameter	Day			
	0	7	14	21
Swelling (score)	2.9	1.8	1.33	1.0
Pain (score)	2.0	0.5	0.33	0
Weight bearing in standing position (score)	1.6	2.0	2.36	2.86
Weight bearing in motion (score)	1.7	2.4	3.33	3.4

and 5-hydroxytryptamine are the pain sensitizers, which cause nerve irritability due to its drainage. When nerve irritability is reduced, the pain is reduced.

The medicament consisting *oialua*, castor oil, *sahajan* gum and snail shell in a specific proportion was heated before the application. This thick paste on application supplies heat to the affected body parts and helps in augmentation of the blood supply and phagocytosis. *Alua* acts as an anti-inflammatory agent, whereas castor oil acts as a mild counter-irritant for a longer duration. However, *sahajan* gum is an antiseptic. The combined action is to reduce the pain and swelling.

Swelling over leg and joint

Ten clinical cases of swelling over limb

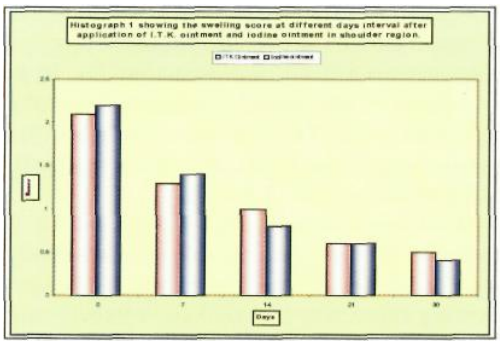

Fig. 3. Swelling score at interval of different days after application of ITK and iodine ointments in shoulder region

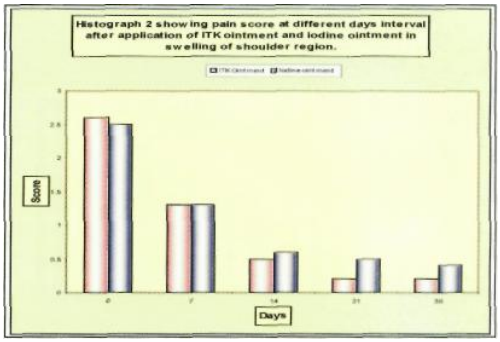

Fig. 4. Pain score at interval of different days after application of ITK and iodine ointments in swelling of shoulder region

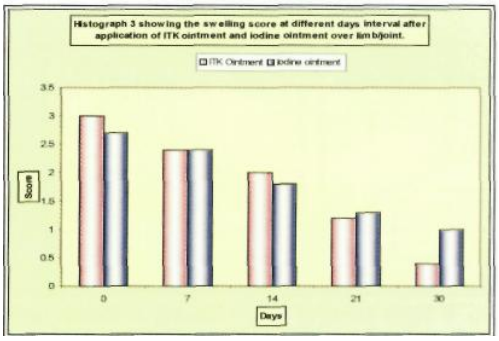

Fig. 5. Swelling score at interval of different days interval after application of ITK and iodine ointments over limb or joint

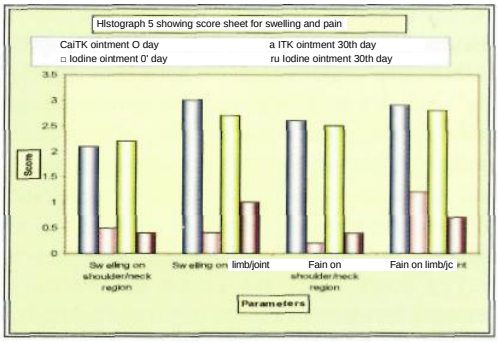

Fig. 6. Score sheet for swelling and pain

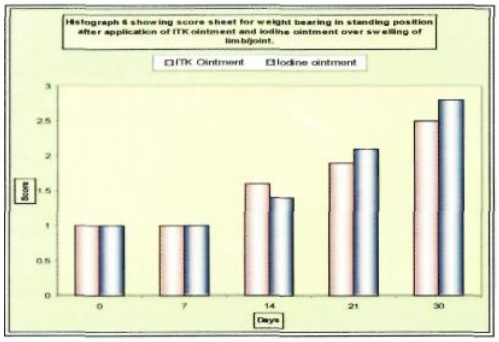

Fig. 7. Score sheet for weight bearing in standing position

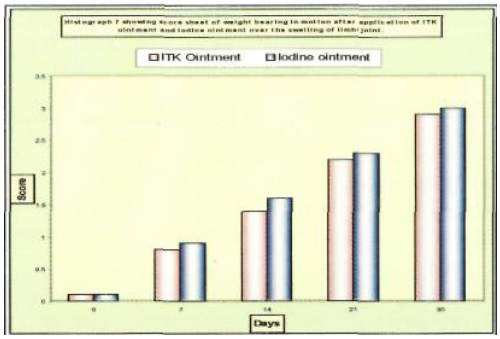

Fig. 9. Score sheet for weight bearing in standing position and weight bearing in motion

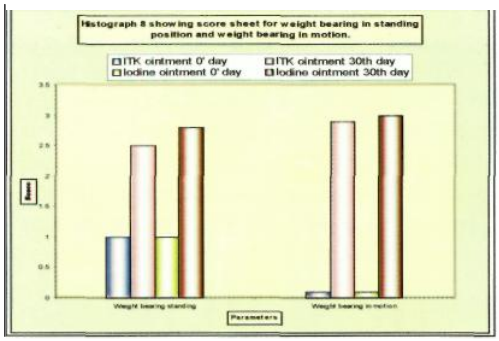

Fig. 8 Score sheet of weight bearing in motion after application of ITK ointment and iodine ointment over the swelling of limb/joint

(8 forelimb and 2 hind limb) were included in group III. Three cases had swelling on knee joint, 5 cases were of swelling over arm and the forearm, whereas two cases had swelling on lateral aspect of metatarsal region below the hock joint. Mostly the swellings were initiated due to trauma. In group IV, two animals had swelling on knee joint, six had swelling on posterior part of the metatarsal and two animals had swelling over knee joint. These animals exhibited the symptoms of lameness and limping of limb during progression. The score sheet evaluation of swellings revealed the mean score 3 on day 0 and 2.4±0.16, 2±0.23, 1.2±0.18 and 0.4, respectively after application of ITK ointment on days 7, 14, 21 and 30. There was regular linear decline trend of swelling over leg and joint. The mean score of swelling in iodine ointment group on day 0 was 2.7±0.15, which later declined in the swelling of shoulder and limb/joints (Tables 2 and 6).

Pain-sensation score on day 0 was 2.9±0.1 which decreased gradually and declined during the course of observations on days 7, 14, 21 and 30, with the pain scores of 2.6±0.16, 2.1±0.23, 1.2±0.2, 1.2+0.19, respectively. The pain sensation in affected limb was 2.8±1.3 on day 0 in iodine ointment treated animals, which declined gradually (Tables 3 and 7).

The score for swelling of shoulder/neck region and swelling over limb/joint on 0 day were 2.1+0.13, 3.0 and 2.2±0.11, 2.7+0.15 as against 0.5±0.20, 0.4, and 0.4 and 1.00, respectively on 30th day in ITK treatment and standard iodine ointment group. The overall observation revealed the decreasing trend of swelling on day 30 as compared to day 0 which suggested that the application of ITK and iodine ointment on swelling was found to be effective due to its antiinflammatory action (Table 8).

The weight bearing of animals on day 0 indicated that they were not able to bear the body weight on the affected limb, and the weight bearing score was 1, 1.6±0.16, 1.9±0.17 and 2.5±0.22, respectively on days 7, 14, 21 and 30 in ITK group. The weight-bearing score was 1

Overall recovery of animals treated with the ITK at IVRI

Disease	Species	No. of animals treated	Number recovered on day				
			7	14	21	28	Total
Shoulder swelling	Bovine	1	0	1	-	-	1
Joints and limb Swelling	Bovine	5	0	2	-	-	2
	Equine	4	0	0	2	-	2
	Equine	6	0	0	0	3	3

Table 6. Score sheet for swelling after application of ITK ointment and iodine ointment over swelling of limb/joint at MASFSU

Treatment	Days of observation				
	0	7	14	21	30
ITK ointment	3	2.4±0.16	2±0.23	1.2±0.18	0.4
Iodine ointment	2.7±0.15	2.4±0.15	1.8±0.20	1.3±0.16	1

Table 7. Score sheet for pain after application of ITK ointment and iodine over swelling of limb/joint at MASFSU

Treatment	Days of observation				
	0	7	14	21	30
I T K ointment	2.9±0.1	2.6±0.16	2.1±0.23	1.2±0.2	1.2±0.19
Iodine ointment	2.8±1.3	2.7±0.15	2.3±0.21	1.4±017	0.7±0.24

Table 8. Score sheet for swelling and pain at MASFSU

Parameter	ITK ointment		Iodine ointment	
	Day 0	Day 30	Day 0	Day 30
Swelling on neck/shoulder region	2.1±0.13	0.5±0.20	2.2±0.11	0.4±0.25
Swelling on limb/joint	3.00	0.4	2.7±0.15	1.00
Pain on neck/shoulder region	2.6±0.13	0.2	2.5±0.16	0.4
Pain on limb/joint	2.9±0.1	1.2±0.19	2.8±1.3	0.7±0.24

Table 9. Score sheet for weight bearing in standing after application of ITK ointment and iodine ointment over swelling of limb/joint at MASFSU

Treatment	Days of observation				
	0	7	14	21	30
I T K ointment	1	1	1.6±0.16	1.9±0.17	2.5±0.22
Iodine ointment	1	1	1.4±0.16	2.1±0.17	2.8±1.3

Table 10. Score sheet for weight bearing in motion after application of ITK ointment and iodine ointment over swelling of limb/joint at MASFSU

Treatment	Days of observation				
	0	7	14	21	30
I T K ointment	0.1	0.8	1.4±0.16	2.1±0.18	2.9±0.20
Iodine ointment	0.1	0.9	1.6±0.16	2.3±0.17	3.0±0.21

Table 11. Score sheet for weight bearing in standing position and weight bearing in motion at MASFU

Parameter	ITK ointment		Iodine ointment	
	Day 0	Day 30	Day 0	Day 30
Weight bearing in standing	1.00	2.5±0.22	1.00	2.8±1.3
Weight bearing in motion	0.1	2.9±0.20	0.1	3.00±0.21

on 0 day in iodine ointment group and animals started weight bearing without any lameness (Table 9). Up to day 21, the animals were able to bear moderate weight and later on started full weight bearing.

During motion the animal in group I had weight-bearing score 0.1, which became 0.8, 1.4±0.16, 2.1 ±0.18 and 2.9±0.20 respectively on days 7, 14, 21 and 30. It indicated that after day 21, animals were able to bear complete body weight on affected limb. In group II, the weight bearing score was 0.1 on day 0 and after day 21 they were able to bear complete body weight on the affected limb (Table 10).

Average score for weight bearing in standing position on day 0 was 1.00 in both ITK and iodine ointment treatment groups, indicating that they were unable to bear weight by the affected limb. The score for weight bearing in standing position on day 30 became 2.5±0.2 and 2.8+1.3, respectively in ITK and Iodine ointment groups. It indicates that animal started bearing weight without showing any symptoms of lameness, and both the treatments are effective. The average score for weight bearing in motion was 0.1 both ITK and iodine ointment groups compared with 2.9±0.20 and 3.0±0.21 on day 30 respectively. These finding indicated that the application of both the ointments was effective and resulted in progressive improvement in bearing weight during motion (Table 11).

Weight bearing depends upon extent of inflammation of the joint, flexor tendon, ligament, nerve, weight of the animals and the type of work extracted. If such animals are used for heavy work, they show signs of lameness. However, low-grade inflammation of the part could be treated successfully with ITK ointment. If ligaments or tendons are affected, more time is required for healing. Therefore weight bearing is delayed.

CONCLUSION

The ITK preparation consisting of *geru* 30 g, snail shell powder 50 g boiled in caster oil. *Alua* 20 g and *kudru* or *sahajan* gum 50 g and proprietary preparation—iodine ointment were found effective in the treatment of swelling of neck or shoulder and limb or joint in bullocks and bulls.

There was decrease in swelling and pain scores of joints and limb at different time intervals after commencement of treatment using ITK. Of the 16 animals, 8 recovered completely, whereas in

spite of reduction in pain and swelling, the rest of the animals did not show complete recovery, especially those having osteoarthritis and chronic capped elbow. The findings at both the centres validated the efficacy of ITK in treatment of swelling of shoulder and joints in animals.

Code : **1285**

Title of the ITK **Treatment of haemorrhagic septicaemia by *kalajeera***

Description of the ITK : This method, practised in many villages of Badaun and Bareilly districts of Uttar Pradesh, is very effective to cure the disease, at the initial stage. Paste *of kalajeera* is applied on the throat of HS-affected animal.

Name and address of the discloser : Dr (Ms) Shagufta Jamal, Department of Adult and Continuing Education and Extension, Jamia Millia Islamia, Jamia Nagar, New Delhi 110 025

Location of use of the ITK : Badaun district is located in western Uttar Pradesh. The climate is semi-arid, hot and sub- humid, suitable to occurrence of hemorrhagic septicemia in large ruminants. Animal husbandry is a supporting business to native farmers along with agricultural farming, by keeping 3-6 buffaloes. They were fully aware of this disease in large animals, its clinical symptoms, efforts and conventional therapy. The farmers were having education of metric to high school level.

Experimenters Dr V.S. Vihan, Head, Dr Ashok Kumar, Senior Scientist and Dr Rajneesh Rana, Senior Scientist, Division of Animal Health, Central Institute for Research on Goats (CIRG) Makhdoom, Farah 281 122, Mathura (U.P.)

METHODOLOGY

Kalajeera powder (100 g) was mixed in jaggery or water to make a paste, and it was applied on swollen throat area to treat haemorr-hagic septicaemia in animals.

Extract of *kalajeera (Vernonia anthelmintica)* was prepared in different solvents, viz. chloroform, acetone, benzene, methanol, ethanol and ether, by using Soxhlet extraction assembly. Besides, hot aqueous extract was also prepared with reflux method to study antibiotic profile under *in-vitro* drug-sensitivity test. Different concentrations of these extracts, ranging between 32,16,8,4 and 2 mg were prepared and absorbed over sterile disc with all sterile precautions.

The Muller-Hinton plates were prepared and their sterility was checked. *Pasteurella multocida* B:2 culture was poured over the plates and excess growth was removed. The *kala jeera* extract absorbed discs were placed over these media plates, along with the control discs. The plates were incubated at 37°C and the zones of inhibition against *Pasteurella multocida* B:2 strain of each extract at different concentrations were recorded.

RESULTS AND DISCUSSION

Phytochemical study: The yield (%) of different extracts varied. It was maximum for the hot methanolic (17.98%) extract and minimum for the hot ether extract (5.40%). On chemical analysis of the extracts, phenolic compounds were detected, whereas none of the extracts revealed the presence of glycosides or alkaloids.

Contents

Table 1. Antibiogram profile of various extracts using *Pasteurella multocida* B:2 strain

Test compound	Zone of inhibition (mm)		
	Trial I	Trial II	Mean
Standard antibiotics			
Sulphadiazine (SZ)	0	-	0
Oxytetracycline (O)	6	-	6
Gentamicin (G)	30	-	30
Kanamycin (K)	24	-	24
Ampicloxacillin AC)	34	-	34
Amoxyclav (AX)	24	-	24
Chloramphenicol (C)	30	-	30
Enrofloxacin (EX)	32	-	32
Ofloxacin (OF)	35	-	35
Lincomycin (L)	36	-	36
Cefuroxime (C)	37	-	37
Erythromycin (E)	24	-	24
Methanol extract (concentration/disc)			
Control	0	0	0
32 mg	12	16	14
16 mg	11	15	13
8mg	9	15	12
4mg	32	14	23
2mg	0	10	5
Ether extract *(concentration/disc)*			
Control	0	0	0
32 mg	6	15	10.5
16 mg	9	14	11.5
8 mg	0	12	6
4mg	0	18	9
2mg	37	18	27.5

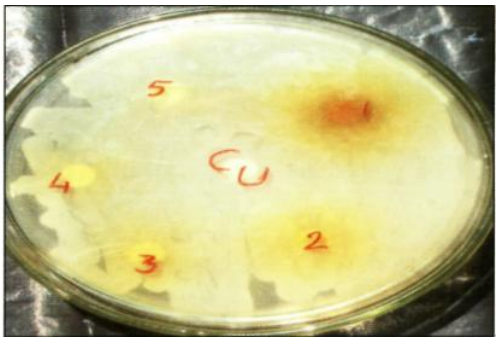

Fig. 1. Antibiogram profile of different extracts of *Kala jeera* against *Pasteurella*

In-vitro *antimicrobial study:* Out of six extracts tested, chloroform, acetone and methanol gave better anti-bacterial effect than other three extracts. All the control discs did not show any zone of inhibition. The range of zone of inhibitions was 15-19 mm in chloroform extract, 10-16 mm in acetone extract, 5-23 mm in methanol extract, 6-27.5 mm in ether extract, 4.5-11.5 mm in benzene extract and 0-7.5 mm in aqueous extract, indicating that the first four extracts had better anti-bacterial property against the causative organism of haemorrhagic septicemia (Table 2, Fig. 1). Hot aqueous extract showed only mild zone of inhibition (7.5 mm) at 32 mg concentration.

Antibiogram of various fractions of methanol extract: Fractionation of metholic extract of *kala jeera* seed *(Vernonia anthelmintic a)* was conducted by solvent technique to further

Table 2. Zone of inhibition at different concentrations of *kalajeera* against HS organism in different solvents

Cone, of extract per disc	Zone of inhibition (mm)					
	Methanol extract	Chloroform extract	Acetone extract	Benzene extract	Aqueous extract	Ether extract
Control (adsorbed with 20 ul solvent)	0	0	0	0	0	0
32 mg	14.0	19.0	16.0	11.5	7.5	10.5
16 mg	13.0	19.0	14.0	8.5	0	11.5
8mg	12.0	16.5	13.0	4.5	0	6.0
4mg	23.0	15.5	12.0	0	0	9.0
2mg	5.0	15.0	10.0	0	0	27.5

Table 3. Antibiogram of petroleum, ether, ethyl acetate, butenol, ethyle/methyl ketone and chloroform sub-fraction

Concentration absorbed/ disc (mg)	Zone of inhibition (mm) sub-fraction									
	Petroleum ether		Ethyl acetate		Butenol		Ethyl methyl ketone		Chloroform	
	I trial	II trial	I trial	II trial	I trial	II trial	I trial	II trial	I trial	II trial
0 (control)	0	0	0	0	0	0	0	0	0	0
32	11	8	14	11	12	8	-	-	0	0
16	8	8	11	10	11	8	0	0	0	0
8	0	0	9	8	8	7	0	0	0	0
4	0	0	8	0	8	7	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
1	-	-	-	-	-	-	-	-	-	-

Table 4. *In-vivo* studies on clinical cases of HS treated with veterinary (VD) drugs alone and veterinary drugs + *kala jeera* (VD+KJ) paste

Treatments	No of cases	No. of cases recovered	Recovery (% 0	No. of days	Outcome
VD+KJ	14	12	85.71	3-4	12 recovered and 2 died 5
VD	10	5	50.0	3-7	recovered and 5 died

fractionate it into different sub-fractions and further to determine their antibacterial properties, e.g. (a) Petroleum ether, (b) Ethyl methyl ketone, (c) Butenol, (d) Ethyl acetate, and (e) Chloroform

The antibiogram profile of various sub-fractions were studied *in vitro* over solid media (Tables 3-7).

Out of the above mentioned antibiogram trials using various sub-fractions, ethyl acetate, butenol and petroleum ether showed better anti-microbial properties. However, ethyl methyl ketone and chloroform did not show any antimicrobial property .

Clinical study: The clinical study was conducted on 14 clinical cases (Table 4, Fig. 2) which were precipitated during monsoon season in buffaloes suffering with pneumonic pasteurellosis and showing all pathgnomonic signs of disease, which consisted of high rise of temperature, respiratory distress, nasal discharge, swelling on throat etc. The animals were completely off fed. Of these 14 cases of buffaloes treated with enrofloxacin, Avil, paracetamol with *kala jeera* paste (Fig. 3) applied on throat showed 85.71% recovery, whereas those treated with veterinary drug alone gave 50% recovery. This clinical study clearly indicated that *kala jeera* extract paste when applied on throat along with veterinary drugs in clinical cases of HS in buffalos helped speedy and higher percentage of recovery.

Fig. 2. Clinical case of HS in buffalo

Fig. 3. Ointment of *kala jeera* extract

Composition of ointment

Crude extract	10 g
Dimethyl sulphoxide :	5% (v/v)
Ethyl alcohol	2% (w/v)
Sodium borate	2% (w/w)
White paraffin wax	100 g

CONCLUSION

The *in-vitro* antibiogram study and *in vivo* clinical studies in field, showed that application of paste of *kala jeera (Veronina anthelmintica)* on swollen throat area in *Haemorrhagic septicaemia* (HS) disease in buffaloes acted as adjunct therapy along with conventionally antibacterial treatment. It helped in speedy recovery from the disease. The ITK, which has been claimed by the discloser, proved scientifically good in clinical management of HS in buffaloes.

Code : **1590**

Title of the ITK **Technique of curing bone fracture in animals**

Description of the ITK : *Harjore* is a perennial climber, used in the treatment of bone fracture in animals as well as in human being. This practice is being used by the villagers of Samtoli village of Simdega district in Jharkhand for the last many years. Paste is prepared by crushing the *harjore* plant and it is applied on the fracture part which is then tied along with sticks. At every 3 days interval it is replaced by fresh *harjore* paste and this process is continued 2 to 3 times.

Name and address of the discloser : Ms Sushmita Khalkho, C/o Dr Niva Bara, Department of Extension Education, Birsa Agricultural University, Ranchi 834 006 (Jharkhand)

Location of use of the ITK : Samtoli, Simdega, Simdega (Jharkhand)

Geographical indicators : *Harjore*, a climber having fleshy stone and quadrangular stem is found throughout the hotter parts of India and Sri Lanka.

Experimenters : Birsa Agricultural University (BAU)

Dr B.K. Roy, Associate Professor, Department of Pharmacology; Dr K.K. Singh, Department of Pathology and Dr Himanshu, Assistant Professor and Dr Vinod Kumar, Teaching Assistant, Department of Surgery, College of Veterinary Sciences, Ranchi (Jharkhand) 834 006

Ch. Sarwan Kumar Himachal Pradesh Krishi Viswavidyalaya (CSKHPKV)

Dr A.C. Varshney, Professor and Head, Dr S.P Tyagi, Assistant Professor, Dr S.K. Sharma, Associate Professor and Dr Adarsh Kumar, Assistant Professor, Department of Surgery and Radiology, College of Veterinary and Animal Sciences, Palampur (Himachal Pradesh) 176 062

METHODOLOGY

Experiment

CSKHPKV

The study was conducted at Palampur during 2004 on six adult healthy mongrel dogs of either sex weighing 15-20 kg divided into two equal groups. The first group (A) was kept as control, whereas the second group (B) served as test group. Prior to the start of experiment the animals were acclimatized in college kennels as per standard practice. The animals were dewormed with

Contents

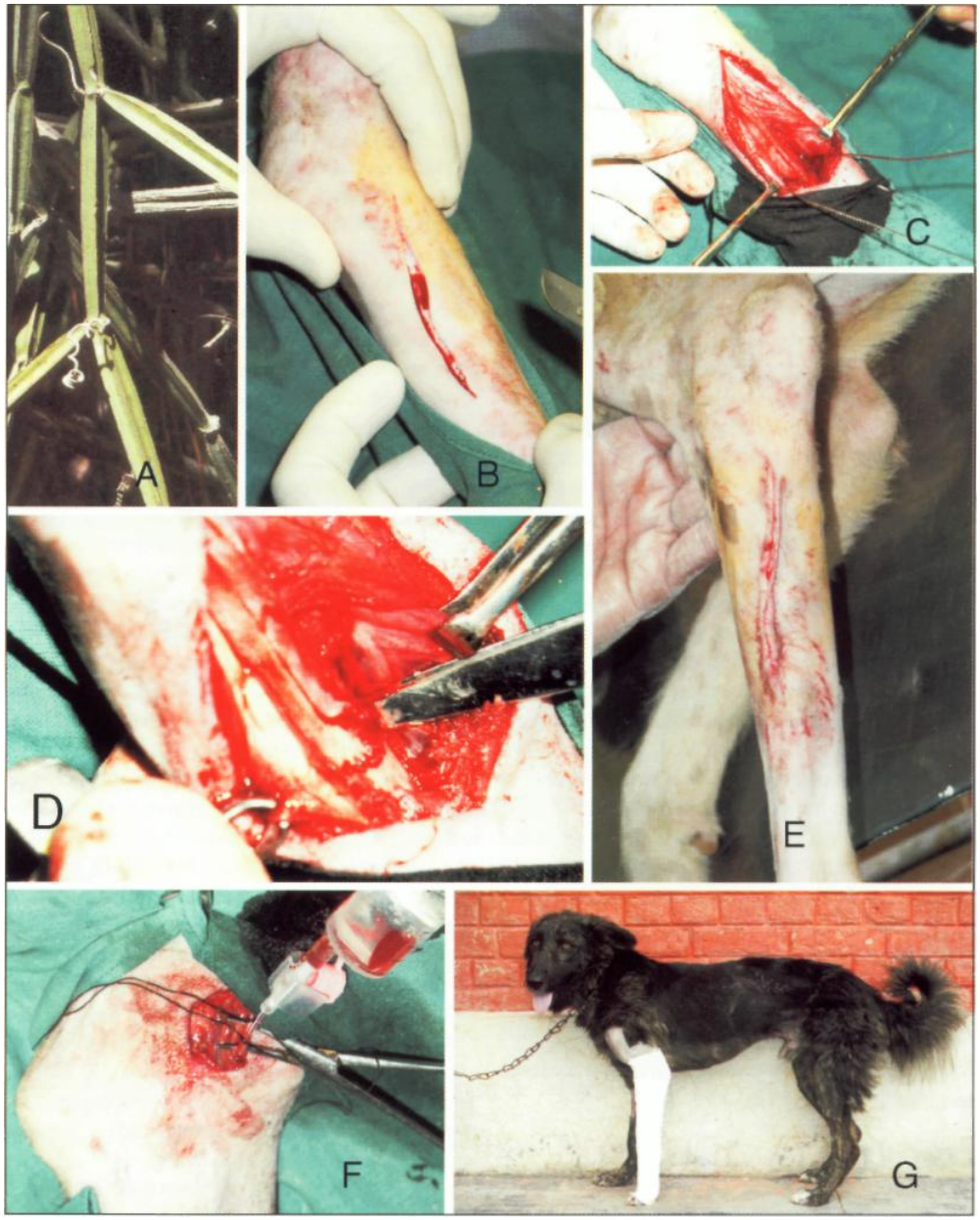

Fig. 1. (a) *Harjore {Cissus quadrangularis)* plant; (b) incision site of operation; (c) osteotomy of ulna; (d) fracture line in ulna after osteotomy (arrow); (e) closure of surgical site; (f) cannulation of brachial artery for angiography; (g) external co-optation by PoP cast

Contents

suspension albendazole (Albomar, Agrivet India Ltd) @ 10 mg/kg body weight orally and vaccinated prophylactically against rabies by injecting Rakhsharab (Indian-immunologicafs-) @ 1 ml/animal given subcutaneously. All the animals were maintained on standard and uniform diet during the entire course of study.

Creation of fracture: All the animals were prepared for aseptic surgery routinely. They were anaesthetized by xylazine and ketamine @ 2 and 10 mg/kg body weight respectively, given intramuscularly 15 min. after subcutaneous injection of atropine @ 0.045 mg/kg. The left ulnar bones of all the animals were subjected to diaphyseal fracture by osteotomy done with the help of giggly wire saw, chisel and hammer (Fig. 1 B, C and D). After the creation of fractures, the surgical wounds were closed routinely (Fig. le).

Preparation o/harjore *paste or ointment:* The *harjore (Cissus quadrangularis)* plant stems were collected and completely dried in oven. These were finely ground in a grinder to form powder. Then 20 g of this powder was used for one application per animal. Just before application the powder was mixed with sufficient quantity of liquid paraffin to form a paste.

Application technique: The paste thus prepared was applied on the skin around the fractured limb and covered with a layer of cotton bandage in the animals of group B. The fractured limbs were then stabilized suitably by means of a bi-valved plaster of paris full-limb cast and secured with adhesive tape and bandages. The *harjore* paste was reapplied at every 4 days interval till 20 days after operation. No medication was used or applied on the fractured limb of animals of group A. However, the fractured limbs were also supported by external cooptation as applied in group B.

Evaluation of fracture healing

Clinical observations: All the animals were clinically examined regularly for the development and progress of inflammation and oedema at the fracture site. The extent of lameness, weight-bearing capability and extent of pain were also recorded. Besides, the routine clinical parameters such as rectal temperature, respiration rate and heart rate were also recorded on days 0, 3, 7, 15, 30, 45 and 60 after operation. The extent of lameness was evaluated during standing and locomotion phase (Table 1).

Table 1. Sign and extent of lameness

Sign	Extent of lameness
Animal not bearing weight on affected limb	+++
Animal is occasionally touching the toes	++
Animal is frequently touching the toes	+
Animal is bearing full weight on affected limb	-

Haemato-biochemical studies: About 5 ml blood was collected from cephalic or recurrent tarsal vein of all the dogs in heparinized syringes on days 0, 3, 7, 15, 30,45 and 60 after operation. A part of it was used for estimation of the levels of haemoglobin, haematocrit, total erythrocyte count (TEC), total leucocyte count (TLC) and differential leucocyte count (DLC). Plasma was separated from the remaining blood samples and the alkaline phosphatase activity and concentration of calcium and phosphorus were estimated using semi-automatic chemistry analyser (RA-50, Bayer India Ltd).

Radiological examinations: Plain medio-lateral radiographs of the fractured limb were taken at 0, 15, 30,45 and 60 days after operation in all the animals using standard radiographic exposure factors. These radiographs were studied for assessment of fracture-healing process.

Angiographic studies: Angiograms of the fractured limb were obtained on days 0, 15, 30, 45 and 60 after operation. Arteriography was carried out in all the animals under general anaesthesia, taking routine aseptic precautions. The brachial artery of the fractured limb was exteriorized and cannulated using 20 G intravenous canula (Fig. If). The contrast agent containing diatrizoate acid and meglumin

(Contrastin 76%, Dabur India Ltd) was injected @ 20 ml/animal rapidly into the brachial artery. The mediolateral radiographs were taken immediately after injection, using standard radiographic exposure factors. The canula was removed and the brachial artery was sutured using 6-0 vicryl (Ethicon). The surgical wound was closed routinely. The arteriograms were evaluated and compared and the course, number, contour and calibre of the vessels supplying the fractured area were studied to assess the amount of blood supply at the site.

BAU

The experiment was conducted on 10 cattle of different age suffering from the fracture. In first group of 5 animals (T), the paste of *harjore* was applied, and in second group of 5 animals (T_2), the plaster of paris was applied. The X-ray was taken before application of plaster, and blood and serum were collected for haematological and biochemical estimation.

Heart rate, respiration rate, rectal temperature, feed intake, extent of lameness and body weight-bearing capacity on different time intervals, i.e. 0,15,30,45 and 60 days, were studied for clinical evaluation.

Blood samples were collected on days 0, 15, 30,45 and 60 and haemoglobin (Hb), packed cell volume (PCV), total erythrocyte count (TEC) and total leucocyte count (TLC) were estimated by cell-counter (Sysmex, Japan). Calcium (Ca), phosphorus (P) and serum alkaline phosphatase (SAP) were also estimated.

In group I (T_1), the X-ray of fractured bones was taken on day 0 and a layer of paste of *harjore* was applied on the fractured bone. The thick layer of paste over the part was also covered by cloth and it was tightly secured by a thin rope. After 5 days the layer of the paste was removed and the next layer was spread after 15 days. The layer of paste was not removed and left for 60 days. In group II (T_2) the fractured bone was aligned and a layer of cotton was spread and plaster of paris (PoP) was applied and left for 60 days.

Table 2. Effect of fracture healing using Harjore *(Cissus quadrangularis)* paste on rectal temperature in Dogs at CSKHPKV

Group	Post-operative day						
	0*	3	7	15	30	45	60
A (N=3)	101.93 ±0.13	101.86 ±0.13	101.8 ±0.2	101.93 ±0.13	102.06 ±0.18	101.6 ±0.23	102 ±0.12
B (N=3)	100.86 ±0.24	101.06 ±0.44	101.13 ± 0.24	101.73 ±0.27	101.73 ±0.18	101.26 ±0.48	101.53 ±0.29

*= Day at which treatment was instituted; P> 0.05 between days as well as groups; N= number of animals in each group; Group A = Untreated control, Group B=animals treated with *harjore* paste

Table 3. Effect of fracture healing using *harjore (Cissus quadrangularis)* paste on respiration rate in dogs at CSKHPKV

Group	Post-operative day						
	0	3	7	15	30	45	60
A (N=3)	39 ± 2.0	41 ± 3.0	42± 3.0	41 ± 2.0	42 ± 4.0	40 ± 2.0	38 ± 1.0
B (N=3)	38 ± 3.0	36 ± 4.0	38 ± 3.0	44 ± 5	39 ± 4.0	40 ± 6.0	40 ± 3.0

Table 4. Effect of fracture healing using *harjore (Cissus quadrangularis)* paste on heart rate in dogs at CSKHPKV

Group	Post-operative day						
	0*	3	7	15	30	45	60
A (N=3)	92 ±3.0	93 ±3.0	95 ±4.0	95 ±3.0	94±2.0	91±3.0	93± 2.0
B (N=3)	86 ± 1.0	86 ± 2.0	92 ± 4.0	86 ± 3.0	75 ± 4.0	86 ± 2.0	86 ± 2.0

Table 5. Extent of lameness in dogs of control and test groups at CSKHPKV

Group	Position of animal	Post-operative day						
		0	3	7	15	30	45	60
A (Control)	Standing	+++	+++	+++	++	+	-	-
	Moving	+++	+++	+++	++	++	+	
B (Test)	Standing	+++	+++	++	+	-	-	-
	Moving	+++	+++	+++	++	+		-

Table 6. Comparative data of different parameters after treatment of fractured bone with *harjore* paste at different intervals in cattle at BAU

parameter	Days after treatment				
	0	15	30	45	60
Heart rate (/min)	58±1.01	48.5±	46.25±0.54	45.5±0.75	44.5±0.43
Respiration rate (/min)	21.6±0.82	19.8±2.3	16.25±0.48	15.5±0.22	15±0.31
Rectal temperature (°F)	103.1±0.22	101.3±0.16	101.4±0.17	101.3±0.11	101.3±0.16
Hb (g/dl)	10.4±0.83	10.7±1.04	12.25±0.62	12.37±0.66	12.37±0.66
PCV (%)	24.6±0.84	24.4±0.93	25.5±0.20	25.3±0.20	25.37±0.20
TLC (10^3/µl)	12.9±0.79	12.55±0.73	11.62±0.40	11.56±0.45	11.68±0.35
TEC (10^6/µl)	7.27±0.60	7.25±0.62	8.18±0.20	8.31±0.10	8.31±0.10

RESULTS AND DISCUSSION

Clinical observations in dogs

The rectal temperature, respiration rate and heart rate in the animals of both the groups remained within the normal range and did not show any significant change during the entire course of study (Tables 2, 3 and 4). Feed intake was also normal in all the animals of both groups throughout the period of study. The animals of both the therapeutic groups showed moderate pain and lameness in the affected limb up to day 3 after operation. The pain gradually decreased in all the animals subsequently. The rate of decline of pain was however greater in the animals of group B when compared with those of control group (A). In general, the animals of group B showed early complete weight bearing on the affected limb, i.e. from day 25 onwards compared with day 38 in control group (Table 5).

Clinical observation in cattle

In *harjore* treatment the heart rate decreased continuously and reached almost within normal range (43-50/min) after 30 days at Ranchi. In plastered animals it did not decrease throughout

Table 7. Comparative data of different parameters after treatment of fractured bone with plaster at different intervals in cattle at BAU

parameter	Day after treatment				
	0	15	30	45	60
Heart rate (/min)	60.40±0.72	56.75±1.70	60.75±0.41	60.40±0.60	57.80±0.91
Respiration rate (/min)	14.20±0.65	12.75±0.41	12.25±0.21	12.25±0.18	12.50±0.43
Rectal temperature (F)	102.8±0.47	101.1±0.32	101.4±0.07	101.2±0.18	101.0±0.21
Hb (g/dl)	9.68±0.45	10.43±0.89	11.0±0.63	10.93±0.62	10.81±0.61
PCV (%)	24.33±0.62	25.12±0.10	25.52±0.26	25.27±0.31	25.35±0.10
TLC (10^3/µl)	11.88±0.71	11.10±0.18	10.35±0.07	10.22±0.08	9.17±0.33
TEC (10^6/µl)	8.00±0.74	10.22±0.08	10.75±0.21	11.17±0.10	11.25±0.12

Table 8. Effect of fracture healing using *harjore* paste on calcium, phosphorus and alkaline phosphatase profile in dogs at CSKHPKV

Group	Post-operative day						
	0*	3	7	15	30	45	60
				Calcium (mg/dl)			
A (N=3)	9.9±1.23	9.1±1.53	9.6±1.16	10.5±0.64	10.3±1.52	10.8±0.15	10.4±0.60
B (N=3)	7.9±0.76	8.5±1.58	7.5±1.21	9.2±0.36	9.76±0.88	9.4±2.15	9.26±1.29
				Phosphorus (mg/dl)			
A (N=3)	5.13±0.17	5.0±0.34	5.1±0.70	5.7±0.28	5.8±0.11	6.36±0.68	6.10±0.52
B (N=3)	3.90±0.26	3.66±0.48	4.23±0.23	5.0±0.46	5.4±0.88	5.9±0.81	4.5±0.32
				Alkaline phosphatase (u/l)			
A (N=3)	124±8.0	150±9.0	143±6.4	125±9.0	124±10	133±5.8	118±4.2
B (N=3)	118±18	150±13	150±17	117±7.2	108±12	126±21	112±8.0

the period of observation, perhaps due to stress caused by immobility posed by plaster. Moreover, decrease in heart rate after *harjore* treatment might be due to good healing effect as well as lack of pain and normal blood supply at the site of injury. There was marked increase in rate of respiration on day as compared to normal value (12-16/min.). However, the initial increase was more in animals treated with plaster of paris (Table 7). No marked difference in rectal temperature was observed between both the treatments. Haemogloblin, packed cell volume, TEC and TLC remained almost same in both the groups (Tables 6 and 7).

Haemato-biochemical observations in dogs

All the dogs showed an insignificant rise in neutrophil count in the immediate post-operative period, which gradually decreased to normal by day 14 in most of the animals. No significant change was observed in other haematological parameters throughout the period of study in the animals both inter-group as well as intra-group. Calcium levels in blood increased slightly in group B and decreased slightly from day 0 to day 3. However, the variation in these values was insignificant. The blood-calcium levels remained slightly higher but insignificant in both the groups at all subsequent observation intervals except on

day 7 (Table 8). The blood phosphorus values also remained at slightly higher level on most of the observation intervals except on day 3 in group B; whereas in group A these values were higher continuously since day 7 after operation. The change was however non-significant between the days as well as between the groups (Table 8). The alkaline phosphatase activity in the blood of the animals of both the groups was significantly higher on days 3 and 7 and became normal subsequently by day 14 (Table 8).

Radiological evaluation in dogs

The radiographs taken immediately after creation of fracture and co-optation of limb on day 0 showed the presence of a clear radiolucent line of fracture in the mid-diaphysis of ulna in all the animals of both groups (Fig. 2 Al and Bl). The fracture line appeared widened in the radiographs taken on day 15 after operation (Fig. 2 A2 and B2). However, in group B this widening was restricted more or less only in the outer third portion of the fracture line. Moreover, development of periosteal callus from both ends of the fracture fragments was clearly visible in group B, whereas no callus activity was identifiable in group A at this stage. The bridging of periosteal callus was complete on day 30 after operation in the animals of group B whose radiolucent fracture line also turned hazy toward transcortical aspect of ulna at fracture site, indicating active osteogenesis (Fig. 2 B3). In the animals of group A, the development of periosteal callus was also clear as small radio-opaque area extending beyond the cis and trans cortical margins of ulna at the fracture site in the radiographs taken on day 30 after operation, however, the callus was still at its preliminary stage and was not of bridging nature (Fig. 2 A3). In the radiographs taken on day 45, remodelling of periosteal callus, as evident by reduction in its volume, was very well evident in all the animals of group B (Fig. 2 B4). In this group, the endosteal callus activity in the form of increased radio-density on endosteal site of the ulnar bone was also clear in all the animals. The fracture line turned hazy but was still visible in group B at this stage. But in animals of group A, the bridging of callus was still not complete radiographically even at this stage and the radiolucent fracture line was clearly visible (Fig. 2 A4). The radiographs taken on day 60 after operation revealed further progress in fracture healing in both the groups. However, on comparative basis the fracture union was far more advanced in all the animals of group B than in those of group A. In group B the medullary continuity was restored, further reduction in the amount of endosteal and periosteal callus was seen and the fracture line was barely visible at this stage (Fig. 2 B5). In group A the fracture line was clearly visible, amount of periosteal callus still moderate and the medullary continuity not restored at this stage.

Angiographic evaluation

On day 0 after creation of fracture, the angiograms were obtained after injection of contrast agent into the brachial artery at the distal third humeral region. They revealed complete opacification of the brachial artery and its distal branches throughout the distal limb in all the animals of both the groups. The relatively wider brachial artery branched into thinner collateral ulnar artery, superficial brachial artery and median artery at the proximal metaphyseal level of radius bone. The main trunks of these branches were clearly visible and well defined throughout their course along side radius and ulna. The superficial brachial and median arteries after originating from main brachial artery immediately gave rise to many prominent smaller arterioles, which coursed proximally, distally and caudally in the adjoining area. The superficial brachial artery once again branched into prominent medial and lateral divisions at about proximal third diaphyseal aspect of radius and ulna. The diameter of the main trunks of these vessels and median artery gradually decreased distally; however, their

entire course along side radius and ulna as well as carpal joint was very clear. The collateral ulnar artery coursed mainly on caudal aspect of ulna and tapered off quickly by the distal third diaphyseal aspect of ulna. All along their course, all these main arteries gave rise to numerous minute branches, which supplied the bones and soft tissues of the area. The density of arterioles and other vessels was relatively more in proximal as well as distal metaphyseal areas of radius and ulna, whereas at rest of the places the penetration of these smaller vessels was almost uniform. At dorsal aspect of radius the intensity of vascular network appeared further less due to presence of less quantity of soft tissue as such (Fig 3 Al andBl).

Angiograms of the limb treated with *harjore* paste (group B) on day 15 after operation revealed extensive vascular proliferation in the proximal ulnar region. The radio-density was profound in the developing callus surrounding the fracture site, indicating its extensive vascularization (Fig. 3 B2). The angiograms in the control group at this stage revealed only slight increase in overall vascular proliferative activity compared with that in the treated group. No increase in radio-density just around the fracture fragments was noticed in this group indicating little healing activity at the site (Fig. 3 A2).

On day 30, increased vascularity was seen in

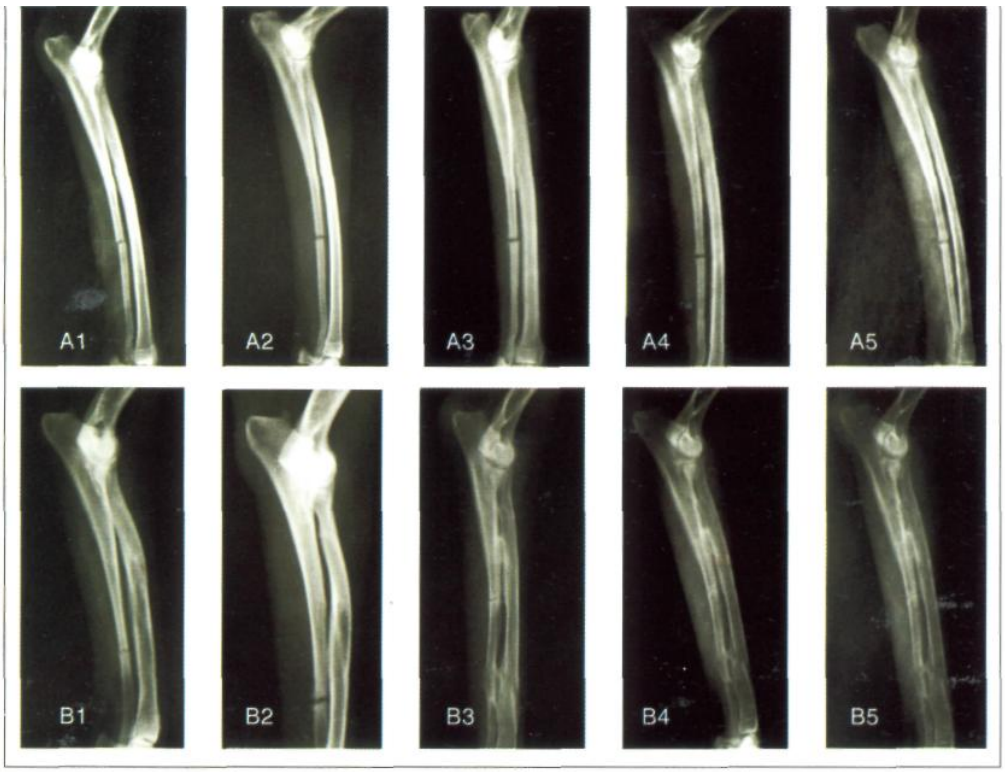

Fig. 2. A. Radiographs of control limb at days 0 (A1), 15 (A2), 30 (A3), 45 (A4) and 60 (A5) after fracture; B. radiographs of test limb (*harjore* treated) at days 0 (B1), 15 (B2), 30 (B3), 45(B4) and 60 (B5) after fracture

both the groups. However, the minute vascular network was less prominent in group B and relatively more pronounced in group As compared with that on day 15 (Fig. 3 A3 and B3). The fracture line was totally masked by radiodense vessels coursing around the fracture site in group B. The fracture line was clearly visible in group A, indicating lesser vascularization than in group B.

The opacification of the site due to increased vascularity decreased in both the groups on day 45. The angiograms of the control group at this stage revealed increased radio-density at fracture line, indicating greater healing tissue progression at the site compared with that on day 30. However, the increase in local vascularity was relatively less compared with that in test group (Fig. 3 A4 and B4). In this group the fracture line was still totally obscured by radio-dense vessels.

The vascular pattern in test group resembled the normal (day 0) angiogram except with a slight increased vascular network opacity day on day 60 after operation. But, in control group the fracture line was still slightly visible, indicating incomplete union at the fracture site (Fig. 3 A5 and B 5).

On the basis of clinical, haematological, biochemical, radiological and angiographic studies, it can be inferred that the use of *harjore (Cissus quandrangularis)* paste over fractured

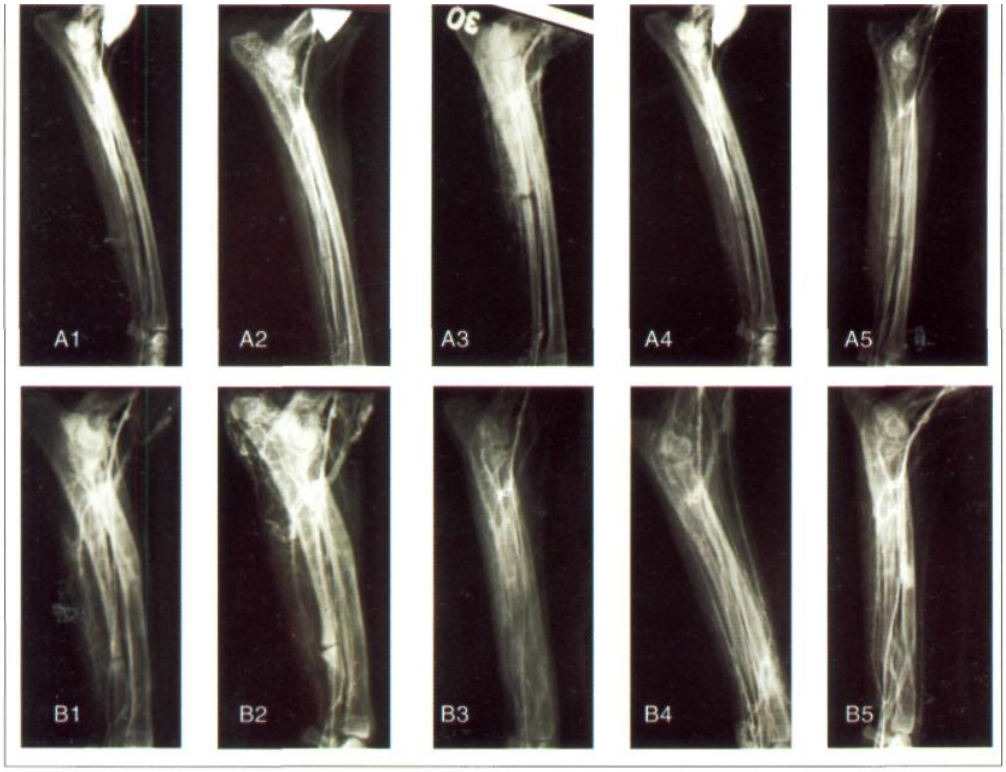

Fig. 3. A. Radiographs of control limb at days 0 (A1), 15 (A2), 30 (A3), 45 (A4) and 60 (A5) after fracture; B. radiographs of test limb (*harjore* treated) at days 0 (B1), 15 (B2), 30 (B3), 45(B4) and 60 (B5) after fracture

area helped in healing of bone without any apparent adverse effects in dogs. The application of *harjore* paste increased the local blood vascularity, which in turn brought more nutrients, phagocytes and osteoblats at the fracture site and thereby generating greater osteogenic turnover. This facilitated the fracture-healing process through early bridging of fracture gap, rapid gain in structural strength of bone and early remodelling of fracture callus.

In cattle, the calcium level on days 15, 45 and 60 in both the groups was similar except on day 30 (Table 10) in which it decreased significantly ($P < 0.05$) in *harjore* treated group. However, on day 0 (before plastering) the calcium level was elevated significantly ($P < 0.01$) in group 2, in which PoP was applied. The repair of bone is fundamentally the same, as healing of any other connective tissue but it is modified by the specialized feature of calcification (Singh and Udupa; 1965). Calcium and ascorbic acid are quite effective in accelerating the rate of bone healing; however, the exact reason of this combination is not known. It is expected that in the presence of ascorbic acid, calcium protein complex is formed, which reaches the fractured site through blood and helps in the healing process of the bone. Srivastava (1982) reported that the tribal people of Chhotanagpur used the paste of this plant as external application in fracture cases. The constituent of th's plant has been analysed as calcium oxalate, carotene and ascorbic acid. This herbal product also contains an steroidal fraction (3-keto steroid), which possesses anabolic properties.

The phosphorus level increased significantly increased on days 0, 15, 30, 45 and 60 in *harjore* treated animals. Phosphorus plays a significantrole in healing of fractured bones. The process of calcium deposition and osteogenesis is enhanced due to increased level of phosphorus, which is needed to produce optimal condition for healing. The extent of lameness did not indicate the complete cure of fractured bone even on day 60. In relation to cure in the extent of lameness, cases treated with PoP were superior to paste of *harjore* (Table 10).

No marked difference in SAP was observed

Table 10. Effect of fracture healing using *harjore* and plaster on calcium and phosphorus concentration and SAP activity in cattle at Ranchi

Treatment	Days after treatment					
	0	15	30	45	60	
			Calcium (mEq/litre)			
TI (*harjore*)	5.65±0.18**	5.50±0.20 NS	6.06±0.18*	6.12±0.18 NS	6.06±0.24 NS	*P<0.05 **P<0.01
T II (plaster)	6.85±0.29	6.17±0.10	4.87±0.10	5.42±0.18	5.87±0.10	
't' value	3.54	3.01	5.56	2.64	0.70	
			Phosphorus (mEq/litre)			
TI (*harjore*)	6.00±0.41*	5.90±0.43*	6.37±0.20	6.43±0.18*	6.62±0.18*	*P<0.05
T II (plaster)	3.24±0.22	3.17±0.20	3.30±0.10	3.92±0.28	3.22±0.30	
't' value	5.83	5.70	13.10	7.47	9.45	
			SAP activity (IU/litre)			
T_1 (*harjore*)	19.35±0.238 NS	18.30±1.62 NS	16.50±1.76 NS	16.43±0.25 NS	16.12±0.10 NS	
T_2 (Plaster)	26.28±1.73	19.92±0.41	16.3±0.10	16.3±0.10	16.12±0.10	
't' value	2.35	0.97	0.11	0.47	0	

between the treated groups however, the values were elevated on days 0 and 15 (Table 10). The alkaline phophatase activity increases from first to third week, and therafter decreases (Singh, J 986).

CONCLUSION

Results of the studies conducted at CSKHPKV suggest that application of *harjore (Cissus quadrangularis)* paste over fractured bone hastened the fracture-healing process. Similar observations were also made in cattle at BAU. However, the extent of cure of lameness was better in the animals treated with Plaster of Paris. The fracture of long bone such as femur and humerus is problematic and the animals gererally die. In this study also one animal died in each of the two treatments.

REFERENCES

Singh, D.P 1986. Studies on dynamics of bone healing by the administration of certain bone inducers in caprine. Ph.D. thesis, submitted to BAU, Ranchi.

Srivastava, R.M. 1982. Cattle in culture and economy of tribal mundas of Bihar. Ph.D. thesis, submitted Kurukshetra University, Kurukshetra (Haryana).

Singh, R.H. and Udupa, K.N. 1965. The effect of calcium and ascorbic acid on healing of fractures in thyroxin treated animals. *Indian J. med. Res.,* 53 (3): 232-239.