THIRD PROGRESS REPORT

January – December 1981

MINOR MILLETS IMPROVEMENT

Project : Millets (India)

IDRC File : 3–P–75–0072

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI, INDIA 110 001

Project : Millets (India)
IDRC File : 3 -P- 75 -0072

M I N O R M I L L E T S I M P R O V E M E N T

Third Report for the period January - December, 1981
submitted to the International Development Research Centre,
Canada by Indian Council of Agricultural Research, New Delhi.

Dr.G. Harinarayana
Principal Investigator
Project Coordinator (Millets)
AICMIP-ICAR
College of Agriculture
PUNE
India 411 005.

Dr.L.M.Jeswani
Principal Investigator
Asstt.Director General (F&FC)
ICAR
Krishi Bhavan
NEW DELHI
India 110 001.

RESEARCH WORKERS

1. Paspalum Improvement Centre, Small Millets Research Development Station, DINDORI, District Mandla, Madhya Pradesh 481 880

Dr.S.N.P.Verma	Senior Millet Breeder and Coinvestigator (MM) College of Agriculture REWA Madhya Pradesh 481 880

(A) Project Staff:

1. Dr.O.P.Katiyar	Scientist (Entomology)
2. Shri N.K.Dhagat	Scientist (Breeding)
3. Shri A.K.Dhagat	Scientist (Agronomy)Left 18.8.81
4. Shri K.K.Choubey	Field Assistant
5. Shri Nathu Sapat	Field Assistant
6. Shri R.N.Raidas	Field Assistant
7. Shri C.L.Garhwal	Field Assistant
8. Shri C.P.G.Unnithan	Steno
9. Shri C.G.Ghatkar	Upper Division Clerk
10. Shri John Masih	Helper
11. Shri G.P.Kewat	Watchman

(B) Cooperators:

1. Shri A.K.Singh	Asstt.Millet Specialist
2. Shri K.R.Naik	Asstt.Agronomist
3. Shri A.N.Tikale	Asstt. Plant Breeder
4. Shri K.N.Mishra	Accountant
5. Shri R.N.Singh	Upper Division Clerk

2. Setaria Improvement Centre, Cotton Research Station, NANDYAL, District Kurnool, Andhra Pradesh 515 502

Shri K.N.Murty	Senior Scientist (Millets) and Coinvestigator Agricultural Research Institute APAU, HYDERABAD 500 030

(A) Project Staff:

1. Shri G.P.Prasada Rao	Breeder (Millets) and Leader
2. Shri M.D.Paul	Entomologist (Millets)
3. Shri R.Bener Raj	Pathologist
4. Shri S.Vasantha Rao	Assistant Entomologist
5. Shri G.Narasimha Rao	Assistant Pathologist
6. Dr.Y.Gurunadha Rao	Assistant Agronomist (Millets)
7. Shri M.Anjanappa	Assistant Statistician
8. Shri J.Sundara Rao	Sub Assistant
9. Shri R.Ramanna	Sub Assistant
10. Shri Md. Zaheeruddin	Sub Assistant
11. Shri R.Pullanna	Record Assistant
12. Shri D.Thirupalu	Record Assistant
13. Shri T.Murthaiah	Record Assistant
14. Shri E.Ramana Goud	Upper Division Clerk(Left 31.10.81)
15. Shri S.Subbarayudu	Lower Division Clerk
16. Shri D.Soundara Raju	Steno
17. Shri M.Nadamuni Reddi	Driver
18. Shri B. Ramudu	Driver

3. Panicum Miliare Improvement Centre, Regional Research Station, OUAT, P.B.No.10, SEMILIGUDA, District Koraput, Orissa 763 002

(A) Project Staff:

1. Shri H.B.Patnaik	Plant Breeder
2. Shri P.K.Mahapatra	Agronomist
3. Shri B.K.Maity	Entomologist

4. Panicum miliaceum Improvement Centre, Tirhut College of Agriculture, Rajendra Agricultural University, DHOLI, District Muzafarpur, Bihar 843 121

Dr.L.B.Chaudhary	Millet Breeder and Coinvestigator

(A) Project Staff:

1. Dr.B.Mishra	Senior Scientist(Pathology)
2. Dr.C.K.Prasad	Senior Scientist(Agronomy)
3. Shri C.P.Singh	Junior Scientist(Agronomy)
4. Dr.D.D.Sharma	Junior Scientist (Entomology)
5. Shri M.M.Jha	Junior Scientist (Pathology)
6. Shri V.K.Chaudhary,	Junior Scientist (Breeding)
7. Shri R.S.Rai	Junior Scientist (Breeding)
8. Shri Vanshidhar	Junior Scientist (Statistics)
9. Shri R.N.Sharma	Junior Scientist (Pathology)
10. Shri Madan Prasad	Accountant-cum-Office Asstt.
11. Shri H.C.Chaudhary	Laboratory Assistant
12. Shri S.S.Dhobi	Laboratory Assistant
13. Shri A.N.Mishra	Laboratory Assistant
14. Shri M.D.Najamuddin	Steno
15. Shri D.Rajak	Store keeper
16. Shri B.N.Pandey	Driver

(B) Cooperators:

1. Dr.B.Rai	Professor and Head
2. Shri R.K.Newatia	Asstt.Research Officer(Breeding)
3. Shri J.N.Lal	Field Overseer
4. Shri Dular Chand	Farm Sardar

5. Echinochloa Improvement Centre, Vivekananda Parvatiya Krishi Anusandhan Shala, ALMORA, District Almora, Uttar Pradesh 263 601

Dr.J.P.Tandon	Director and Coinvestigator

(A) Project Staff:

1. Shri H.S.Mehra	Research Associate (Breeding)
2. Shri Jitendra Chikara	Research Associate (Cytogenetics)
3. Shri Nagesh Kumar Sah	Research Associate (Entomology)
4. Shri P.S.Chauhan	Research Associate (Pathology)
5. Shri N.P.Malkania	Research Asstt. (Cytogenetics)
6. Dr.J.S.Bist	Research Asstt. (Pathology)
7. Shri G.S.Bankoti	Technician T-1
8. Shri K.Singh	Technician T-1

(B) Cooperators:

1. Shri H.C.Joshi	Scientist-2 (Breeding) and Coinvestigator
2. Shri Ved Prakash	Senior Research Assistant(Agronomy)
3. Shri J.Joshi	Technician I
4. Shri K.D.Joshi	Technician I
5. Shri R.K.Sharma	Technician I

6. Germplasm Centre, National Bureau of Plant Genetic Resources, CTO Complex, IARI Campus, NEW DELHI 110 012

Dr.K.L.Mehra	Director and Coinvestigator
(A) Project Staff:	Nil

(B) Cooperators:

1. Shri M. Kazim	Scientist-2

7. All India Coordinated Millets Improvement Project

(A) Project Staff: Nil

(B) Cooperators: (i) Coordinating Unit,College of Agriculture,Pune

1. Shri H.B.Mungse	Physiologist
2. Shri D.G.Gaikwad	Pathologist
3. Shri C.P.Pawar	Senior Research Assistant(Pathology)
4. Shri T.K.Murty	Entomologist
5. Shri S.M.Shirole	Senior Research Assistant(Entomology)
6. Shri S.S.Harpale	Field Assistant
7. Shri P.R.Bhosale	Field Assistant
8. Shri S.N.Jadhav	Field Assistant
9. Smt. M.K.Nakhate	Steno
10. Shri A.F.Netake	Steno
11. Shri R.R.Shevate	Helper

(ii) Germplasm Unit, University of Agricultural Sciences, GKVK Campus, Bangalore 560 065

Dr.A.Seetharam	Project Coordinator (Millets Germplasm)

CONTENTS

CHAPTER I

MINOR MILLETS

1. INTRODUCTION

Minor millets are the staple food grains of the poorest of the poor. Minor millets have, therefore, attracted the attention of the public, the policy makers and the plant scientists. The developmental input by the International Development Research Centre, Canada has added impetus to their improvement.

Minor millets are grown in fertility depleted soils. They are sown broadcast either singly or mixed with other crops. The local cultivars are low yielding and are vulnerable to pests and diseases. Their nutritional quality is second to none of the other cereal grains. They have a long storage life. The dependence on minor millets during distress have earned the nickname "famine grains". The Minor Millet Improvement Project has therefore been initiated with a view to evolve high yielding and stable varieties combining pest and disease resistance. It is also proposed to maximise production potential through management of inputs like seed, fertilizers etc.

The Minor Millet Improvement Centres are located in difficult to approach areas in the heart of cultivated lands in hilly and tribal regions. The infrastructure facilities like land, laboratory, equipment and staff have been provided during the early stages. Germplasm has also been assembled and research initiated. The results of research incorporated in the First (October, 1978 to December, 1979) and Second (January to December, 1980) Progress Reports are abstracted in the following sections. The progress of research till December, 1981 is detailed in the subsequent chapters.

2. HIGHLIGHTS OF RESEARCH, FIRST PROGRESS REPORT

2.1 Kodo Millet, Dindori

2.1.1 Germplasm: 153 genetic stocks of kodo millet were obtained from the Coordinating Unit, Pune.

2.1.2 Inputs Management: Dry sowing one week before the onset of monsoon gave significantly higher yields. Line sowing had given encouraging results over the local practice of broadcasting. Kodo millet and groundnut (1:1 mixture) were compatible and had given more yield than kodo millet alone.

2.1.3 Pest Management: Field survey and screening revealed the occurrence of a number of pests on kodo millet in Madhya Pradesh. The vulnerable stage of the millet and the peak period of infestation were identified.

2.2 Foxtail Millet, Nandyal

2.2.1 Germplasm: A total number of 3738 lines of foxtail millet were assembled from within and outside the State. They included 1474 old and 2264 new collections. Quantitative and qualitative data were collected. Preliminary classification was attempted.

2.2.2 Varietal Improvement: A number of promising lines had been identified for testing. 122 selections from Nandyal, Lam and other centres were evaluated in five series of yield trials. 35 promising lines excelling the released variety Arjuna by 1 to 30 per cent were identified. Some of the types would be tested in all-India Coordinated Trials during kharif, 1980.

2.2.3 Pest Management: Leaf spot caused by two beetles Chaetocnema basalis Baly and Madurasia sp. and leaf minor caused by Occidomyidae (Diptera) and Cynipidae were observed. Germplasm screening revealed 26 entries with no leaf miner incidence.

During summer or dry season, stemborer and leaf roller incidence was noticed. No shootfly was observed. The incidence of major pests was studied in staggered plantings.

Field surveys revealed the incidence of ants and stemborers besides diseases like downy mildew and blast.

2.3 Little Millets, Semiliguda

2.3.1 Germplasm: 260 genetic stocks had been assembled and evaluated.

2.3.2 Varietal Improvement: A comparative yield trial indicated that Koraput Local had given 2.8 times more grain yield than CO 2 (4.2 q/ha), the released variety. Koraput Local was also earlier by 10 to 12 days than CO 2.

2.3.3 Inputs Management: Little millet can be planted between June 15 and 30 to obtain maximum grain yields.

2.3.4 Pest Management: Furadan 3 G effectively reduced shootfly incidence and increased grain yield in CO 2.

2.4 Proso Millet, Dholi

2.4.1 Germplasm: 115 new collections were added to the existing 47 stocks of proso millet. 346 stocks were received from Bangalore. Considerable genetic diversity was observed for basal and nodal tillers, plant height, days to 50 % flowering and maturity, panicle length and grain yield.

2.4.2 Varietal Improvement: A large number of single plant selections were made for line improvement. BR 7 with a grain yield of 12.7 to 15.4 q/ha was identified as the best entry in a comparative performance of proso millets developed at Dholi.

2.4.3 Inputs Management: Proso millet responds positively to nitrogen fertilization. 40 kg N/ha had produced the highest grain yield in the variety MS 4872.

2.4.4 Diseáse Management: Survey revealed that Helminthosporium leaf blight is the chief disease on proso millet. It is seed borne.

PV 27 was found to be free from Helminthosporium incidence, Seed dressing with 0.2 % Captan reduced seedling mortality caused by different soil and seed microflora including Helminthosporium. Drenching the soil with Zinc sulphate also reduced Helminthosporium and other leaf spot diseases.

2.4.5 Pest Management: BR 4 had less than one per cent shootfly incidence compared to 20 per cent in PV 27 found resistant to Helminthosporium leaf blight.

Dimecron 100 EC @ 0.2 kg a.i./ha effectively reduced shootfly occurrence and also enhanced grain yield in BR 8.

2.5 Barnyard Millet, Almora

2.5.1 Varietal Improvement: New varieties of barnyard millet combining high yields and early maturity had been identified. VL Madira 8, already approved by the State Varietal Release Committee, needs popularisation.

2.5.2 Inputs Management: Barnyard millet could be planted any time from first of May to fifteenth of June without much reduction in grain yield.

The application of 50 kg/ha of nitrogen and about 20 kg/ha of phosphorus ensured high grain yields ranging from 25 to 30 q/ha. Combined use of organic and inorganic fertilizers was more beneficial than either of them.

2.5.3 Disease Management: Grain smut of barnyard millet, the most predominant disease, could be controlled to a considerable extent by seed treatment with Vitavax or Benlate.

2.6 Research at Coordinating Unit, Pune

2.6.1 Germplasm: Genetic stocks of kodo millet (154), foxtail millet (697), little millet (103) and barnyard millet (195) were collected and characterised.

2.6.2 Varietal Improvement: Single plant selections were made in 8 kodo millet, 441 foxtail millet, 103 little millet and 28 barnyard millet stocks.

1268 pure line selections made in foxtail millet were evaluated. Lines with more than 25 q/ha of grain yield were selected for multilocational trials. Two outstanding selections were to be tried in all-India Trials during kharif, 1980.

The per se performance of 167 uniform looking barnyard millets was evaluated. Lines with 16.8 to 54.7 per cent more grain yield than the check were identified for multilocation trial. Two selections were to be tried in all-India Trials during kharif, 1980.

2.6.3 Physiological Investigations: Physiological investigations in foxtail millet revealed that early maturing varieties produced more grain yield with better harvest index than late maturing varieties. The better partitioning in early varieties appears to be chiefly due to reduced plant height and better seed weight.

2.7 All India Coordinated Programme

2.7.1 Germplasm: New collections of foxtail millet (70) and barnyard millet (55) were made at Dholi and evaluated.

2.7.2 Varietal Improvement: Initial and Advance Trials helped to identify promising selections in kodo millet (RPs 76 from Rewa), foxtail millet (288 A from Guntur, SI 5307 from Kovilpatti, DH 277 and RAU 1 from Dholi), proso millet (BR 1 and MS 4806/2) and barnyard millet (VL 13 from Almora, RAU 3 and SAM 1 from Dholi).

2.7.3 Inputs Management: Maximum grain yields were obtained with 60 kg N and 20 kg P_2O_5/ha in kodo millet and 40 kg N/ha in foxtail millet. Intercropping kodo millet with greengram was found beneficial.

2.7.4 Disease Management: SI 76/4 and JNSE 9 A were found moderately resistant to Helminthosporium and Pyricularia.

2.7.5 Pest Management: Kodo millets IPs 209-1 and Niwas 1 exhibited relative resistance to shootfly which was progressively reduced with delayed planting. Aldicarb (@ 1.5 kg a.i./ha) was effective in checking shootfly incidence and increasing grain yields in kodo millet.

RPm 222 and RPm 24 little millets had low incidence of shootfly which declined with delayed plantings. Aldicarb (@ 1.5 kg a.i./ha) was effective in controlling shootfly in little millet.

3. HIGHLIGHTS OF RESEARCH, SECOND PROGRESS REPORT

3.1 Kodo Millet, Dindori

3.1.1 Genetic Resources: 181 kodo millets were evaluated for total and effective tillers, plant height, pest incidence and grain yield.

3.1.2 Varietal Improvement: A promising selection IPS 236-1 had given 30 per cent more grain yield than the best check CO 2 (5.1 q/ha). RPS 41 had given maximum grain yilld in advanced trial.

3.1.3 Inputs Management: The improved varieties JNK 364 and IPS 147-1 had given more than 12 q/ha of grain without fertilizer application. The application of fertilizers had positive effect on grain yield. Maximum grain yields were obtained with 40 kg N and 20 kg P_2O_5/ha.

Positive response to Azospirillum biofertilization was observed with or without starter nitrogen.

3.1.4 Pest Management: Three selections tolerant to gall fly were isolated. Early plantings were heavily infested with shootfly, but the late plantings had given lower grain yields.

3.1.5 Nutritional Quality: Considerable variability was observed for protein (7.5 to 9.48 per cent), lipids (2.73 to 3.67 per cent) and ash (2.77 to 3.94 per cent) contents in the small samples examined.

3.2 Foxtail Millet, Nandyal

3.2.1 Genetic Resources: 3774 germplasm lines were characterised for a large number of quantitative and qualitative characters.

3.2.1 Varietal Improvement: A number of single plant selections that excelled the released variety Arjuna were identified for advanced and all India testing.

3.2.3 Inputs Management: Summer foxtail millet should be planted during the first week of January. Summer planted foxtail millet responded to nitrogen upto 60 kg/ha. Biofertilization coupled with N-application (40 kg N/ha) substantially increased grain yields, indicating that 20 kg N/ha could be saved. Stress during flowering and grain formation stages had adversely affected the grain yield.

Early sowing during kharif, in the second fortnight of July produced maximum grain yield. Nitrogen application significantly influenced grain yield. The variation in plant population (25.0 cm x 5.0 cm to 25.0 cm x 10 cm) did not produce significant yield differences. Neither the dates of planting nor fertility levels also influenced the population effect.

3.2.4 Pest Management: Large genetic stocks were screened for pest incidence. The pest resistance in some of the lines was reconfirmed.

3.2.5 Nutritional Quality: Proximate analysis indicated wide variability for protein (9.5 to 12.8 per cent), ether extracts (4.3 to 5.2 per cent) and ash (2.2 to 3.8 per cent) in foxtail millet.

Oil could be extracted from bran. The raw oil could be used in industries and the refined oil as a consuming medium.

3.3 Little Millet, Semiliguda

3.3.1 Germplasm: 251 genetic stocks had been reevaluated. Based on two years data, three promising cultures were identified.

3.3.2 Varietal Improvement: CO 2 had been identified as the best variety.

3.3.3 Management of Inputs: Planting with the onset of monsoon before June 15 was found beneficial.

20 cm between rows and 5 cm between plants besides enhancing grain yield, permits intercropping. Maximum grain yield was obtained with 20 kg N and 10 kg P_2O_5/ha.

3.4 Proso Millet, Dholi

3.4.1 Germplasm: 478 genetic stocks were evaluated for plant height, ear length, branches per main panicle, basal tillers and grain weight.

46 elite genotypes were classified into seven clusters using 'Mahalanobis' D^2 statistic.

3.4.2 Varietal Improvement: BR 7 was identified as the most promising culture in many stationsas well as on-farm trials.

3.4.3 Management of Inputs: Planting of proso millet during March 1-15 was found beneficial. Proso millet responded favourably to application of nitrogen, upto 20 kg N/ha.

3.4.4 Disease Management: Proso millets resistant to leaf blight (Helminthosporium panici-miliacei) and blast (Pyricularia grisea) had been identified.

Seed treatment with Captan 0.2 % effectively checked the occurrence of leaf blight during the two years of study.

Soil treatment with $ZnSO_4$ also reduced leaf blight and leaf spots.

3.4.5 Pest Management: Shootfly appears to be the chief pest. Shootfly could be controlled through spraying of Phosphamidon (0.05 %) or Methyldemeton (0.05 %) once just after the appearance of infestation.

3.5 Barnyard Millet, Almora

3.5.1 Varietal Improvement: VL 11 was identified by the All India Millet Workshop for minikit demonstrations on farmers' fields.

3.5.2 Management of Inputs: Plantings earlier than the end of May had been found to suffer from the attack of insect pests more severely than those in June. Plantings in June were, therefore, recommended.

Planting in mid-June did not have any adverse effect on yield which remained almost similar for plantings between mid-April to mid-June. This is a very favourable situation for changing the cropping sequence in the region where normally the crop is sown after rabi fallow in the month of April end or May beginning.

The crop had given extremely encouraging yield increase even at 20 kg of nitrogen application which had been found to markedly increase when used in combination with 100 q/ha of farm yard manure.

Planting of barnyard millet after pea or chickpea was more productive than keeping the land fallow.

3.5.3 Disease Management: Three selections tolerant to smut and six selections resistant to leaf spot were identified.

3.5.4 Pest Management: May first week plantings were found to be more infested with pests. Plantings in the first week of June had low shootfly and borer incidence.

3.5.5 Physiological Investigations: Longer period of spikelet formation leading to more number of spikelets and longer grain filling period appeared to chiefly determine grain yield in barnyard millet. Maturity was related to spikelet initiation.

3.6 National Bureau of Genetic Resources, New Delhi

3.6.1 Genetic Resources: 204 minor millet accessions including kodo (6), foxtail (41), little (28), proso (2), barnyard (5) and finger (102) millets were assembled.

3.7 Research at Coordinating Unit, Pune

3.7.1 Genetic Resources: Pune added new foxtail (223), little (32) and barnyard (198) millets to germplasm.

3.7.2 Varietal Improvement: Promising single plant selections of kodo (2768-80K), foxtail (1298-80K ,1349-80K and 1352-80K), little (1619-80K and 1574-80K) and barnyard (2126-80K) millets were identified.

Multilocational testing helped to identify best foxtail (548-79K named SIC 3), and barnyard (1593-79K named ECC 3 and 1598-79K named ECC 4) millets.

3.7.3 Pest Management: Shootfly resistant little millets were isolated.

3.7.4 Disease Management: Many barnyard millet stocks were moderately resistant to grain smut.

3.7.5 Physiological Investigations: Growth analysis revealed that CO 3, CO 5 and Arjuna accumulated more dry matter, and produced better harvest indices in that order.

3.7.5 Nutritional Quality: The protein and mineral contents of foxtail millet genetic stocks ranged from 7.16 to 15.73 and 1.10 and 4.86 per cent respectively.

3.8 All India Coordinated Programme

3.8.1 Varietal Improvement: The superiority of RFS 76 (kodo millet) and RAU 3 (barnyard millet) was confirmed. The initial trials helped to identify promising selections in kodo millet (RFS 62-3, PSC 1 and RFS 107-1), foxtail millet (SIA 326 and RSE 42-2), little millet (RPM 3-1 and RPM 124), proso millet (MS 4887, MS 1437 and 5224) and barnyard millet (RAU 5, 6, 8 and 9).

Protogynous lines in kodo millet were identified and anthesis studied.

3.8.2 Inputs Management: Maximum grain yields were obtained with planting with the onset of monsoon in kodo, proso and barnyard millets.

High grain yields were obtained with a minimum fertilization of 20 kg N/ha in kodo and barnyard millets. Azospirillum addition did not increase yield in kodo millet.

Kodo millet-soybean intercropping had returned higher total yield at 2:1, 4:1 and 8:1 proportions.

3.8.3 Pest Management: Shootfly resistant lines were identified in kodo millet (RPS 75-1 and RPS 123) and little millet (RPM 66-1 and Dindori 1-2).

Early plantings minimised shootfly incidence. Delay resulted in increased shootfly incidence as also low grain yields.

Phorate @ 1 kg a.i./ha effectively checked the incidence of shootfly in kodo and little millets.

3.8.4 Disease Management: Selections resistant to smut in kodo millet (RPS 69-1, 181-2 and 355-1) and Pyricularia and Helminthosporium (ISe 700, 701 and 702) and rust (VHC 2030, VHC 2426, L 23 and VL 1) in foxtail millet were identified.

Ceresan and Captan seed treatment (2 g/kg seed) completely checked smut in kodo millet.

CHAPTER II

KODO MILLET - PASPALUM SCROBICULATUM L.

1. INTRODUCTION

1.1 General

The research work on the improvement of small millets was started at Dindori as early as in April, 1963. The scheme was further strengthened with assistance from International Development Research Centre, Canada through Indian Council of Agricultural Research, New Delhi.

1.2 Location

The station is located at Government Farm, Dindori, which is at 22.51°N latitude, 81.51°E longitude and at an altitude of 710 meters above M.S.L. It is situated on Jabalpur - Amarkantak Road, 144 km south of Jabalpur (Head Office of Jawaharlal Nehru Krishi Vishwa Vidyalaya).

1.3 Cropping Pattern

During kharif season, millets are grown predominently in hilly tracts either as pure or mixed crops (kodo- sesame or kodo + sesame + pigeonpea or little millet - kodo - niger).

Other crops grown during kharif season include maize, rice and blackgram. During rabi season, mustard, wheat, gram, pea, linseed and lentil are grown by the farmers. The average yields of some of the kharif crops is summarised in Table II.1.).

Table II.1 : Average Yield of kharif Crops in Madhya Pradesh, 1977

Crops	Grain Yield (q/ha)			Yield Potential with Recommended Technology (q/ha)
	State	District Mandla	Tahsil Dindori	
Kodo Millet	2.6	2.6	0.8	12.0
Little Millet	2.0	2.1	0.8	8.0
Niger	1.8	2.2	-	5.0
Rice	9.9	5.7	0.7	30.0
Moong	3.0	2.2	-	7.0
Maize	8.3	10.2	0.2	15.0
Pigeonpea	7.3	11.1	-	15.0

1.4 Rainfall

Usually rains start in the third week of June, intensify in July and August and stop in October. The rainfall data for the year 1981 at Dindori is given in Table II.2.

Table II.2 : 1981 Rainfall Pattern, Dindori

Month	Rainfall (mm)	Rainy Days (No)
June	148.2	7
July	325.4	21
August	306.9	17
September	171.0	17
October	10.8	2
November	Nil	Nil
Total	962.3	64

2. GENETIC RESOURCES

2.1 Characterisation

A total number of 196 kodo millet stocks collected from all over Madhya Pradesh were sown on 27.6.81 in a randomized block design replicated three times. The plot consisted two rows of 3 meters length. Three checks (IPs 147-1 , Keharpur and JNK 364) were also included. Besides morphological and yield characters, they were also screened for pest incidence, especially for shoot fly and gall fly.

2.1.1 Protogyny : Three protogynous lines (D-3513, D-3525 and D-3420) were isolated from the germplasm.

2.1.2 Early and Late Maturing Lines : 21 lines were found to mature in 85 to 100 days. Four lines were very late, maturing in 110 to 120 days.

3. VARIETAL IMPROVEMENT

3.1 Performance of Germplasm

A number of high yielding selections were made in the germplasm (Table II.3).

Table II.3 : Performance of Top Selections in Kodo Germplasm

Entry	Height (cm)	Days to Flowering	Days to Maturity	Effective Tillers (No)	Yield (g/2rows)
3224	23.6	62	103	3	43
3385	19.6	83	107	2	46
3386	22.8	83	107	3	42
3387	20.8	79	107	3	50
3388	20.3	79	107	3	47
3400	29.0	82	107	3	47
3481	28.6	66	107	4	50
3486	22.2	80	102	2	48
3468	24.8	88	106	2	42
3439	22.8	75	103	3	48
3456	26.8	78	107	5	50
3457	25.2	65	106	3	42
3462	18.2	83	107	2	43
3463	20.8	70	98	3	43
D-11	26.4	82	107	2	50
D-27	30.4	64	98	3	42
RPS 76	18.8	62	89	3	45
IPS 147-1	21.0	65	92	2	30
Keharpur	20.8	70	104	4	30
JNK 364	25.0	75	95	4	38

3.2 State Varietal Trial

Ten promising entries from local collections were tested to determine their response to two levels of nitrogen (0 and 10 kg/ha) and their adaptability to the Mandla tract. Material was grown in a randomised block design with three replications.

Application of higher dose of nitrogen was found significantly superior to no nitrogen (Table II.4). Per cent increase over no N ranged from 112 to 295. RPS 123 topped the list (295 %), followed by RPS 76 (243 %) and JNK 228 (204 %). There were significant differences among varieties, between nitrogen levels and interaction effects.

IPs 236-1 ranked first with and without nitrogen. It was also found to mature 10 days later under fertilization.

Table II.4 : Varietal Performance and Response to Fertilization in Kodo Millet

Variety	Origin	Days to Maturity		Grain Yield q/ha		% Over N_0	Fodder Yield q/ha	
		N_0	N_{10}	N_0	N_{10}		N_0	N_{10}
RPS 76	Rewa	86	89	1.6	4.0	243	18.8	17.7
RPS 117	Rewa	97	97	3.2	3.7	112	16.7	18.0
RPS 123	Rewa	93	106	2.0	5.9	295	18.9	19.2
JNK 228	Jabalpur	109	108	2.6	5.3	204	17.6	18.6
JNK 364	Jabalpur	97	97	1.9	3.0	159	18.8	17.3
IPs 147-1	Dindori	97	95	3.0	5.0	168	17.6	17.9
IPs 236-1	Dindori	97	107	3.7	6.4	165	17.5	18.1
Keharpur	Dindori	96	107	3.8	5.7	171	17.2	17.6
Pali	Dindori	97	94	3.4	4.7	136	18.0	17.5
D 78	Dindori	107	109	2.5	3.4	137	17.3	17.5
Mean		98	101	2.7	4.7	179		
Significance		N		V	N x V			
S.E.		0.3		0.6	0.8			
C D 5 %		0.7		0.2	0.2			

4. MANAGEMENT OF INPUTS

4.1 Sowing Dates x Plant Populations

The effect of three dates of sowing (onset of monsoon, normal setting of monsoon and delayed sowing) and three plant populations (unthinned, 22.5 x 7.5 and 22.5 x 5.0 m) on grain and straw yields was studied in this experiment. The trial was laid out in a randomized block design with six replications.The gross plot size was 5.0 m x 2.25 m and the net plot 4.5 m x 1.8 m. The field was fertilized with 20 kg N, 20 kg P_2O_5 and 10 kg K_2O /ha. IPS 147-1 was sown on June 25, July 10 and July 25, 1981, and harvested on 14th and 20th October, and 16th November, 1981.

Sowing at the onset of monsoon had recorded significantly higher yield than later sowings (Table II.5). A delay of 2 weeks in sowing reduced the grain and straw yields by 34 and 41 per cents respectively. Further delay of two more weeks reduced the grain and straw yields by 74 and 60 per cents respectively. Increase or decrease of the plant population showed no effect on grain yield but fodder yield increased significantly with increase in plant population. The interactions were not significant.

Table II.5 : Effect of Sowing Dates x Plant Spacing on Yield of Kodo Millet

Sowing Dates	Grain (q/ha) Spacing (cm X cm)				Fodder (q/ha) Spacing (cm x cm)			
	Un-thinned	22.5 x 7.5	22.5 x 5.0	Mean	Un-thinned	22.5 x 7.5	22.5 x 5.0	Mean
25-6-81	20.5	19.9	20.3	20.2	45.3	38.4	46.6	43.4
10-7-81	14.8	12.1	13.2	13.3	29.6	21.3	26.2	25.7
25-7-81	6.2	4.4	5.3	5.3	19.1	15.6	17.0	17.2
Mean	13.8	12.1	12.9	13.0	31.3	25.1	29.9	28.8

	Dates (D)	Spacing (S)	DxS	Dates	Spacing	DxS
Significant	1%	N.S.	N.S.	1%	5 %	N.S.
S.Em. ±	0.6	0.6	1.1	1.8	1.8	3.1
C.D.5 %	1.8	-	-	5.1	5.1	-

4.2 Time of Sowing x Seed Rate

The experiment was conducted to assess the optimum time of sowing and seed rate for kodo millet under local practice of broadcasting. The treatments included three dates of sowing (onset of monsoon, 10 and 20 days after monsoon) and 3 seed rates (10, 15 and 20 kg/ha). The trial was laid out in a randomised block design with 4 replications. A uniform dose of 10kg N and 10 kg P_2O_5/ha was broadcasted in all plots at seeding. The gross and net plot sizes were 5.0 m x 2.25 m and 4.5 m x 1.80 m respectively. IPs 147-1 was sown on June 26, July 6 and 16, 1981 and harvested on October 15 and 20, and November 6, 1981.

Table II.6 : Effect of Time of Sowing x Seed Rates on Kodo

Dose	Grain (q/ha) Seed Rate (kg/ha)				Fodder (q/ha) Seed Rate (kg/ha)			
	10	15	20	Mean	10	15	20	Mean
26-6-81	6.1	6.6	5.3	6.0	11.3	13.4	11.8	12.2
6-7-81	6.6	4.1	6.4	6.0	11.3	10.5	13.4	11.7
16-7-81	3.4	4.2	3.9	3.8	11.7	12.7	10.8	11.7
Mean	5.4	5.3	5.2	5.3	11.4	12.2	12.0	11.9

	Dates	Seed Rate	Int.	Dates	Seed Rate	Int.
Sig.	1%	N.S.	1%	N.S.	N.S.	5 %
SEm ±	0.2	0.2	0.3	0.4	0.4	0.7
C.D.5 %	0.5	-	0.9	-	-	2.2

Dates of planting have significantly influenced grain yield (Table II.6). Sowing with the onset of monsoon and 10 days after monsoon were found at par. A delay of 20 days in sowing from the onset of monsoon reduced the grain yield by 2.2 q/ha. Variation in seed rate did not show any effect on the yields of kodo.

Time of sowing x seed rate interaction was found significant, both for the grain and straw yields. Maximum grain (6.6 q/ha) yield was obtained when sown at the onset of monsoon at the seed rate of 15 kg/ha, whereas maximum straw yield (13.4 q/ha) was obtained when sown at the onset of monsoon at the seed rate of 15 kg/ha or 10 days after monsoon at the seed rate of 20 kg/ha.

4.3 Varieties x Nitrogen Levels

The response of five kodo varieties (IPs 147-1, Keharpur, Pali, JNK 364 and RPS 76) to three levels of nitrogen (0, 10 and 20 kg/ha) was studied in a trial laid out in a randomised block design with four replications. The gross and net plot sizes were 5.0 m x 2.25 m and 4.5 m x 1.80 m respectively. The crop was sown on July 2, 1981 by broadcasting the seed and fertilizer, and harvested on October 11, 13 and 21, 1981.

Table II.7 : Response of Kodo Varieties to Nitrogen

Variety	Grain (q/ha)				Fodder (q/ha)			
	N levels				N levels			
	0	10	20	Mean	0	10	20	Mean
IPs 147-1	6.2	6.1	8.1	6.8	14.8	14.1	16.5	15.1
Keharpur	9.3	10.3	7.6	9.0	18.3	20.3	15.0	17.9
Pali	6.1	8.1	6.2	6.8	17.2	23.6	22.3	21.0
JNK 364	4.9	7.1	7.0	6.3	10.2	14.0	16.2	13.5
RPS 76	5.8	4.8	4.5	5.0	8.0	7.7	6.6	7.4
Mean	6.4	7.3	6.7	6.8	13.7	15.9	15.3	15.0
	V	N	Int.		V	N	Int.	
Sig.	1%	5%	1%		1%	1%	1%	
S.Em.+	0.2	0.2	0.4		0.4	0.3	0.7	
C.D.5%	0.7	0.5	1.2		1.1	0.8	1.9	

Amongst the varieties, Keharpur recorded significantly higher grain yield (9.0 q/ha) than the other varieties (Table II.7). Pali gave the highest fodder yield of 21.0 q/ha. Nitrogen application influenced both grain and straw yields significantly. An application of 10 kg N/ha increased the grain and straw yields by 14 and 16 per cent over no nitrogen. The interaction varieties x N-levels was also

significant in both the cases, i.e. grain and straw yields. Maximum grain yield of 10.3 q/ha was obtained at 10 kg N/ha, while the highest fodder yield (23.6 q/ha) was obtained with Pali at the same level of N.

4.4. Response to Nitrogen and Phosphorus

The response of three varieties of kodo millet (IPS 147-1, Keharpur and JNK 364) to four levels of nitrogen (0, 20, 40 and 60 kg/ha) and two levels of phosphorus (0 and 20 kg/ha) was studied in a split plot design replicated three times. An uniform dose of 10 kg K_2O/ha was applied commonly to all the treatments. The gross and net plot sizes were 5.0 m x 2.25 m and 4.5 m x 1.80 m, respectively. The crop was sown on June 26, 1981 and harvested on October 19, 21 and 22, 1981.

Two years data revealed differences in the application of nitrogen and phosphorus. On an average, nitrogen application @ 20 kg/ha gave 35 per cent increase in grain yield over control. Further increase in N-level enhanced the grain yield. However, 40 and 60 kg N/ha were at par (Table II .8). Phosphorus application @ 20 kg/ha gave 2.2 /ha more grain than no phosphorus.

Varieties did not show significant difference among themselves. However, JNK 364 with no fertilizer had recorded the highest mean yield of 14.0 q/ha, followed by IPS 147-1 (13.5 q/ha) and Keharpur (12.7 q/ha).

The interactions were found significant only in 1981. The maximum grain yields of 27.3, 27.1 and 25.9 q/ha (two years mean) were obtained with the variety IPS 147-1, Keharpur and JNK 364 at N_{40} and P_{20} kg/ha respectively.

Nitrogen application influenced fodder yield significantly in both the years. Phosphorus application showed appreciable differences in yield only during 1981. Significant differences were observed in straw yield among the varieties. Interactions between different treatments were significant only in 1981. The maximum fodder yield of 77.0 q/ha was obtained with IPS 147-1 at 40 N and 20 P_2O_5 kg/ha. JNK 364 at the same level of N and P_2O_5 kg/ha had recorded the second highest yield of 67.3 q/ha.

Table II.8 : Grain Yield (q/ha) of Kodo Millet with N and P Fertilization

N kg/ha	1980-81							1981-82						
	0 P_2O_5			20 P_2O_5				0 P_2O_5			20 P_2O_5			
	IPS 147-1	Kehar-pur	JNK 364	IPS 147-1	Kehar-pur	JNK 364	Mean	IPS 147-1	Kehar-pur	JNK 364	IPS 147-1	Kehar-pur	JNK 364	Mean
0	12.9	12.4	14.2	14.5	14.3	14.8	13.8	14.1	13.1	13.9	15.5	17.2	17.1	15.1
20	18.4	18.0	17.9	17.7	20.3	20.8	18.8	19.5	23.3	17.4	21.0	21.7	18.9	20.3
40	19.0	23.8	21.6	25.7	24.7	22.5	22.9	23.4	21.9	22.9	29.0	29.6	29.4	26.0
60	21.7	23.7	23.5	24.0	24.5	22.9	23.4	24.8	22.7	27.6	26.5	29.2	23.7	25.7
Mean	18.0	19.5	19.3	20.5	20.9	20.2	19.7	20.4	20.2	20.4	23.0	24.4	22.3	21.8
Mean P_2O_5		18.9			20.5				20.3			23.2		

	N	P	V	N x P	N x V	P x V	NxPxV	N	P	V	N x P	N x V	P x V	NxPxV
Significance	1%	5%	NS	NS	NS	NS	NS	1%	1%	N S	1%	1%	5%	1%
S.Em ±	0.9	0.6	0.5	1.2	1.0	0.7	1.5	0.4	0.3	0.3	0.5	0.6	0.4	0.9
C.D.5 %	2.6	1.9	-	-	-	-	-	1.1	0.8	-	1.6	1.8	1.3	2.5

4.5 Biofertilization

Nitrogen fixation studies were undertaken with Azospirillum brasilense to effect nitrogen economy in kodo millet production. Azospirillum was tried with and without the addition of nitrogen (10 and 20 kg/ha) in a randomized block design replicated four times. A uniform dose of 20 kg P_2O_5 and 10 kg K_2O /ha was applied to all the treatments. The gross and net plot sizes were 5.0 m x 2.25 m, and 4.5 m x 1.80 m, respectively. IPS 147-1 was sown on July 9, 1981 and harvested on October 22, 1981.

Table II.9 : Effect of Azospirillum on Grain Yield (q/ha) of Kodo Millet

Nitrogen Source	1980-81 N levels (kg/ha)				1981-82 N levels (kg/ha)			
	0	10	20	Mean	0	10	20	Mean
No Azo	3.5	6.2	9.5	6.1	8.1	11.0	11.2	10.1
Azo	6.2	10.4	9.5	8.7	10.0	11.8	13.2	11.7
Mean	4.8	8.3	9.0	7.4	9.0	11.4	12.2	10.9

	N Source	N Level	NSxNL	N Source	N level	NSxNL
Sig.	NS	NS	NS	NS	NS	NS
SEm ±	1.2	1.5	2.1	0.8	0.9	1.3

Table II.10 : Effect of Azospirillum on Fodder Yield (q/ha) of Kodo

Nitrogen Source	1980-81 N-Levels (kg/ha)				1981-82 N-levels (kg/ha)			
	0	10	20	Mean	0	10	20	Mean
No Azo	4.0	9.2	12.0	8.4	12.7	16.3	17.5	15.5
Azo	7.2	15.9	13.4	12.2	14.7	18.5	18.7	17.3
Mean	5.6	12.5	12.7	10.3	13.7	17.4	18.1	16.4

	N-Source	N level	NSxNL	N source	N level	NSxNL
Sig.	NS	NS	NS	NS	NS	NS
SE ±	2.1	2.6	3.6	1.0	1.2	1.8

Two years results indicated that Azospirillum application did not differ significantly from control (uninoculated and no nitrogen). Similarly bacterial treatment in presence or absence of nitrogen had no effect in increasing grain (Table II.9) and straw (Table II.10) yields of kodo. The incompatibility between kodo millet and Azospirillum was clearly brought out, indicating the necessity of identifying nitrogen bacteria specific to Paspalum species.

5. PEST MANAGEMENT

5.1 Screening

5.1.1 Germplasm : 198 genetic stocks were sown in two row plots on 27-6-1981 in a randomized block design replicated three times. The material was scored for gall fly (Orscolia sp.). Nineteen lines (2422, 3376, 3383, 3386, 3387, 3392, 3447, 3503, 3523, 3524, 3534, D 8, D 9, D 28, D 29, JNK 147, CO 2, MS 1065 and PSC 2) showed infestation between 10 and 25 per cent. 3392, 3503, 3523 and 3524 had shown similar reaction during 1980, indicating that these are relatively tolerant. All other lines (179) were susceptible (more than 25 per cent incidence).

5.1.2 Screening of 14 Varieties : Fourteen promising varieties were sown on 24-6-1981 in two row plots of 3 meters length in 3 replications in a randomized block design. Basal doses of 40 kg N and 40 kg P_2O_5/ha were applied uniformly in the field.

The data were recorded in respect of dead hearts due to shoot fly on 7-8-81 and 29-8-81, and silver shoots due to gall faly on 29-8-81. The data were also recorded in respect of duration for flowering, maturity and harvesting. The average per cent dead hearts recorded on 7-8-81 varied from 2.4 (RPS 41) to 32.9 (IPS 236-2), but during second observation on 29-8-81, minimum per cent dead hearts 4.9 was recorded in IPS 236-1, and maximum 20.1 in CO 2 (Table II.11). Per cent silver shoots formed du to gall fly varied from 4.6 (CO 2) to 30.4 (IPS 236-1) which was also recorded on 29-8-81.

5.1.3 Screening of 9 Varieties : Nine promising varieties were sown on 25-6-81 in two row plots of 3 meters length in a randomised block design with three replications. A basal dose of 40 kg N and 40 P_2O_5/ha was applied uniformly in the field.

The data on dead hearts caused by shoot fly were recorded on 7-8-81 and 29-8-81, and silver shoots formed due to gall fly on 29-8-81. On 7-8-81, percentage dead hearts varied from 5.2 (RPS 123) to 26.8 (JNK 50). Subsequent observations on 29-8-81 indicated variations from 10.9 (JNK 236, RPS 576) to 29.4 (CO 2) per cent dead hearts . The silver shoots due to gall fly were recorded on 29-8-81 which varied from 3.9 (CO 2) to 20.8 (RPS 76).

Table II.11 : Pest Incidence in Kodo Millet

Varieties	Dead Hearts (%)		Silver Shoots (%)
	7-8-81	19-8-81	29-8-1981
RPS 123	6.6	11.3	9.2
CO 2	16.9	20.1	4.6
IPS 236-1	32.9	4.9	30.4
IPS 147-1	15.8	12.2	7.9
Local (D-73)	9.7	17.0	7.1
RPS 117	10.0	13.5	12.2
Keharpur	7.7	18.8	15.0
MS 1065	16.9	14.8	9.1
RPS 41	2.4	19.3	18.3
JNK 364	9.0	14.5	6.7
JNK 228	6.6	13.8	6.6
RPS 76	9.7	14.1	6.2
Pali	13.5	10.5	6.1
RPS 576	8.8	16.8	7.3

Table II.12 : Screening of Selected Varieties of Kodo against Insect Incidence

Variety	Dead Hearts (%)		Silver Shoots(%)	Yield
	7-8-81	29-8-81	29-8-81	(g/10 Plants)
RPS 62-3	17.8	12.6	18.6	55.0
RPS 576	10.5	10.9	20.0	53.3
RPS 41	13.3	16.3	9.5	43.3
JNK 117	18.5	12.7	9.6	45.0
JNK 236	22.3	10.9	24.9	43.3
JNK 50	26.8	17.6	13.7	43.3
RPS 123	5.2	17.4	7.3	32.7
CO 2	11.5	29.4	3.9	83.3
RPS 76	10.3	19.0	20.8	36.7
Mean	15.1	16.3	14.2	48.4

5.2 Effect of Date of Sowing on Kodo Pests

Four promising varieties of kodo millet (IPS 147-1, JNK 364, JNK 228, Keharpur and D-73) were sown on 23-6-81, 30-6-81, 14-7-81 and 21-7-81 in a randomized block design in 3 replications, in two row plots. No fertilizer was applied.

Early planting (23-6-81 had low shootfly incidence, but higher gall fly (Table II.13). Planting on 30-6-81 had given higher yield besides low gall fly and medium shootfly incidence.

Table II.13 : Effect of Date of Planting on Incidence of Pests in Kodo Millet, 1981

		Dindori 73	IPS 147-1	JNK 364	JNK 228	Keharpur	Mean
		i. Shootfly - Dead Hearts (%)					
23-6-81	Aug.7	13.8	14.4	14.8	16.5	13.8	14.6
	Sept.4	4.8	4.0	8.0	8.3	8.1	6.6
30-6-81	Aug.7	18.8	12.4	16.8	21.3	17.1	17.3
	Sept.4	13.9	5.7	25.2	10.6	40.9	19.3
7-7-81	Aug.7	25.2	21.4	24.7	18.3	22.8	22.5
	Sept. 4	45.2	12.0	31.9	21.0	36.9	29.4
24-7-81	Aug.7	19.4	13.4	15.3	7.4	7.7	12.7
	Sept.4	35.5	24.5	21.0	43.2	43.5	33.5
31-7-81	Aug.7	5.6	11.1	16.9	9.5	9.1	10.4
	Sept.4	41.8	46.6	50.5	53.2	57.8	50.0
		ii. Gall Fly - Silver Shoots (%) September 4					
23-6-81		13.7	18.6	23.5	14.4	22.2	18.5
30-6-81		11.5	16.2	6.7	4.8	6.0	9.1
7-7-81		5.0	7.6	22.1	6.4	14.1	11.0
24-7-81		4.5	10.2	8.7	7.5	8.1	7.8
31-7-81		4.5	8.5	11.6	6.7	9.4	8.2
		iii. Grain Yield - g/2 Rows					
23-6-81		260	212	224	297	247	248
30-6-81		306	383	220	321	263	299
7-7-81		214	287	98	155	235	198
24-7-81		293	138	225	267	212	228
31-7-81		176	256	142	230	173	195

6. HIGHLIGHTS OF RESEARCH

6.1 Genetic Resources

196 collections were evaluated for various descriptors.

6.2 Varietal Improvement

IPS 236-1 had given maximum yield with and without nitrogen application. New promising selections from germplasm were also identified for further evaluation.

Protogyny was observed in D 3420, D 3513 and D 3525.

6.3 Management of Inputs

Sowing at the onset of monsoon in the last week of June had recorded significantly higher yield. A 2 week delay reduced grain yield by 34 per cent.

Plant spacings 22.5 cm x 7.5 cm to 22.5 cm x 5 cm did not affect grain yield as also seed rates (10, 15 and 20 kg/ha).

Nitrogen application upto 60 kg N/ha influenced the grain yield positively. The response to nitrogen ranged from 9 kg grain/ kg N at 10 kg N to 23.8 at 40 kg N/ha.

The response to phosphorous was 11.5 kg grain/kg P_2O_5 at 20 kg P_2O_5.

Azospirillum application resulted in marginal yield gains with and without nitrogen supplementation.

6.4 Pest Management

Germplasm screening revealed that 3392, 3503, 3523 and 3524 were relatively resistant to gallfly over a two year period.

Planting one week after the monsoon on 30-6-81 had given maximum grain yield with medium shootfly and low gallfly incidence.

CHAPTER III

FOXTAIL MILLET- SETARIA ITALICA BEAUV

1. INTRODUCTION

1.1 Research Centre: Centre for the improvement of foxtail millet (Korra) crop has been located in Andhra Pradesh, which has the largest acreage in India. The Project is located at Regional Agricultural Research Station, Nandyal, under the control of the Andhra Pradesh Agricultural University, Hyderabad.

Regional Agricultural Research Station is situated at 15.29° N latitude, 78.32° E longitude and at an altitude of 211.7 m above MSL.

1.2 Soils: Soils of this region are texturally under clay loams with pH range of 8.4 to 8.7. The soils are very poor in organic carbon and low to medium in available phosphorus.

1.3 Detailed History of the Crop: Foxtail millet is essentially a dryland grain crop suited to conditions of low and moderate rainfall ranging from 500 to 700 mm. It is one of the short duration millet crops grown, maturing in about 100 days, giving almost as good yield as crops of much longer duration. It can be grown even at an altitude of 6000 feet and is an important food grain in the foot hills of the Himalayas. Foxtail millet can be grown throughout the year as a crop from early rainy season (May), monsoon season (June-July), the late rains (August-September) and again in the summer season (February-March). In Sough India it can be grown throughout the year.

In the hilly regions of North India, foxtail millet is sown with other kharif crops and matures in about two months, providing food during scarcity periods. In Punjab, Himachal Pradesh and Uttar Pradesh, it is grown from June-July to September-October, either as a border or as a mixed crop in maize fields and other kharif crops and receive the same care as the major crop.

Foxtail millet is mostly grown mixed with other crops like cotton, castor, redgram, bajra, groundnut and ragi. It is also grown as a pure crop, particularly in black cotton soils, where it is followed by a rabi crop like coriander in favourable seasons or by safflower or horsegram in years of less rainfall.

Alluvial loams, red loams, light soils, black-cotton soils and clayey soils are all suited for its cultivation.

The land is ploughed once and harrowed twice or thrice. Irrigated crop is manured with about five tons of farm yard manure per hectare. Application of fertilizer is now becoming a habit slowly. The seed is sown by a country drill or broadcast 6 to 10 kg/ha. In mixed cropping, seperate rows are sown. Except one weeding, no intercultivation is generally done in pure crop. In intercropping, foxtail millet shares the inter culturing of the subsidiary crop.

The ripe earheads are cut, heaped for a week to dry and then threshed by trampling under the feet of the cattle or using a stone roller. In Maharashtra and North India, the crop is reaped with sickle, the spikes are cut off and threshed.

The yield of the rainfed pure crop varies from 400 to 800 kg of grain per hectare and 1000 to 2000 kg of straw per hectare. Under irrigation, the yield is more than double. The straw is thin and can be fed unchaffed.

Generally cooked like rice or made into porridge, it makes a nourishing food, which is considered to be very nutritious. The grain must be pounded or otherwise husked before cooking to remove the tightly enclosed glume.

1.4 Season and Rainfall: In order to present a more comprehensive picture of the degree of variability within a year and between years and its effect on crop reaction (grain and straw yields depicted correspondingly) weekly precipitation totals have been calculated for the years 1979, 1980 and 1981. Histograms of 1-week rainfall are plotted in Figure III.1 and monthly rainfall (mm) for the three years (1979-81) alongwith 50 years average is depicted in Figure III.2.

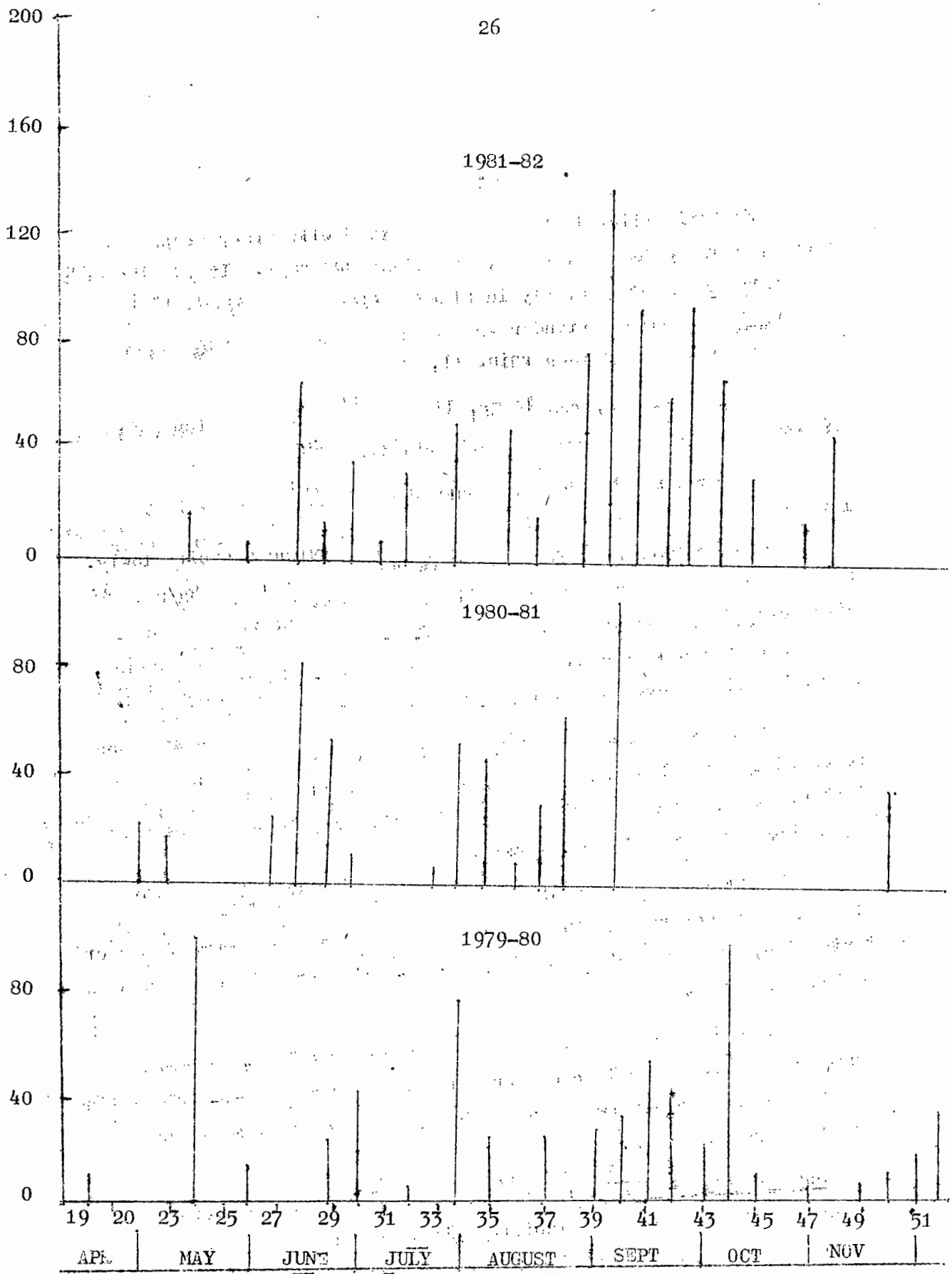

Figure III.1: Weekly Precipitation Totals (mm)

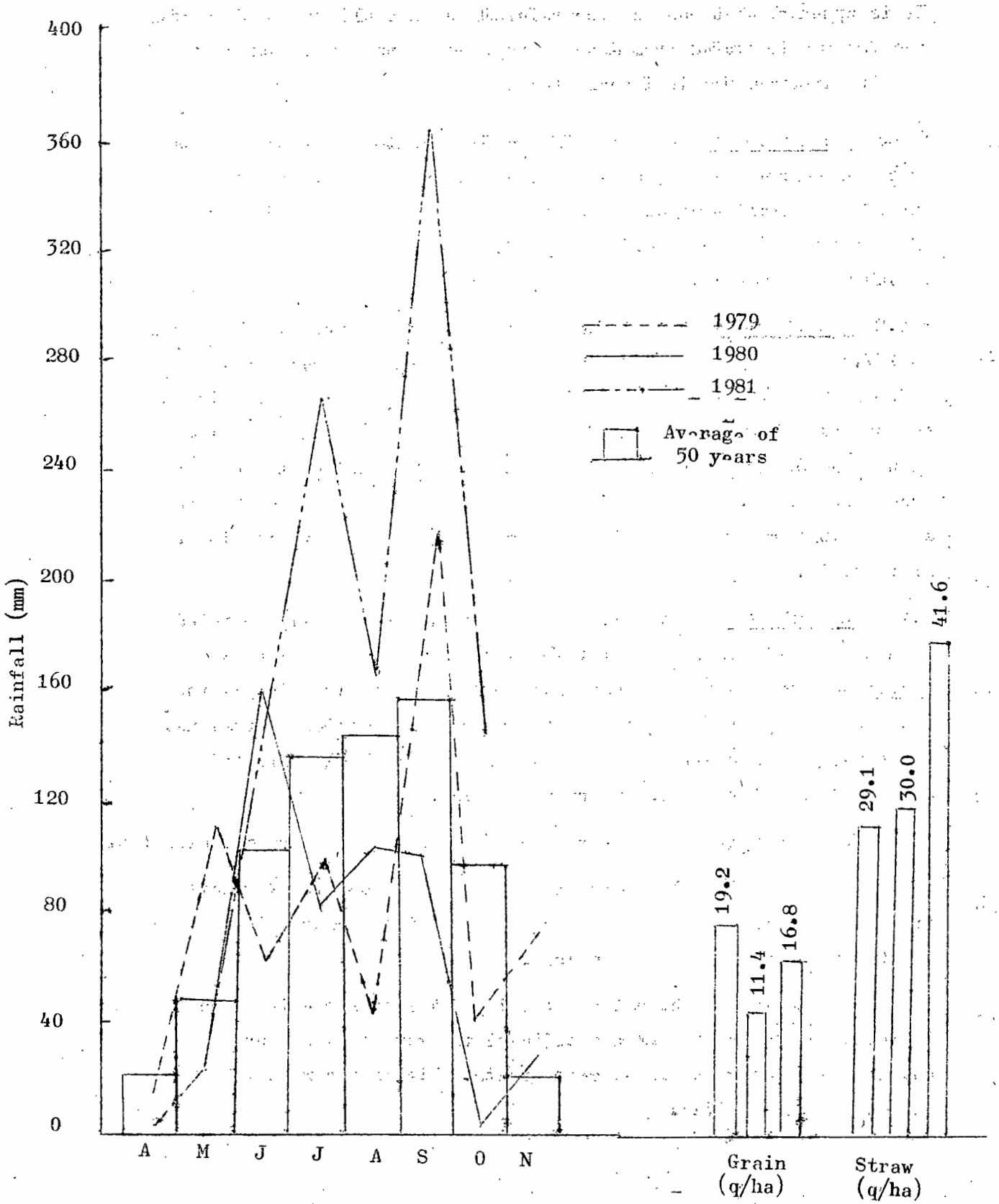

Figure III.2: Monthly Rainfall and Dry Matter Production

It is apparant that most of the rainfall is normally received during the four month period from June to September and the amount of rainfall and its distribution is inconsistent.

1.4.1 Kharif 1979: The rainfall received during the month of June July and August was far below the normal, and thus the initial drought caused poor establishment of the crop. Subsequent rains in the month of September (above normal) remarkably revived the crop and normal yields were obtained.

1.4.2 Kharif 1980: Though June is normally a dry month, a rainfall of 157.4 mm received in 12 rainy days saturated the soil profile to a depth of plough zone and facilitated the sowings of setaria in the second half of July. Rainfall received during the month of July, August and September though far below the normal helped the crop to grow luxuriently. Severe drought prevailed in the month of October which coincided with flowering and grain setting, badly upseting the grain yield.

1.4.3 Kharif 1981: Rainfall during Kharif, 1981 greatly deviated from normal pattern (Figure III.2) as well as the preceding two kharif seasons. More than normal rainfall was received in all the months, greatly hindering the field and crop production operations. And thus, the crop establishment and growth were badly affected. October rainfall resulted in grain shedding.

The precipitation patterns for the last three years revealed that

1. The rainfall of June is not enough to moisten the soil profile sufficient to sow the small seeded millet crops like setaria and the sustenance of the sown crop.

2. Early drought after attaining 3-4 leaf stage is advantageous to induce deeper root system beneficial to draw more moisture and nutrients at later stages of crop growth. Yields recorded in 1979 supported this finding.

3. Drought as well as heavy rains at later stages of crop growth particularly at flowering and grain setting adversely affected the grain yield. Heavy rains in 1981 also created harvesting problems and loss of grain.

2. GENETIC RESOURCES

2.1 Cataloguing, Characterisation and Classification of Foxtail millet Collections: Setaria collections procured from different centres were studied during the previous seasons for various characters like yield (grain and straw), duration (early, medium and late), size (small, medium or large), shape (conicle, cylindrical, elliptical, spindle like or club shaped), compactness (loose, semi-loose or compact), bristles (very short, short, medium, medium long and long), grain color (black, red and yellow) and height of plant (tall, medium, dwarf).

During kharif, 1981 season, 1323 collections received from Anantapur, Lam, Bangalore and the Project Coordinator, and 2547 local collections were evaluated.

All the above collections were planted on 14.8.81 in rows of two meters length in augmented block design. The two checks N 1 and Arjuna were sown after every 25 rows for comparison. Germination was satisfactory in all the entries. But from the day of sowing, continuous heavy rains prevailed. A total rainfall of 594.6 mm was recorded on 24 rainy days from sowing till the end of October, 1981. Due to continuous waterlogged conditions, the crop growth was not uniform and the entries in low lying patches suffered much. Hence no reliable data could be collected. Seed material was collected for study during next season.

3. VARIETAL IMPROVEMENT

3.1 Comparative Performance of Developed Varieties

3.1.1 Advanced Yield Trial, Summer, 1981: A total number of 130 promising lines were tested in five series of yield trials during Kharif, 1980. Twenty four entries which have given higher grain yield over the high yielding control, were studied in an advanced yield trial during summer, 1981, along with Arjuna and N 1.

Table III.1 Performance of Setaria Selections during Summer, 1981

Entry	Origin	Days to 50% Bloom	Days to Maturity	Grain q/ha	Grain %over control	Straw q/ha	Straw %over control
SIA 1253	Kurnool	45	74	39.8	180.0	33.8	85.4
SIA 395	Anantapur	48	74	39.4	178.3	33.3	83.9
SIA 1135	Kurnool	49	76	37.1	167.8	27.9	70.4
SIA 1842	Prakasam	54	77	36.0	162.6	40.2	101.4
P No.563	Pune	53	77	35.6	160.8	44.0	111.2
P No 765	Pune	54	81	35.4	160.0	37.3	94.2
SIA 1162	Kurnool	49	72	34.8	157.4	26.7	67.4
SIA 1142	Kurnool	54	76	34.6	156.5	32.3	81.5
SIA 5	Kurnool	51	73	34.6	156.5	36.0	90.7
SIA 326	Kurnool	52	74	34.4	155.6	34.2	86.4
SIA 1931	Prakasam	52	77	34.2	154.8	29.0	73.4
SIA 242	Kurnool	52	76	34.0	153.9	31.3	79.1
SIA 67	Kurnool	52	76	33.7	152.1	36.5	92.2
SIA 17	Kurnool	52	74	33.3	150.4	35.4	89.3
SIA 36	Kurnool	52	72	33.3	150.4	28.8	72.8
SIA 341	Kurnool	51	74	32.1	145.2	35.2	88.8
N 1	Nandyal	58	82	31.9	144.3	43.5	109.7
GK 22	Guntur	52	76	31.7	143.4	29.6	74.8
SIA 1171	Kurnool	49	74	31.5	142.6	32.9	83.0
K 2	Kovilpatti	55	80	30.4	137.4	35.4	89.3
SIA 1085	Kurnool	57	80	30.2	136.5	34.4	86.9
SIA 2134	Cuddapah	53	75	27.7	125.2	36.3	91.7
P No. 768	Pune	58	84	27.7	125.2	39.6	100.0
P No 764	Pune	57	84	25.4	114.8	42.5	107.3
Arjuna	Guntur	54	75	22.1	100.0	39.6	100.0
ISe 377	Anantapur	57	82	14.6	66.1	31.2	78.6
General Mean		-	-	32.1	-	34.9	-
Significance		-	-	Yes	-	Yes	-
SE		-	-	0.27	-	0.44	-
CD		-	-	0.77	-	1.26	-
CV %		-	-	16.4	-	2.2	-

The grain yield differences were found to be significant. All the entries except ISe 377, gave higher yields of grain over the control Arjuna (Table III.1)

The entry SIA 1253 topped the list with 39.8 q/ha, 80 per cent increase over Arjuna. This entry was also found to be early and matured in 74 days. The second best entry was SIA 395 with 39.4 q/ha (78.3 per cent increase). This is consistantly giving higher yields during the past two seasons.

The straw yield differences were also found to be significant. Four entries viz. P No 563, N 1, P No 764 and SIA 1842 gave higher yields of straw over the control Arjuna.

3.1.2 Advanced Yield Trial, Kharif, 1981: 26 promising lines from Kharif, 1980 were sown in an advanced yield trial on 12-8-81 along with the checks N 1 and Arjuna. They were sown in randomised block design, replicated thrice and in plots of 3.75 x 2.65 sq m. In each plot there were 10 rows, and the spacing between rows was 26.5 cm.

Germination was satisfactory in all the entries. All the entries in genera l suffered from continuous wet weather from the time of sowing.

The results were significant both for grain and straw yields (Table III.2).

Excepting GK 22, all other entries gave higher yield than Arjuna. Fifteen entries, SIA 106, 326, 1162, 1253, 395, 67, 1142, 36, 242, P 563, ISe 377, SIA 17, 805, N 1 and SIA 5 gave higher yields of grain over general mean. Selection SIA 1062 from Kurnool district of Andhra Pradesh, topped the list with 22.8 q/ha, 53.4 per cent increase over control, followed by SIA 326 with 21.9 q/ha.

Three entries SIA 805, 1062 and P 768 gave higher straw yield than Arjuna.

3.1.3 State Trial: Seven promising lines were selected at Nandyal from out of the local collections and studied during the previous seasons. Besides the above, two promising lines from Regional Agricultural Research Station, Lam and one from Agricultural Research Station, Anantapur were obtained for study in State Level trial. The following are the details. Twelve entries were planted in a randomised block design replicated three times in net plots of 3.75 x 2.12 sq m. All the entries were sown on 12-8-81. Germina tion was satisfactory in all the entries. The crop growth was poor due to continuous wet conditions.

Table III.2 Performance of Foxtail Millet Selections, Kharif, 1981

Entry	Origin	Days to 50 % bloom	Days to Maturity	Grain q/ha	Grain % over control	Straw q/ha	Straw % over control
SIA 1062	Kurnool	54	78	22.8	153.4	29.9	102.2
SIA 326	Kurnool	52	75	21.9	147.5	28.1	95.7
SIA 1162	Kurnool	51	73	21.8	146.6	25.9	88.4
SIA 1253	Kurnool	53	77	21.8	146.6	27.8	94.9
SIA 395	Anantapur	51	74	21.3	143.2	27.9	95.3
SIA 67	Kurnool	55	77	20.9	140.7	27.4	93.6
SIA 1142	Kurnool	54	77	20.9	140.7	27.3	93.1
SIA 36	Kurnool	51	73	20.4	137.3	27.4	93.6
SIA 242	Kurnool	53	76	20.3	136.4	26.8	91.4
P 563	Pune	52	75	20.0	134.8	27.9	95.3
ISe 377	Anantapur	53	77	19.9	133.9	28.3	96.6
SIA 17	Kurnool	55	77	19.9	133.9	27.7	94.4
SIA 805	Kurnool	56	79	19.5	131.4	30.6	104.3
N 1	Nandyal	55	78	18.9	127.1	29.2	99.6
SIA 5	Kurnool	55	77	18.9	127.1	29.2	88.8
SIA 341	Kurnool	53	76	18.6	125.4	28.2	96.1
SIA 1171	Kurnool	52	75	18.1	122.0	28.1	95.7
SIA 1135	Kurnool	53	77	17.5	117.8	27.5	94.0
SIA 1931	Prakasam	54	78	17.1	115.3	27.8	94.9
P 768	Pune	54	78	16.7	112.0	29.8	101.7
P 765	Pune	53	77	16.6	111.9	29.3	100.0
SIA 1842	Prakasam	56	80	16.4	110.2	27.3	93.1
SIA 1085	Kurnool	53	77	16.0	107.0	26.8	91.4
P 764	Pune	54	77	15.7	105.0	29.3	100.0
SIA 2134	Cuddapah	53	77	15.2	102.5	29.3	100.0
K 2	Kovilpatti	55	79	15.1	101.0	27.0	92.3
Arjuna	Guntur	54	77	14.8	100.1	29.3	100.0
GK 22	Guntur	53	77	14.2	95.8	27.0	92.3
General Mean				18.6	-	28.0	-
Significant or nor				Yes	-	Yes	-
SE				0.47	-	0.64	-
CD				1.35	-	1.82	-
CV %				0.04	-	0.04	-

Table III.3 Performance of Foxtail Millet Selections, Kharif, 1981

Entry	Origin	Days to		Grain		Straw	
		50 % Bloom	Maturity	q/ha	% over control	q/ha	% over control
SIA 326	Kurnool	52	75	13.6	110.2	16.6	96.4
SIA 1842	Prakasam	56	80	13.6	110.2	16.6	96.4
SIA 395	Anantapur	51	74	13.5	109.2	16.1	93.4
SIA 67	Kurnool	55	77	13.3	108.2	16.0	92.7
SIA 1253	Kurnool	53	77	13.3	108.2	15.7	91.2
SIA 242	Kurnool	53	76	13.2	103.1	16.4	94.9
410 B	Guntur	55	80	13.2	103.1	16.7	97.4
ISe 377	Anantapur	53	77	13.1	106.1	16.1	93.4
SIA 1135	Kurnool	53	77	13.0	105.1	16.0	92.7
N 1	Nandyal	55	78	12.7	103.1	16.7	97.1
288 A	Guntur	55	80	12.7	103.1	16.1	93.4
Arjuna	Guntur	54	77	12.3	100.0	17.2	100.0
General Mean		-	-	13.1	-	16.4	-
Significant or not		-	-	Yes	-	No	-
SE	-	-	-	0.25	-	-	-
CD		-	-	0.74	-	-	-
CV %		-	-	0.03	-	-	-

The grain yield differences were significant (Table III.3). All the entries gave higher grain yield than Arjuna. SIA 326 and 1842 topped the list with 13.6 q/ha each.

The straw yield differences were not significant. None of the entries gave higher straw than Arjuna.

3.2 Recombination Breeding: Foxtail millet is a highly self pollinated crop. So far the varietal improvement was achieved by pure line selection only. For achieving higher yield potential and to induce earliness and high tillering, hybridization programme was initiated during Kharif, 1980. Crosses were effected by contact method and were sown in observation rows along with their parents during summer, 1981. None of the hybrids were found to be better than the parents. No single plant could be collected.

3.3 Mutation Breeding: ISe 119, Arjuna and N 1 were irradiated at 20, 40 and 60 kR and were sown on 15-2-80. Four hundred and eighty single plant selections were sown on 27-7-80. Seventy lines in ISe 119, 66 in Arjuna and 55 in N 1 were selected for study in M 3 generation. These were again sown on 3-2-81. The following lines were found to be promising.

ISe 119: Nos. 1, 4, 12, 14, 22, 26, 27, 31, 32, 39, 42, 43, 44, 47, 50, 53, 54, 57, 64, 167, 227, and 363-(22).

Arjuna : Nos. 1, 10, 12, 13, 15, 17, 20, 26, 28 and 44-(10).

N 1 : Nos. 15 and 17 - (2).

All the above 34 entries were sown on 12-8-81 in an initial evaluation trial along with ISe 119, Arjuna and N 1 for comparison. The following are the details. The entries were planted in a randomized block design replicated four times in a net plot of 3.75 x 2.12 sq.m. Germination was satisfactory in all the entries. The crop suffered much due to excessive and continuous rains.

The results were significant both for grain and straw yields (Table III.4). Seven selections(119-64, 119-363, 119-53, 119-31, 119-227, A 44 and 119-42) gave higher yield than the three controls.

Six selections (119-42, 119-64, A 20, 119-227, 119-363 and 119-27) gave higher straw yield than Arjuna, the high yielding control.

Table III.4 Performance of Foxtail Millet Selections, Kharif, 1981

Entry	Days to		Grain		Straw	
	50 % Bloom	Maturity	q/ha	% over control	q/ha	% over control
119-64	55	81	16.0	124.1	22.4	106.0
119-363	55	80	15.5	120.6	21.8	103.0
119-53	56	81	14.5	112.8	20.5	97.0
119-31	56	81	14.3	111.8	16.5	78.0
119-227	54	80	14.2	110.8	21.8	103.0
A 44	56	82	14.0	108.8	17.6	83.3
110-42	56	81	13.7	106.9	22.6	107.1
A 20	56	81	13.3	103.9	22.1	104.8
119-27	56	81	13.3	103.9	21.4	101.2
N 1	55	80	13.3	103.9	17.9	85.1
119	56	81	13.2	102.9	17.1	81.0
A 1	56	81	13.2	102.9	18.2	86.3
A 17	55	79	13.1	102.0	19.6	92.9
N 17	57	83	12.8	100.0	16.7	79.2
Arjuna	54	79	12.8	100.0	21.1	100.0
A 10	56	81	12.8	100.0	20.6	98.2
119-14	56	81	12.5	97.1	17.6	83.3
119-32	56	81	12.3	96.1	17.0	80.4
N 15	57	83	11.9	93.1	19.2	91.1
119-43	54	79	11.8	92.2	21.1	100.0
119-39	56	81	11.7	91.2	20.0	94.6
A 12	56	81	11.7	91.2	20.3	95.8
119-167	54	79	11.7	91.2	17.5	82.7
119-50	55	79	11.7	91.2	16.1	76.2
119-47	56	81	11.3	88.2	16.5	78.0
119-44	54	79	11.3	88.2	20.3	95.8
119-12	56	82	11.1	86.3	18.6	88.1
A 15	55	80	11.1	86.3	18.6	88.1
119-54	56	81	10.8	84.3	18.0	85.1
119-26	54	83	10.4	81.4	18.7	88.7
119-57	56	81	10.3	80.4	17.1	81.0
119-1	53	78	10.2	79.4	16.5	78.0
A 13	56	81	10.2	79.4	16.7	79.1
A 28	56	81	9.7	75.5	18.2	86.3
119-22	56	82	9.6	74.5	15.2	72.0
A 26	56	81	8.6	66.7	20.8	98.2
119-4	54	79	8.3	64.7	15.6	73.8
General Mean			12.1	-	18.9	-
Significant or not			Yes	-	Yes	-
SE			0.31	-	0.45	-
CD			0.88	-	1.28	-
CV %			0.05	-	0.05	-

4. MANAGEMENT OF INPUTS

4.1 Summer Irrigated Experiments: Two experiments were studied during summer season, 1981 under irrigation.

4.1.1 Varieties x Inter and Intra Row Spacing: An experiment was conducted to determine the optimum inter and intra-row spacings for two promising setaria cultivars under agro-climatic conditions of Nandyal valley of Andhra Pradesh.

The experiment was laid out on clay loam soils at the farm of Regional Agricultural Research Station, Nandyal during summer, 1981 under irrigated conditions.

Two promising varieties SIA 36 and Jodhpur 19 were grown at three inter row (20, 25 and 30 cm) and three intra row spacings (5.0, 7.5 and 10 cm). SIA 36 is a tall, medium duration. (80-85 days) variety, while Jodhpur 19 is a dwarf variety with 65 days crop period. Half of the total N (30 kg/ha) and entire amount of phosphorus (30 kg P_2O_5 /ha) were broadcasted before sowing. 1/4 of the total nitrogen (15 kg N/ha) and the remaining 1/4 of nitrogen were top dressed at maximum tillering and flowering stages.

The experiment was laid out in a split plot design with three replications. Varieties were kept in main plots, inter and intra row spacings were in sub plots, and sub sub plots respectively.

SIA 36 a tall variety with medium duration significantly out yielded Jodhpur 19, a dwarf short duration variety in grain and straw yields (Table III.5).

Close inter row spacing (20 cm) gave significantly higher grain and straw yields over 25 and 30 cms, 25 cm is superior to the wider spacing.

All the intra-row spacings tried gave similar yields in both grain and straw.

Table III.5: Grain and Straw Yield as Affected by Varieties, Inter and Intra-row Spacings

Treatment	Grain Yield (q/ha)	Straw Yield (q/ha)
	Varieties	
Jodhpur 19	20.8	25.2
SIA 36	28.1	38.9
SEm ±	1.2	0.7
CD 5%	5.2	3.1
	Inter-row Spacing (cm)	
20	28.6	35.9
25	24.7	29.9
30	20.2	25.1
SEm ±	1.3	1.7
CD 5%	3.1	4.0
	Intra-row Spacing (cm)	
5.0	25.1	31.0
7.5	24.3	30.0
10.0	24.1	29.7
SEm ±	0.6	0.7
CD 5%	-	-

4.1.2 Varieties x Nitrogen Levels: With a view to study the response of high yielding setaria cultivars to nitrogen under irrigated conditions an experiment was conducted at Regional Agricultural Research Station, Nandyal during summer, 1981.

The soil type of the experimental plot was clay loam having a pH 8.4, organic carbon 0.42 percent and available P 15 kg/ha. The treatments consisted of two setaria cultivars (SIA 36 and Jodhpur 19) and seven nitrogen levels (0, 20, 40, 60, 80, 100 and 120 kg N/ha) replicated thrice in a randomized block design. Phosphate was applied at 30 kg P_2O_5/ha. Half of N and all phosphate was applied at the time of sowing in the form of Urea and single super phosphate. Rest of the nitrogen was again split into two equal halves and applied at maximum tillering and flowering stages of the crop. V ariety Jodhpur 19 was earlier in maturity by 15 days than SIA 36.

SIA 36 recorded the highest grain yield and gave more than Jodhpur 19 (Table III.6). The former cultivar also gave higher straw yield because of its better tillering and more plant height over Jodhpur 19.

A significant response to N was obtained upto 100 kg N/ha beyond which no significant increase was observed in grain and straw yields. The response to N was thus quadratic nature.

Table III.6: Grain and Straw Yield as Affected by Varieties and Nitrogen Levels:

Treatment	Grain Yield (q/ha)	Straw Yield (q/ha)
	Varieties	
Jodhpur 19	17.7	15.7
SIA 36	23.0	25.0
SE±	0.7	0.9
CD 5%	2.1	2.5
	N-rates (kg N/ha)	
0	10.3	9.2
20	14.0	13.6
40	18.3	19.5
60	22.5	20.1
80	20.0	23.0
100	27.0	27.6
120	28.8	29.2
SEm ±	1.4	1.6
CD 5%	3.9	4.8

No interaction was found to be significant.

4.2 Kharif (Rainfed) Experiments

4.2.1 General Information: One tractor ploughing was given to remove the cotton and sorghum stubbles as these two were the preceding crops. After receiving sufficient rainfall light ploughing was given with a six tyned gorru. Sowings were done in the first fortnight of July and good germination was obtained in experiments sown before 9-7-81 as there was sufficient moisture in the soil profile. Because of continuous severe drought for 18 days coupled with higher temperatures the crops sown after 9th July did not properly germinate particularly

castor and cotton which were sown as inter crops. Proper measures like thinning of seedlings, compacting the soil in between rows to avoid more loss of soil moisture were taken up to save tender seedlings from drought. Resowing of intercrops was taken up in the second fortnight of July (22-7-81) and subsequent rains helped in complete germination. Thinning of seedlings, gap filling and top dressing of fertilizers could not be taken up as scheduled because of continuous heavy rains. Yellowing of seedlings was noticed in few patches where the rain water stagnated. Top dressing with 20 kg N/ha in the shape of Urea was given in the last week of August except in fertilizer trials. Two hoeings were given to the crop with a wheel type hoe to break the hard soil crust formed due to continuous heavy rains experienced during the season.

Early matured varieties could not be harvested in time because of continuous rains and thus grain shedding was noticed.

Severe incidence of army worm was noticed in the second week of September. (Armyworm damage was also experienced during the same period in Kharif, 1980) One spraying of Nuvacron @ 1 ml per one litre of water was given to control the pest.

4.2.2 Varieties x Dates of Sowing: A field trial was laid down during Kharif, 1981. The treatments included twelve cultivars of early, medium and long duration and four dates of sowing at an interval of ten days. The experiment was laid out in a split plot design with three replications. The dates of sowing as main plots and entries as sub plots were kept.

Early sowing in the first fortnight of July had a significant advantage in getting higher grain and straw yield. As the sowings delayed drastic reduction in grain and straw yields were noticed (Table III.7). No significant difference was seen in both total and productive tillers due to delayed sowings. The loss in grain yield was due to delayed sowings resulting in less number of grains per earhead. Ear length and number of branches per earhead did not affect grain yield.

Among the entries, medium duration varieties recorded higher grain yield over short and long duration cultivars. Jodhpur 19 and 20 (short duration varieties) and CO 3 (long duration variety) were on par with control in grain yield and the rest of the cultivars are superior to control Arjuna.

Table III.7: Grain and Straw Yields and yield components as Affected by Varieties and Dates of Seeding

Treatment	Tillers/m Total	Tillers/m Productive	Ear Length (cm)	Branches/ Earhead (No)	Grains/ Earhead (No)	Grain Yield (q/ha)	Straw Yield (q/ha)
Dates of Sowing							
8-7-81	68.0	66.1	11.5	42.0	572.4	17.7	50.3
18-7-81	57.3	53.9	10.7	41.0	570.1	17.3	41.7
12-8-81*	54.1	50.1	11.1	40.9	405.7	12.3	39.3
22-8-81*	55.2	48.1	11.0	42.1	385.0	13.0	35.3
SEm ±	3.7	5.0	0.13	1.2	7.1	0.50	0.56
CD 5%	-	-	0.44	-	24.6	1.72	2.24
Varieties							
Jodhpur 3	62.4	59.0	8.5	21.2	306.5	13.7	26.7
Jodhpur 11	64.7	60.7	7.9	25.4	305.1	14.3	27.7
Jodhpur 19	53.2	50.8	9.2	26.6	379.1	13.0	26.3
Jodhpur 20	59.8	57.0	10.0	31.6	295.8	12.7	26.0
SIA 36	54.2	50.8	10.1	49.4	540.3	16.3	38.3
ISe 377	49.6	44.3	16.1	60.5	901.2	22.7	45.9
SIA 1085	52.2	48.9	15.2	64.5	734.8	14.0	42.3
SIA 326	56.0	53.6	12.9	61.6	878.7	20.0	52.9
SIA 805	71.9	63.4	10.9	29.2	272.6	16.3	45.9
CO 3	62.9	58.8	9.0	22.5	283.1	11.7	56.9
SIA 5307	65.6	61.4	12.1	53.9	465.3	15.7	55.0
Arjuna	51.4	46.0	11.3	51.5	436.4	10.7	55.0
SEm ±	3.5	3.3	0.4	2.9	26.7	1.1	2.9
CD 5%	9.6	9.0	1.2	5.7	73.9	2.9	8.0

* Sowings could not be taken up as scheduled (at 10 daysintervals) because of heavy and continuous rains.

Table III.8: Dates of Sowing x Varieties Tnteraction on Number of Grains per Earhead

Varieties	Dates of Sowing				Mean
	8-7-81	18-7-81	12-8-81	22-8-81	
Jodhpur	329	359	265	274	306
Jodhpur 11	257	422	269	274	305
Jodhpur 19	354	492	395	376	379
Jodhpur 20	310	418	215	241	296
SIA 36	664	636	466	396	540
ISe 377	1098	1015	747	745	901
SIA 1085	952	893	581	513	735
SIA 326	1061	1004	781	668	879
SIA 805	328	360	204	199	273
CO 3	318	306	226	281	283
SIA 5307	599	575	354	333	465
Arjuna	598	461	366	321	436
Mean	572	570	406	385	

	SEm ±	CD 5%
For comparing means of dates of sowing at varietal means	51.6	149.5
For comparing varietal means at the same date of sowing	53.4	147.9

Long duration varieties recorded higher straw yield followed by medium duration varieties. Short duration varieties recorded the lowest straw yield as they are dwarf in stature.

Significant interaction between dates of sowing and varieties was found in number of grains per earhead (Table III.8), and grain yield (Table III.9).

All the varieties under test showed reduction in number of grains per earhead and correspondingly the grain yield as the sowings were delayed.

Table III.9: Dates of Sowing x Varieties Interaction on Grain Yield (q/ha)

Varieties	Date of Sowing				Mean
	8-7-81	18-7-81	12-8-81	22-8-81	
Jodhpur 3	14.3	16.0	11.0	13.3	13.7
Jodhpur 11	16.0	18.0	10.3	13.0	14.3
Jodhpur 19	12.3	14.3	12.7	12.0	13.0
Jodhpur 20	11.0	12.0	12.7	14.7	12.7
SIA 36	16.7	18.7	14.3	16.0	16.3
ISe 377	33.3	30.7	14.3	12.7	22.7
SIA 1085	14.0	15.0	16.3	10.0	14.0
SIA 326	26.0	22.3	18.0	13.7	20.0
SIA 805	23.7	19.3	9.0	13.0	16.3
CO 3	15.7	12.3	8.7	10.0	11.7
SIA 5307	17.3	22.0	9.3	14.0	15.7
Arjuna	11.0	9.0	9.3	13.0	10.7
Mean	17.7	17.3	12.3	13.0	

	SEm ±	CD 5%
For comparing means of dates of sowing at varietal means	2.08	6.03
For comparing varietal means at the same date of sowing	2.11	5.92

4.2.3 Varieties x Nitrogen x Phosphorus: To study the response of three setaria entries of different crop periods and plant type (Jodhpur 11, SIA 36, and Arjuna) to different combinations of nitrogen (0, 20, 40 and 60 kg N/ha) and phosphorus (0 and 20 kg P_2O_5/ha), a trial was laidout during Kharif, 1981, in a split plot design with three replications. Varieties were kept in main plots, N-levels in sub plots and phosphorus levels in ultimate plots.

Half of the dose of nitrogen and the entire amount of P_2O_5 were applied at seeding. The remaining half of nitrogen was given at tillering.

Variety SIA 36 significantly outyielded the other entries under test (Jodhpur 11 and Arjuna) in grain yield. Arjuna, a tall thick stemmed variety recorded significantly higher straw yield (Table III.10). Though the length of earhead and number of branches per earhead recorded was more in Arjuna these characters did not contribute to grain yield as this cultivar recorded the lowest grain yield of all the varieties under test. In case of number of grains per earhead, SIA 36 recorded more and the same variety stood first in grain yield.

Significant increase in grain yield was observed by N-application only upto 40 kg N/ha, whereas significant increase in straw yield was observed upto 60 kg N/ha, the highest level tested. Though there was increase in number of grain per earhead upto 60 kg N/ha, the grain yield did not increase. This may be due to less productive shoots recorded at higher level of N tested.

Significant response for phosphorus was observed in case of grain yield and this was due to increase in grain number per earhead.

Genotype x fertilizer interaction was significant (Table III.11) in case of grains/earhead and grain yield (Table III.12).

4.2.4 Varieties x Spacing x N-levels: An experiment was conducted to determine the effect of inter row spacing at different fertility levels on improved setaria varieties. This trial was laid down in a split plot design with varieties as main plot treatments, spacings as sub plot treatments and N levels as ultimate plot treatments. The data on grain and straw yield and yield attributes was presented in Table III.13.

SIA 326 produced more grain yield which was significantly higher than Jodhpur 19. More grain yield in SIA 326 may be attributed to ear length, number of branches/earhead and number of grains/earhead. Though SIA 326 recorded less number of tillers, it recorded more straw yield because of more plant height.

Table III.10: Grain and Straw Yield and Yield Attributes as Affected by Varieties, Nitrogen and Phosphorus

Treatment	Tillers/m		Ear Length (cm)	Branches/ Earhead (No)	Grains/ Earhead (No)	Grain Yield (g/ha)	Straw Yield (g/ha)
	Total	Productive					
Varieties							
Jodhpur 11	56.3	52.0	8.5	26.7	254.2	10.9	19.8
SIA 36	50.0	47.0	9.7	49.3	529.3	12.1	26.2
Arjuna	50.0	47.0	10.5	59.2	370.4	9.7	31.4
SEm ±	2.64	2.57	0.15	0.93	1.01	0.04	0.03
CD 5%	-	-	0.58	3.63	3.97	-	0.11
N-Levels (kg N/ha)							
0	44.6	41.3	8.5	41.9	351.3	7.9	16.9
20	54.1	51.9	9.6	41.7	369.9	10.7	24.0
40	59.1	53.3	9.9	47.8	387.9	12.8	29.3
60	50.9	48.1	10.3	48.7	429.3	12.0	32.8
SEm ±	2.86	3.58	0.06	1.37	9.02	0.01	0.21
CD 5%	-	-	0.17	4.07	26.81	0.03	0.62
P-Levels (kg P_2O_5/ha)							
0	52.6	48.9	9.4	45.0	380.9	9.5	24.6
20	51.6	48.4	9.8	45.0	388.4	12.2	26.9
SE ±	1.96	1.68	0.10	0.61	3.24	0.01	0.02
CD 5%	-	-	0.30	-	-	0.02	-

Table III.11: Genotype x Nitrogen interaction on grain/earhead

Varieties	N-Levels (Kg N/ha)				Mean
	0	20	40	60	
Jodhpur 11	230	256	262	269	254
SIA 36	438	504	542	633	529
Arjuna	386	350	361	385	370
Mean	351	370	388	429	

	SEm ±	CD 5%
For comparing varietal means at the same level of N	19.17	56.96
For comparing N means at the varietal means	22.11	65.68

Table III.12: Genotype x Nitrogen Interaction on Setaria Yield (q/ha)

Varieties	N-Levels (Kg N/ha) 0	20	40	60	Mean
Jodhpur 11	8.7	11.3	12.7	10.7	10.9
SIA 36	8.3	12.7	14.3	13.0	12.1
Arjuna	6.7	8.3	11.3	12.0	9.6
Mean	7.9	10.8	12.8	11.9	

	SEm ±	CD 5%
For comparing varietal means at the same level of N	0.05	0.14
For comparing N means at the varietal means	0.05	0.16

Table III.13: Grain and Straw Yield and Yield Attributes as Affected by Varieties, Spacing and N-Levels

Treatment	Tillers'm Total	Tillers'm Productive	Ear Length (cm)	Branches/ Earhead (No)	Grains/ Earhead (No)	Grain Yield (q/ha)	Straw Yield (q/ha)
Varieties							
Jodhpur 19	49.3	45.9	8.5	27.2	296.3	21.7	26.4
SIA 326	44.2	41.9	11.7	59.4	777.4	27.7	42.5
SEm ±	1.0	0.96	0.67	1.58	14.78	0.64	1.28
CD 5%	-	-	1.41	6.81	89.96	3.90	7.80
Spacing (cm)							
20	49.0	46.2	10.7	41.5	593.4	29.3	39.2
25	48.6	45.7	10.0	43.7	545.3	24.2	34.5
30	42.7	39.7	9.7	44.6	471.9	20.2	29.7
SEm ±	1.92	1.92	0.26	1.97	16.50	1.11	1.92
CD 5%	-	-	-	-	53.81	3.61	5.53
Fertility Levels (Kg N/ha)							
0	40.6	37.9	9.4	38.6	478.1	16.1	19.8
30	47.3	45.0	10.2	43.8	551.0	24.8	36.3
60	52.4	48.8	10.7	47.5	581.5	32.8	47.2
SEm ±	1.19	1.06	0.20	1.57	10.54	1.36	1.36
CD 5%	3.12	3.08	0.59	6.78	30.77	3.97	3.97

Closer spacing gave higher grain and straw yield. More grain at higher plant population level may be due to more number of grains/ earhead.

N application increased the grain yield over its preceding N rate. Application of 30 and 60 Kg N/ha increased the grain yield over no nitrogen. Similar trend was observed in straw yield. The increased grain and straw yields by increased N-rates may be attributed to increase in ear length, number of branches and number of grains per earhead. Increased straw yield at higher level of N may be due to more tillering.

Genotype x Spacing and genotype x N interactions were significant on grain and straw yields respectively (Table III.14 and III.15).

Table III.14: Genotype x Spacing Interaction on Foxtail millet Yield (q/ha)

Variety	Spacing (cm)			Mean
	20	25	30	
Jodhpur 19	21.9	23.0	20.0	21.6
SIA 326	36.7	25.7	20.7	27.7
Mean	29.3	24.2	20.2	

	SEm ±	CD 5%
For comparing means of spacing at varietal means	0.05	0.15
For comparing means of varieties at the spacing	0.04	0.26

Table III.15: Genotype x N-level Interaction on Straw Yield (q/ha)

Variety	N - Levels (Kg N/ha)			Mean
	0	30	60	
Jodhpur 19	14.0	20.7	30.3	21.7
SIA 36	18.7	29.0	35.3	27.7
Mean	16.1	24.8	32.8	

	SEm ±	CD 5%
For comparing means of N levels at varietal means	0.08	0.24
For comparing varietal means at the same level of N	0.06	0.18

4.2.5 Bio-fertilization Trial: The experiment was laid out during Kharif, 1981 in a randomized block design with four replications. The treatments included inoculation with Azospirillum in the presence and absence of nitrogen. The test variety was Arjuna.

Nitrogen application proved to be beneficial to setaria. Inoculation with Azospirillum in the presence of nitrogen proved to be superior than N application alone in enhancing the yield attributes and grain and straw yields (Table III.16). Among the nitrogen levels, no significant difference in grain yield was observed. In case of straw yield N application increased the same.

Table III.16: Effect of Bio-fertilization on Foxtail millet

Treatment	Tillers/m Total	Tillers/m Productive	Ear Length (cm)	Branches/ Earhead (No)	Grains/ Earhead	Grain Yield (g/ha)	Straw Yield (g/ha)
Control	28.2	25.5	4.4	39.4	291	6.0	13.3
Azospirillum	27.8	28.0	4.9	37.7	297	8.0	17.0
10 Kg N/ha	36.5	32.2	7.5	50.1	380	11.0	25.0
20 Kg N/ha	40.5	37.5	8.2	51.9	432	13.1	35.0
10 Kg N/ha + Azo	37.7	36.5	8.5	52.5	429	14.3	37.7
20 Kg N/ha + Azo	41.0	40.0	8.7	55.1	450	18.0	43.0
SEm ±	1.4	1.5	0.4	1.2	35.0	1.1	2.7
CD 5%	4.3	4.6	1.2	3.5	105.6	3.2	8.1

5. PEST MANAGEMENT

5.1 Survey of Foxtail Millet Pests

5.1.1 Storage Pests: Some of the places in Kurnool, Anantapur, Cuddapah and Prakasam Districts were surveyed for the storage methods and storage pests.

In Kurnool District the villages Gadigarevula, Gadivemula, Nandikotkur, Atmakur, Koilkuntla, Amadala, Gulamnabipet, Banaganapalli, Owk, Kolimigundla, Donnagiri and Jaladurgam, and in Anantapur District, Raghavarajupalli, Nandipadu, Anantapur, Rekalagunta, Urvakonda, Pen Ahobilam, P. Kotha kota, Vazrakarur, Peravali and Thuggali were visited.

In all the above areas, foxtail millet is the main crop. The grain is stored in 'Gariselu' made of stone or "Gadelu" made of bamboo, or mud pots or gunny bags. No pest incidence was reported in storage in all these regions. When plenty of grain is available, it will be stored upto two years.

5.1.2 Field Pests: Field visits to Anantapur and Western parts of Kurnool District where vast areas of black soil were sown with foxtail millet were surveyed for pests. As rains were received throughout the Kharif period, the growth was very good. Unusually low to high incidence of armyworm damage was noted in some localities of Kurnool, Anantapur and Cuddapah. This is the first time that such an incidence of pest was noticed. At Anantapur 80 per cent of leaf area and some earheads were damaged. (Table III.17)

5.2 Screening

5.2.1 Coordinated Trial-13: Fifty entries were sown on 14-8-81. Each entry was sown in two rows of 3.75 meters length. Thinning was done on 25-8-81.

On 28th day, scoring for beetle incidence and shootfly incidence would have been done but for the continuous rains. In the early stage, no shootfly or borer incidence was noted. Even though the armyworm appeared by second week of September the beating rains controlled the pest and the damage done to the crop was below normal.

Table III.17: Insect Pest Survey on Foxtail Millets, Kharif, 1981

District	Village	Crop stage	Local/ improved	Name of the Pest	Pest Status/damage
Kurnool	Koilkuntla	Earhead	Improved	Leaf scraping beetle	Light
	Amadala	Earhead	Local	Chaetocnema sp.	Light
	Gulamnabipet	Earhead	Local	Armyworm (Mythimna sp)	Light
	Banaganapalli	Mid growth	Local	Armyworm (Mythimna sp)	Light
	Cwk	Mid growth	Local	Chaetocnema sp.	Light
	Kolimigundla	Mid growth	Local	Chaetocnema sp.	Light
	Jaladurgam	Earhead	Improved	Mythimna sp.	Light
	Jonnagiri	Earhead	Improved	Mythimna sp.	Medium
Anantapur	Rekalagunta	Earhead	Improved	Mythimna sp.	Very serious
	Uravakonda	Seedling	Local	Chaetocnema sp.	Light
	Penahobilam	Seedling	Local	Chaetocnema sp.	Light
	P.Kothakota	Mid growth	Local	Chaetocnema sp.	Light
	Vazrakarur	Mid growth	Local	Mythimna sp.	Light
	Peravali	Earhead	Local	Mythimna sp.	Light
	Thugoali	Earhead	Local	Mythimna sp.	Light

Note: In Anantapur and Kurnool Districts the incidence of armyworm was felt for the first time.

Table III.18: Pest Incidence on Foxtail Millets from Bangalore

Entry	Leaf Scraping by beetle	Leaf Roller	Earhead damage by armyworm	Yield (q/ha)
GS 13	2	-	-	10.
GS 55	4	1	2	8.
GS 64	4	-	1	19.
GS 84	1	-	-	13.
GS 95	1	1	1	12.
GS 158	5	-	2	15.
GS 176	2	1	-	15.
GS 180	3	-	2	9.7
GS 206	2	-	2	15.9
GS 260	2	1	2	15.1
GS 269	3	1	1	16.4
GS 296	2	1	2	12.8
GS 304	5	-	3	13.3
GS 324	4	-	1	18.5
GS 336	3	1	1	13.9
GS 347	4	-	2	11.3
GS 391	2	1	2	10.8
GS 386	4	2	3	12.3
GS 496	4	-	2	11.8
GS 504	5	1	3	11.8
GS 516	2	-	2	4.6
GS 540	1	-	1	6.2
GS 560	1	2	2	8.7
GS 568	1	-	1	12.8
GS 587	1	-	2	6.7
GS 620	1	3	3	4.6
GS 654	1	-	2	9.7
GS 655	1	-	1	6.1
GS 659	1	-	1	6.1
GS 675	1	-	-	4.6
GS 744	1	-	1	8.2
GS 964	1	1	1	4.1
GS 979	-	-	1	2.6
GS 1032	1	-	2	2.5
GS 1085	1	-	2	8.2
GS 1109	1	-	1	7.2
GS 1116	1	-	1	17.4
GS 1151	1	-	1	3.6
GS 1164	1	-	3	10.3
GS 1191	1	-	1	3.1
GS 1192	3	-	1	12.3
GS 1229	2	-	1	10.8
GS 1276	1	-	1	5.1
GS 1295	1	-	1	16.4
GS 1351	1	-	1	4.6
GS 1374	-	-	1	18.0
GS 1384	1	1	2	18.9
GS 1400	1	-	1	11.8
GS 1412	2	-	3	6.7
GS 1417	5	1	2	9.3
N 1	2	-	3	17.9
Arjuna	2	1	1	12.8

The leaf roller appeared for the first time in Kharif season. Out of 52 entries, 14 entries had leaf roller incidence of 10 to 20 per cent. Leaf scraping incidence was below 10 per cent in 26 entries. In the remaining entries, the incidence was above normal. Armyworm incidence and its damage was below normal. No damage was observed in GS 13, 84, 176 and 675. Stemborer incidence was however noticed in these entries. GS 1374 with erect and narrow leaf character had no leaf scraping incidence and leaf roller. Maximum yields were harvested in GS 64, 324, 1374 and 1384.

5.2.2 Advanced Yield Trial-I (State): A total of 26 entries were sown alongwith Arjuna and N 1 on 12-8-81. These were sown in a randomised block design replicated four times in plots of 3.75 x 2.65 sq.m. by the Breeder. Due to continuous rains the pest incidence was low. Even then, armyworm appeared with less virulence. Three replications were protected while the fourth replication was left without protection.

Table III.19: Advance Yield Trial: Pest Occurrence

Entry	Leaf Scraping (Score)	Armyworm Damage to Ear	
		Protected	Unprotected
SIA 5	1	1.0	2
SIA 17	1	1.0	2
SIA 36	1	1.0	1
SIA 67	2	1.0	2
SIA 242	2	1.0	2
SIA 326	1	1.0	2
SIA 341	1	1.0	1
SIA 395	1	1.0	2
SIA 805	2	1.0	1
SIA 1062	1	1.0	2
SIA 1085	1	1.0	2
SIA 1135	1	1.0	2
SIA 1142	1	1.0	2
SIA 1162	1	1.0	2
SIA 1171	1	1.0	2
SIA 1253	1	1.0	3
SIA 1842	1	-	1
SIA 1931	1	0.3	2
SIA 2134	2	1.3	2
ISe 377	1	1.0	3
GK 22	2	1.0	2
K 2	1	1.0	2
P No 563	1	-	0
P No 764	1	1.0	2
P No 765	1	1.0	2
P No 768	1	-	1
N 1	1	1.6	2
Arjuna	2	1.0	2

The pest pressure was low but the maximum incidence was upto 30 per cent (Table III.19). P No 563 recorded no army worm incidence. The grain yield varied from 9.4 to 28.1 q/ha in unprotected to 22.1 to 39.8 q/ha in protected plots.

5.2.3 State Level Coordinated Trial: Selected entries were sown on 12-8-81 in a randomised block replicated four times. Leaf scraping beetle and armyworm were noted.

Table III.20: Scoring for Pests in State Trial

Entry	Leaf Scraping (Score)	Armyworm damage to earhead	
		Protected	Unprotected
288 A	1.6	1.3	2.0
410 B	1.3	1.3	2.0
SIA 377	2.0	2.3	3.0
SIA 67	1.6	1.3	2.0
SIA 242	2.3	1.3	2.0
SIA 326	2.3	1.0	2.0
SIA 395	1.3	1.6	3.0
SIA 1135	1.3	1.6	2.0
SIA 1253	1.3	1.3	3.0
SIA 1842	1.3	1.3	2.0
N 1	2.0	2.0	2.0
Arjuna	2.0	2.0	3.0

The leaf scraping incidence was less (Table III.20). Armyworm incidence was slightly above control with 2.3 in the entry SIA 377. Under unprotected conditions, SIA 377, 395 and 1253 showed as much susceptibility as the Arjuna. The remaining eight entries were having less than 20 per cent incidence.

5.2.4 Coordinated Yield Trial of Nandyal Varieties: A total of 13 entries were sown on 12-8-81 and replicated three times. All the 13 entries had low leaf scraping damage than Arjuna (Table III.21). Eleven were also having low earhead damage. SIA 395, 805, 1842 and ISe 377 had the lowest scoring of 1.0.

Table III.21: Pest Incidence in Nandyal Varieties

Entry	Leaf Scraping (Score)	Armyworm damage to earhead
SIA 36	1.0	2.0
SIA 67	1.0	1.6
SIA 242	1.0	1.6
SIA 326	1.0	1.6
SIA 395	1.3	1.0
SIA 805	1.3	1.0
SIA 1062	1.3	1.3
SIA 1135	1.0	2.3
SIA 1142	1.6	2.3
SIA 1253	1.3	1.3
SIA 1842	1.3	1.0
SIA 22	1.6	2.0
ISe 377	1.3	1.0
Arjuna	2.3	2.3

5.2.5 Initial Evaluation Trial: 36 M_3 lines which gave better yields were sown in a randomised block design replicated four times. As the leaf scraping incidence was very low, earhead damage was scored. Twenty entries recorded less damage (Table III.22).

Table III.22: Earhead Damage in Irradiated Progenies

Progeny	Armyworm Damage to Earhead
ISe 119 20 Kr 1	1.6
-do- 4	2.3
-do- 12	1.0
-do- 14	1.0
-do- 22	1.6
-do- 26	1.3
-do- 27	1.3
-do- 31	1.0
-do- 32	1.0
-do- 39	1.6
-do- 42	1.0
-do- 43	1.0
-do- 44	1.3
-do- 47	1.0
-do- 50	1.0
-do- 53	1.00
-do- 54	1.0
-do- 57	1.0

Contd..

Table III.22 : Contd..

Progeny	Armyworm Damage to Earhead
ISe 119 20 Kr 64	1.6
-do- 167	1.0
-do- 227	1.3
-do- 363	1.0
Arjuna 40 Kr 1	1.0
-do- 10	1.0
-do- 12	2.0
-do- 13	2.0
-do- 15	1.0
-do- 17	1.0
-do- 20	1.0
-do- 26	1.6
-do- 28	1.6
-do- 44	1.6
N 1 60 Kr 15	1.0
-do- 17	1.0
ISe 119 Control	1.0
Arjuna	1.6
N 1	1.0

5.2.6 Coordinated Advanced Setaria Trial XII & XIII: The Coordinator has supplied 17 entries plus Arjuna to take up the trial. The trial was sown on 12-8-81 in a randomised design replicated thrice. All the entries fared better than the control Arjuna (Table III.23).

5.2.7 Multilocation Trial: About 38 entries supplied by the Coordinator were sown on 12-8-81 in a randomised block design replicated twice. The plot size was 3.75 x 2.12 sq.m. As the leaf scraping incidence was negligible, earhead damage was scored (Table III.24).

Out of 37 entries, 21 entries had low earhead damage compared to control Arjuna. Entries 521, 1298, 563, 592 had more damage with 2.5 score as compared to Arjuna.

Table III.23: Pest Incidence in Coordinated Entries

Entry	Leaf Scraping	Earhead Damage by Armyworm
VL 16	1.3	1.0
VL 17	1.0	1.0
ITS 2	1.3	1.0
ITS 25	1.3	1.0
ITS 60	2.0	1.0
AS 2	1.3	1.6
SIC 1	1.6	1.0
SIC 2	1.0	2.0
SIC 3	1.0	1.0
SIC 4	1.6	1.0
SIC 5	1.6	2.0
SIC 6	1.0	2.0
SIC 7	1.3	1.0
S 46	1.6	1.0
AS 1	1.3	1.0
ITS 69	1.0	1.3
CO 3	1.6	1.3
Arjuna	2.3	2.6

Table III.24: Screening for Armyworm Damage in Multilocation Trial

Entry	Score for earhead damage	Entry	Score for earhead damage
464 80 K	1.0	1354 80 K	1.0
473 "	1.0	1357 "	1.0
513 "	1.5	1363 "	1.0
521 "	2.5	1373 "	2.0
1051 "	1.5	1402 "	1.0
1294 "	1.0	1470 "	1.0
1296 "	1.0	2875 "	1.0
1298 "	2.5	2879 "	2.0
1309 "	1.0	2884 "	1.0
1312 "	2.0	2885 "	1.0
1327 "	1.0	300 79 K	1.5
1328 "	2.0	548 "	1.0
1329 "	1.0	563 "	2.5
1331 "	2.0	592 "	2.5
1334 "	1.0	685 "	1.5
1337 "	1.0	764 "	2.0
1339 "	2.0	765 "	1.0
1349 "	1.0	SE 21-1	1.0
1352 "	2.0	Arjuna	2.0

5.2.8 Rescreening: 31 entries which showed some tolerance either to leaf scraping beetle or armyworm were sown in a non-replicated two row trial on 14-8-81.

Table III.25: Rescreening for Pest Incidence in Foxtail Millet

Entry	Leaf Scraping	Leaf Roller	Army-worm	Remarks
ISe 84 A	1	2	1	
ISe 90 K	3	0	1	Stemborer
ISe 174 AK	0	0	1	
ISe 176	0	1	1	
ISe 183	3	0	1	
ISe 186 A	1	2	1	Early
ISe 196 K	1	0	1	Early
ISe 202	2	2	1	
ISe 206	0	1	1	
SIA 330	2	0	2	
SIA 588	1	0	1	
SIA 589	1	0	1	
SIA 695	1	0	2	
SIA 698	2	0	3	
SIA 1214	0	0	2	
SIA 2250	0	0	1	Erect leaf
Poona 563	2	0	2	Erect leaf
Poona 652	0	0	2	Stem erect
Poona 675	1	0	0	
Poona 699	1	1	2	
Poona 765	1	0	0	
SIA 2437	1	0	0	
SIA 1842	0	0	0	
SIA 2134	2	0	0	
ISe 119 20Kr-17	1	0	1	Broad leaf
-do- 29	1	1	0	Broad leaf
-do- 76	1	1	1	Narrow leaf
-do- 461	1	0	0	
Arjuna 40 Kr 31	1	0	2	Tillering
-do- 315	1	0	1	Narrow leaf
N 1	2	0	2	
Arjuna	2	1	2	
119	3	1	2	

Except ISe 90K, 183 and 698, all the entries fared well during this season also confirming last year's results of their tolerance to the leaf scraping beetle and armyworm (Table III.25).

5.3 Date of Sowing Vs Pest Incidence: The first sowing on 14-8-81 in a low level area failed to grow. Leaf scraping beetle was observed on second sowing (12-10-81). The final sowing was done on 20-11-81. The plants were sick and stunted, and mite population was observed.

5.4 Estimation of Losses in Rural Storage: Foxtail millet grains are stored in big bamboo baskets or stone chambers or gunny bags in and around Kurnool and Anantapur Districts. However, no storage pest was observed. At the Research Station, the grain was stored since April, 1980. So far no insect damage was observed.

6. DISEASE MANAGEMENT

6.1 Screening of Local Collections

A total of 2547 collections were raised in single rows of 2.0 meters length on 14-8-81. Heavy rains were received in the early stage of the crop due to which thinning could not be taken up.

The blast incidence was heavy in the early stages of the crop upto 30 days after sowing. The incidence ranged from 10 to 50 per cent. Downy mildew was also observed to some extent in the vegetative stage of the crop (upto 5 per cent). Rust appeared at later stages of the crop. Rust was recorded in the first week of November. The incidence ranged from 25 to 75 per cent. In some entries, 100 per cent incidence was observed. Fourteen entries had shown less than 25 per cent incidence. They are SIA 1369, 1379, 1413, 1469, 1470, 1471, 1474, 1475, 1568, 1569, 1715, 1835, 1824, 2546. Smut did not appear.

6.2 Screening of Germplasm

A total of 1386 entries were raised in single rows of 2.0 meters length on 14-8-81. All the entries were screened for blast, downy mildew, rust and smut. Heavy rains were received in the early stages of the crop, and no thinning was done.

Blast incidence was heavy till 30 days after sowing. The incidence ranged from 10 to 25 per cent. Downy mildew observed in very few plants, was negligible. Rust appeared 78 days after sowing (towards the end of October, 1981). The incidence was observed in all entries with the disease intensity ranging from 10 to 50 per cent.

6.3 Yield Trials

6.3.1 Advanced Yield Trial: Twenty six promising lines were sown along with Arjuna and N 1 as checks on 12-8-1981 by the Breeder. These were sown in a randomised block design replicated four times in plots of 3.75 x 2.65 sq.m. Blast appeared in the early stages of the crop due to heavy rains. The incidence was moderate (Table III.26). In the later stages of the crop, rust was observed in all entries but the intensity was less.

Table III.26: Disease Incidence in Breeder's Advanced Yield Trial

Entry	Blast*	Downy Mildew	Rust	Smut
SIA 5	2	2	2	2
SIA 17	2	2	2	2
SIA 36	3	2	3	2
SIA 67	2	2	2	2
SIA 242	3	2	2	2
SIA 326	3	2	2	2
SIA 341	3	2	3	2
SIA 395	3	2	2	2
SIA 805	2	2	2	2
SIA 1062	2	2	2	2
SIA 1085	3	2	2	2
SIA 1135	2	2	3	2
SIA 1142	2	2	2	2
SIA 1162	2	2	3	2
SIA 117	3	2	2	2
SIA 1253	2	2	3	2
SIA 1842	2	2	2	2
SIA 1931	2	2	2	2
SIA 2134	2	2	2	2
ISe 377	3	2	2	2
GK 22	3	2	2	2
K 2	3	2	2	2
P No 563	3	2	2	2
P No 764	2	2	2	2
P No 765	2	2	2	2
P No 768	2	2	2	2
N 1	2	2	2	2
Arjuna	3	2	2	2

Blast and Rust:

1. No infection.
2. Few scattered spots/pustules.
3. Spots/Pustules covering upto 10% of leaf area.
4. Spots/Pustules covering upto 25% of leaf area.
5. Spots/Pustules covering upto 50% of leaf area.
6. Spots/Pustules covering above 50% of leaf area.

Downy Mildew:

1. No infection.
2. Few scattered plants.
3. Infected plants upto 10%.
4. Infected plants upto 25%.
5. Infected plants upto 50%.
6. Infected plants above 50%.

Smut:

1. No infection.
2. Few scattered smutted grains in the earhead.
3. Smutted grains covering upto 10% of earhead.
4. Smutted grains covering upto 25% of earhead.
5. Smutted grains covering upto 50% of earhead.
6. Smutted grains covering above 50% of earhead.

All entries were equally susceptible to blast. Twelve of the 28 entries recorded the blast incidence over 10 per cent while the rest of the entries recorded less than 10 per cent.

Downy mildew incidence was observed in all the 28 entries. The disease incidence was low, less than 10 per cent. Green ears were seen in very few plants scattered in the field.

Rust incidence was observed in the later stages of the crop. The disease was recorded in all the entries under test. The intensity in 5 entries was more than 10 per cent.

Very low incidence of smut was observed in all entries. Few grains in the earhead were converted into smut sori.

6.3.2 Advanced Entries: Sixteen promising lines along with Arjuna and N 1 as controls were sown on 12-8-81. Blast and downy mildew were recorded on 14-9-81, and rust and smut on 2-11-81. No plant protection measures were undertaken.

Table III.27: Disease Incidence in Advanced Setaria Entries

Entry	Blast	Downy Mildew	Rust	Smut
SIA 36	3	2	3	2
SIA 67	3	2	3	2
SIA 242	3	2	3	2
SIA 326	3	2	4	2
SIA 395	3	2	3	1
SIA 805	3	2	3	2
SIA 1062	3	2	3	2
SIA 1135	3	2	4	2
SIA 1142	3	2	3	2
SIA 1253	3	3	3	2
SIA 1842	3	2	3	1
ISe 377	3	2	3	2
ISe 288 A	3	2	3	2
ISe 410 B	3	2	3	2
GK 20	3	2	3	2
GK 22	3	2	3	2
N 1	3	2	3	2
Arjuna	3	2	4	2

All the 18 entries tested were susceptible to blast, and downy mildew (Table III.27). The incidence of blast was above 10 per cent in all the entries. Downy mildew incidence was less than 10 per cent in all except SIA 1253. Rust was observed in all entries and the heavey incidence (25 per cent and above) was recorded in SIA 326, SIA 1135 and Arjuna, while in others the incidence ranged between 10 and 25 per cent. Smut incidence was observed on a mild scale in all except SIA 395 and SIA 1842.

6.3.3 Initial Evalution Trial: A total of 34 entries with ISe 119, N 1 and Arjuna as checks were sown on 12-8-81. Disease incidence was recorded on two days, 15-9-81 and 3-11-81.

Table III.28: Disease Incidence in Initial Evaluation Trial

Entry	Blast	Downy Mildew	Rust	Smut
ISe 119, 20 Kr 1	3	2	3	1
" 4	2	2	3	1
" 12	2	1	3	1
" 14	3	2	3	1
" 22	3	2	3	1
" 26	3	1	3	1
" 27	3	1	3	1
" 31	2	2	3	1
" 32	2	2	3	1
" 39	2	1	3	1
" 42	3	1	3	1
" 43	2	2	3	1
" 44	3	1	3	1
" 47	2	2	3	1
" 50	3	2	3	1
" 53	4	2	3	1
" 54	3	2	3	1
" 57	3	2	3	1
" 64	3	2	3	1
" 167	2	1	3	1
" 227	3	2	3	1
" 363	2	1	3	1
Arjuna 40 Kr 1	3	1	3	1
" 10	3	2	3	1
" 12	2	1	3	1
" 13	2	2	3	1
" 15	3	1	3	1
" 17	3	1	3	1
" 20	3	2	3	1
" 26	3	1	3	1
" 28	3	2	3	1
" 44	2	1	3	1
N 1 60 Kr 15	3	2	3	1
" 17	3	1	3	1
ISe 119 (control)	3	2	3	1
Arjuna (Control)	3	2	3	1
N 1 (Control	3	1	3	1

All the 37 entries were susceptible to blast. Maximum incidence of 25 per cent was recorded in ISe 119, 20 Kr-53, while it ranged from 1 to 25 per cent. Very low incidence of downy mildew was recorded in 22 entries, while the rest of 15 entries were free from the diseases.

Rust incidence was observed in all the 37 entries on a moderate scale. The disease intensity was more than 10 per cent.

All the entries were free from smut.

3.3.4 Multilocation Trial: A total of 37 entries with Arjuna as control were sown on 12-8-81. The disease incidence was taken on two days, on 15-9-81 for blast and downy mildew, and on 3-11-81 for rust and smut.

Table III.29: Disease Incidence in Multilocation Trial

Entry	Blast	Downy Mildew	Rust	Smut
464 80K	3	2	3	1
473 80K	2	1	3	1
513 80K	3	1	3	1
521 80K	2	2	3	1
1051 80K	2	2	3	1
1294 80K	3	2	3	1
1296 80K	2	1	3	1
1298 80K	2	1	3	1
1309 80K	2	2	3	1
1312 80K	2	1	3	1
1327 80K	3	1	3	1
1328 80K	2	2	3	1
1329 80K	2	1	3	1
1331 80K	2	1	4	1
1334 80K	2	2	3	1
1337 80K	2	1	3	1
1339 80K	3	1	3	1
1349 80K	3	1	4	1
1352 80K	2	1	3	1
1354 80K	2	1	3	1
1357 80K	3	2	3	1
1363 80K	2	1	4	1
1373 80K	2	1	3	1
1402 80K	2	1	3	1
1470 80K	3	1	3	1
2875 80K	3	1	3	1
2879 80K	2	2	3	1
2884 80K	2	2	3	1
2885 80K	2	1	3	1
300 79K	2	1	3	1
548 79K	2	1	3	1
563 79K	3	1	3	1
592 79K	2	2	3	1
685 79K	2	2	3	1
764 79K	3	1	3	1
765 79K	2	1	3	1
SE 21-1	2	1	3	1
Arjuna	2	1	3	1

All the 38 entries were susceptible to blast, but the incidence was more than 10 per cent in eleven. (Table III.29).

Downy mildew incidence was low in 12 entries, while the rest of 26 entries including Arjuna were free from the disease.

Rust was observed in all the 38 entries on a moderate scale, more than 25 per cent in 3 entries (1331-80K, 1349-80K and 1363-80K).

All the entries were free from smut incidence.

6.3.5 Coordinated Advanced Setaria Trial XII & XIII: Eighteen entries supplied by the Project Coordinator were sown on 12-8-81 in a randomised block design replicated thrice. The disease incidence was recorded on 16-9-81 for blast and downy mildew and on 4-11-81 for rust and smut.

Table III.30: Disease Incidence in Coordinated Advanced Setaria Trial

Entry	Blast	Downy Mildew	Rust	Smut
VL 16	3	2	4	1
VL 17	3	2	3	1
ITS 2	3	2	3	1
ITS 25	2	1	2	1
ITS 60	3	1	3	1
AS 2	3	1	3	1
SIC 3	3	2	3	1
SIC 4	3	2	3	1
SIC 5	3	1	3	1
SIC 6	3	2	3	1
SIC 7	3	1	3	1
S 46	3	1	3	1
AS 1	2	2	3	1
ITS 69	3	1	2	1
SIC 1	3	1	3	1
SIC 2	3	1	3	1
CO 3	2	1	2	1
Arjuna	3	2	4	1

All the 18 entries were susceptible to blast (Table III.30). The incidence was low in 3 entries, ITS 25, AS 1 and CO 3.

Downy mildew was observed in 8 entries with low intensity. The rest of the 10 entries were free from the disease.

All the 18 entries were susceptible to rust. The incidence was more (25% above) in VL 16 and Arjuna and less (less than 10%) in ITS 25, ITS 69 and CO 3. The incidence in other entries ranged between 10 and 25 per cent.

All the eighteen entries were free from smut incidence.

6.3.6 Setaria Yield Trial XII & XIII (A): Fourteen entries supplied by the Project Coordinator were sown on 12-8-81 in a randomised block design with 3 replications. The disease incidence was recorded for blast and downy mildew on 16-9-81, and for rust and smut on 4-11-81.

Table III.31: Disease Incidence in Setaria Yield Trial

Entry	Blst	Downy Mildew	Rust	Smut
SIA 36	3	2	3	1
SIA 67	3	2	3	1
SIA 242	3	2	3	1
SIA 326	3	2	3	2
SIA 395	3	2	2	1
SIA 805	3	2	3	1
SIA 1062	3	2	3	1
SIA 1135	3	2	3	1
SIA 1142	3	2	3	1
SIA 1253	3	2	3	2
SIA 1842	3	2	2	1
GK 22	3	2	3	2
ISe 377	3	2	3	2
Arjuna	3	2	3	1

All the 14 entries tested were moderately susceptible to blast (Table III.31). The incidence was more than 10 per cent.

Low incidence of downy mildew (less than 10%) was recorded in all the entries.

All the 14 entries were susceptible to rust. The incidence was low in SIA 395 and SIA 1842, while the rest recorded more than 10 per cent disease.

Except for four entries, SIA 326, SIA 1253, GK 22 and ISe 377, all were free from smut incidence.

6.3.7 State Level Coordinated Trial: A total of ten entries with Arjuna and N 1 as checks were sown on 12-8-81. The disease incidence was recorded on 16-9-81 for blast and downy mildew, and on 4-11-81 for rust and smut.

Table III.32: Disease Incidence in State Level Coordinated Trial

Entry	Blast	Downy Mildew	Rust	Smut
288 A	3	1	3	1
410 B	3	1	3	1
GK 22	3	1	3	1
SIA 67	2	1	3	1
SIA 242	3	1	3	1
SIA 326	2	1	3	1
SIA 395	3	1	3	1
SIA 1135	2	1	3	1
SIA 1253	2	1	3	1
SIA 1842	2	1	3	1
N 1	3	1	3	1
Arjuna	2	1	3	1

All the twelve entries were susceptible for blast (Table III.32). The incidence was more than 10 per cent in six entries, and less in others.

Downy mildew was absent in all twelve entries.

Rust was observed in all the entries and the incidence was more than 10 per cent.

All the entries were free from smut incidence.

6.3.8 Screening of Selected Germplasm: Fifty entries supplied by the Associate Coordinator were sown in two rows each of 3.75 m length on 14-8-81 with Arjuna and N 1 as checks. Thinning was done on 25-8-81. On 30th day, observations on blast and downy mildew, and on 70th day on rust and smut were taken.

Table III.33: Screening of Selected Foxtail Millets

Entry	Blast	Downy Mildew	Rust	Smut
GS 13	2	1	3	1
GS 55	2	1	3	1
GS 64	2	2	3	1
GS 84	2	2	3	1
GS 95	2	2	3	1
GS 158	2	2	4	1
GS 176	2	2	4	1
GS 180	2	2	3	1
GS 206	2	2	3	1
GS 260	2	2	3	1
GS 269	2	2	3	1
GS 296	2	1	3	1
GS 304	2	1	3	1
GS 324	3	2	3	1
GS 336	3	2	4	1
GS 347	3	2	4	1
GS 391	3	2	4	1
GS 436	2	2	3	1
GS 496	3	2	3	1
GS 504	3	2	4	1
GS 516	2	2	3	1
GS 540	2	1	3	1
GS 560	2	2	3	1
GS 568	2	2	3	1
GS 587	2	1	3	1
GS 620	2	2	3	1
GS 654	2	2	3	1
GS 655	2	2	3	1
GS 659	2	2	3	1
GS 675	3	2	3	1
GS 744	2	2	3	1
GS 964	2	2	3	1
GS 979	3	2	3	1
GS 1032	4	2	4	1
GS 1085	3	2	3	1
GS 1109	4	2	4	1
GS 1116	3	2	3	1
GS 1155	3	2	3	1
GS 1164	3	2	3	1
GS 1191	4	2	4	1
GS 1192	3	2	3	1
GS 1229	3	2	4	1
GS 1276	4	3	3	1
GS 1295	3	2	3	1
GS 1351	4	3	4	1
GS 1375	3	2	3	1
GS 1384	3	2	3	1
GS 1400	2	2	3	1
GS 1412	2	2	3	1
GS 1417	2	2	3	1
Arjuna	2	2	3	1
N 1	3	2	3	1

All the entries were susceptible to blast and rust (Table III.33). Blast incidence was low to moderate except in 5 entries, (GS 1032, 1109, 1191, 1276 and 1351) Rust incidence was moderate to high, while downy mildew was low in all entries. None of the entries are susceptible to smut.

6.3.9 Field Screening during Summer, 1981: Twenty six entries which were in advanced stages were tested for the incidence of blast, downy mildew, rust, smut and viral streak during summer 1981.

All the 26 entries were free from blast, rust and smut diseases. Downy mildew was observed to a moderate level in all the entries. Viral streak was observed in few plants viz., SIA 5, SIA 17, SIA 242, SIA 395, SIA 1142, SIA 1842, SIA 2134, ISe 377 and GK 22. The incidennce of downy mildew is given in Table III.34.

Table III.34: Occurrence of Downy Mildew in Summer Foxtail Millet

Entry	Grade	Entry	Grade
SIA 5	3	SIA 1253	3
SIA 17	2	SIA 1842	3
SIA 36	2	SIA 1931	3
SIA 67	2	SIA 2134	3
SIA 242	3	ISe 377	3
SIA 326	2	GK 22	3
SIA 341	3	K 2	2
SIA 395	3	P No 563	3
SIA 1085	3	P No 764	3
SIA 1132	3	P No 765	3
SIA 1142	3	P No 768	3
SIA 1162	3	N 1	3
SIA 1171	3	Arjuna	3

6.4 Survey of Losses Caused by Diseases

During 1981-82, some places in Kurnool and Anantapur districts and Alampur taluk of Mahaboobnagar were surveyed for disease incidence on millet crops particularly foxtail millet. Details are given under 5.1.

Moderate incidence of rust was noted in some localities of Kurnool and Anantapur districts. Downy mildew incidence was negligible in almost all areas.

7. HIGHLIGHTS OF RESEARCH

7.1 Genetic Resources

3870 collections were planted, but could not be evaluated due to unfavourable weather conditions.

7.2 Varietal Improvement

The superiority of SIA 326 was confirmed.

New promising selections (SIA 1062, SIA 1253, SIA 1842) were identified. Two promising progenies (ISE 119-64; ISE 119-363) were also isolated from irradiated ISE 119.

7.3 Management of Inputs

Early sowing in the first fortnight of July had given higher grain yield. SIA 326 planted on July 8 gave 26 q/ha as compared to 11 q/ha of Arjuna. Closer (20 cm) row to row spacing gave significantly higher yields under rainfed and irrigated conditions.

Significant response to nitrogen application upto 60 kg N/ha under rainfed, and upto 100 kg N/ha under irrigated conditions was observed. The response was 27.9 kg grain/ kg N at 60 kg N/ha under rainfed conditions. Phosphorous application upto 20 kg/ha also increased grain yields.

Azospirillum increased grain yields with and without nitrogen. The response was better with added nitrogen. Azospirillum increased grain yield by 2, 3.3 and 4.9 q/ha with 0 (6 q/ha), 10 (11 q/ha) and 20 (13.1 q/ha) kg N/ha.

7.4 Pest Management

Rescreening revealed that SIA 1842 was completely free from armyworm, leaf scraping beetles and leaf rollers. Besides, ISE 174 AK, SIA 1214, SIA 2250 and Pune 652 were free from leaf scraping beetles and leaf rollers.

Foxtail millet grains stored in bamboo baskets, gunny bags or stone chambers were free from all stored grain pests.

7.5 Disease Management

Foxtail millet was susceptible to blast, downy mildew, rust and smut. None of the cultures screened were free from all the diseases.

CHAPTER IV

LITTLE MILLET- PANICUM MILIARE LAM

1. INTRODUCTION

1.1 General

The Little Millet Improvement Centre was established during January, 1979 at Regional Research Station, Semiliguda. The staff under this scheme were only posted from September, 1981 onwards. Till then one Senior Research Assistant was managing the scheme with the supporting assistance of Orissa Agricultural Development Project Specialists. During the year under report, four breeding trials, three agronomical and three entomological trials were conducted.

1.2 Location

The Research Station is situated at 18.20° N and 82.30° E in the district of Koraput in Orissa. It is located at an altitude of 884 m above mean sea level. There are five hillocks and two jholas (low land). There are several gullies which originate from the hills and terminate in a rivulet called "Golgadda". The gullies are filled with water only during rainy days and dry up as soon as the rain stops. The nearby Minor Irrigation Project is having its left side canal to a length of 1500 m inside the Research Station having an ayacut area of about 40 hectares. The irrigation water is available from October to February. Therefore, the Research Station is fully dependant on rainfall.

1.3 The Soil

The soil of the farm are red with sandy-loam to sandy-clay-loam in texture. The pH varies from 5.0 - 6.3. It is poor in basic cations and soluble salt contents, whereas it is rich in oxides of iron and aluminium. It is deficient in nitrogenous phosphates.

1.4 Weather

The weather data for 1981-82 is presented in the Table IV.1.

Table IV.1: Weather at Semiliguda, 1981-82

Met. Week	Dates		Rainfall (mm)	Rainy Days	Temperature (oC)		Humidity (%)	
					Min	Max	Min	Max
22	May-June	28-3	66.9	4	16.3	32.8	48.3	78.3
23	June	4-10	71.6	2	17.9	31.4	48.1	76.9
24	June	11-17	46.8	3	17.1	32.2	47.3	86.3
25	June	18-24	11.6	5	16.7	27.4	65.6	85.1
26	June-July	25-1	50.6	7	16.0	25.3	77.0	90.7
27	July	2-8	23.3	7	16.3	24.6	80.4	90.1
28	July	9-15	97.4	7	17.2	24.6	75.1	90.3
29	July	16-22	30.1	6	16.4	26.8	74.4	91.1
30	July	23-29	22.9	4	16.6	27.3	73.4	93.3
31	July-August	30-5	51.4	7	16.3	26.3	80.3	92.6
32	August	6-12	128.2	5	15.8	23.8	78.9	90.4
33	August	13-19	44.2	6	16.0	24.7	74.7	92.1
34	August	20-26	46.6	5	15.7	26.6	75.6	91.4
35	Aug.-Sept.	27-2	48.7	6	15.3	27.0	76.1	93.7
36	Sept.	3-9	52.3	2	15.5	26.8	75.1	92.4
37	Sept.	10-16	138.3	5	14.2	26.9	70.4	93.1
38	Sept.	17-23	53.9	5	15.4	26.6	69.7	88.0
39	Sept.	24-30	50.5	6	15.9	26.5	72.2	92.1
40	October	1-7	-	0	13.9	28.5	55.4	91.5
41	October	8-14	-	0	9.5	27.3	39.4	87.7
42	October	15-21	-	0	8.5	28.7	39.4	88.3
43	October	22-28	-	0	11.7	28.4	43.1	87.7
44	Oct.-Nov.	29-4	-	0	11.3	28.5	39.4	86.7

1.5 Minor Millets in Orissa

Minor millets form the staple food of larger section of the tribal and hilly people. They are cultivated in plains and slopes under purely rainfed conditions. They are cultivated mainly during Kharif, and to a limited extent in rabi season. So, minor millet crops need to be evaluated both in the plains (with water stress condition), and in hilly slopes. Crop at different altitudes differs in duration.

The minor millets occupy an area of 2,08,502 hectares in the State of Orissa (Table IV.2).

Table IV.2: Minor millets in Orissa*

District	Area (Hectares)	Production (Tonnes)	Yield (q/ha)
Balasore	189	80	4.2
Bolangir	23388	5698	2.4
Cuttack	909	455	5.0
Dhenkanal	17824	2964	1.7
Ganjam	6494	3613	5.6
Kalahandi	57246	15795	2.8
Keonjhar	3137	627	2.0
Koraput	59009	21774	3.7
Mayurbhanj	5616	2247	4.0
Phulbani	15949	2392	1.5
Puri	748	224	3.0
Sambalpur	17993	7823	4.3
Sundargarh	-	-	-
Total	208502	63692	3.1

* Source: Orissa Agricultural Statistics, 1979-80.

The tribal and hilly people are cultivating a variety of species and cultivars of different minor millets under varied agroclimatic conditions. Depending upon their needs, these are sown as pre-monsoon, monsoon and post-monsoon crops, with a view to mitigate the acute food shortage faced from time to time by them. The minor millets are either raised as pure or mixed with sorghum, maize, other millets and pulses. These crops are drought resistant, suited for the worst soil conditions and of short duration. For this reason the tribal people do not want to leave these crops at all even though their yields are low. Hence, minor millets require immediate research and development to improve the productivity and production.

2. VARIETAL IMPROVEMENT

2.1 Evaluation Trial

The performance of 7 advanced entries was evaluated in a randomised block design replicated three times. Two checks Koraput Local and K 2 were also included. The plot size was 3.75 m x 2.75 m

and was fertilized with 30 Kg N, 15 Kg P_2O_5 and 15 Kg K_2O/ha. The crop was planted on 22-6-81. The yield levels were low (Table IV.3) Dindori-1 outyielding all other entries. Very early or very late varieties were performing better than mid maturing genotypes, indicating the necessity to relate growth to weather.

Table IV.3: Performance of Selected Little Millets

Entry	Tillers No.		Height (cm)	Days to		Panicle Length (cm)	Yield (q/ha)
	Basal	Effective		50% Flowering	Maturity		
CO 2	1.4	1.9	84.3	63	92	23.0	0.7
Umaria	2.2	3.5	68.2	43	73	17.9	2.8
Dindori 1	2.5	4.3	62.0	43	73	17.1	3.2
Guldi 3	1.5	2.1	75.3	45	82	21.4	2.5
Girijabund	1.3	2.5	73.7	44	81	18.9	1.3
RPM 8-1	1.1	1.9	67.9	47	80	17.1	1.0
RPM 124	1.3	2.2	65.9	44	84	20.5	1.7
Koraput Local	2.3	4.3	58.2	43	72	17.3	2.8
K 2 (Check)	1.4	1.9	72.7	104	145	20.1	2.4

3. MANAGEMENT OF INPUTS

3.1 Effect of Date of Sowing

The experiment was conducted during kharif, 1981 in a randomized block design with seven replications to findout the suitable date for sowing of P.miliare. The test variety was Koraput Local. The sowing was done on 8-6-81, 18-6-81 and 2-7-81 in 10 m x 8 m plots. The fertilizer was applied @ N-30, P_2O_5-15 and K_2O-15 kg/ha. 15 kg each of N, P_2O_5 and K_2O was applied as basal dose and the rest 15 kg N was applied three weeks after sowing.

The dates of sowing have marked effect on the grain yield (Table IV.4). Sowing of P.miliare on 8-6-81 resulted in maximum yield as compared to the other dates of sowing. Delaying the date of sowing by 10 days resulted in 41 per cent reduction in yield.

Table IV.4: Effect of Date of Sowing on Yield and Maturity of P.miliare

Date of Sowing	Maturity (Days)	Yield (q/ha)
8-6-81	71	6.7
18-6-81	71	4.7
2-7-81	68	1.1
C.D. 0.05%		1.2

3.2 Effect of Plant Density

The trial was laid out in a split plot design with inter row spacing as the main plot and intra-row spacing as the sub plot (5 x 2m) with four replications. The variety Koraput local was sown on 10-6-81 and was harvested on 24-8-81. The fertilizers were applied @ 30 kg N, 15 kg P_2O_5 and 15 kg K_2O/ha. Adequate plant protection measures were taken against the midge infestation at jointing stage (Nuvacron 1.0 lit/ha).

Table IV.5: Yield of grains as affected by varying degree of plant density of P.miliare (q/ha)

Intra-row spacing (cm)	Inter-row spacing (cm)			Mean
	10	15	20	
5	21.8	21.9	21.5	21.7
10	20.6	23.0	20.3	21.3
15	18.3	19.0	14.8	17.3
20	16.5	14.8	15.5	15.6
Mean	19.3	19.7	18.0	

CD 5% for Intra-row spacing = 1.9

There is no significant difference between inter-row spacings (Table IV.5), whereas significant differences were observed between intra-row spacings. Intra-row spacing of 5 to 10 cm gave higher yield than the wider spacings. It is better to go for 5 to 10 cm intra-row spacing for achieving better grain yield, which confirmed the previous year's result (1980-81).

3.3 Intercropping of Panicum miliare with Pigeonpea

An experiment was laidout in a randomized block design with four replications to study the effect of P.miliare (variety Koraput local) intercropped with pigeonpea, a local pulse crop. The plot size was 10 m x 8 m. 20 kg N, 20 kg P_2O_5 and 10 kg K_2O was applied. Nitrogen was applied in two splits, 10 kg as basal and the rest 10 kg as topdressing three weeks after germination. Pigeonpea was sown on 8.6.81 and harvested on 18.12.81 and P.miliare was sown on 25.6.81 and harvested on 24.8.81.

Table IV.6: Grain Yield and Economics of Little Millet-Pigeonpea Intercropping

System	Yield (q/ha)		Gross Returns (Rs.)
	Little millet	Pigeonpea	
Little millet (Pure)	8.3.	-	866.25
Little millet 1R + Pigeonpea 1R	7.8	0.2	894.69
Little millet 2R + Pigeonpea 1R	7.1	0.2	802.29
Little millet 3R + Pigeonpea 1R	6.9	0.2	775.89
Pigeonpea (Pure)	-	2.4	716.25
C.D. 5%			

Little millet : Rs. 1.05/kg Pigeonpea: Rs. 3/kg

Pigeonpea suffered maximum loss in grain yield in little millet-pigeonpea intercropping system confirming that the two crops are not compatible.

4. PEST MANAGEMENT

4.1 Effect of Date of Sowing on Shootfly

Seven plantings were done at 10 days interval in a randomized block design replicated three times and fertilized with 20 kg N, 10 kg P_2O_5 and 10 kg K_2O/ha. Shootfly count was done 30 days after germination.

Very early and very late plantings recorded low incidence of shootfly (Table IV.7), indicating the relattionship with weather and varieties.

Table IV.7: Effect of Date of Sowing on Shootfly in Little millet

Date of Sowing	Shootfly Damage (Per cent)
8-6-81	25.67
18-6-81	43.33
28-6-81	47.50
14-7-81	51.33
29-7-81	41.67
13-8-81	36.50
28-8-81	24.00
C.D. (0.05)	N.S.

4.2 Insecticidal Control of Shootfly

Five spray formulations and one combination of soil application and spray were tried against shootfly in Koraput local in a randomized block design replicated three times. The plot size was 7 m x 3 m, and was fertilized with 30 kg N, 15 kg P_2O_5 and 15 kg K_2O/ha. The shootfly count was taken 25 days after planting (17-6-81).

Table IV.8: Effect of Insecticides on Shootfly damage and Grain Yield of P.miliare.

Name of the Insecticides	Dose a.i./ha	Infestation	Yield (q/ha)
Quinolphos	0.05%	25.0	6.1
Phosphamidon	0.05%	26.4	7.0
Methyldemeton	0.05%	11.0	7.1
Dichoorovos	0.05%	35.0	5.4
Dimithoate	0.05%	30.2	6.3
Carbofuran + Chloropyriphos @ 0.05%	0.5kg	11.8	7.1
Control	-	49.8	4.1
C.D. (0.05)	-	8.2	1.7

Methyl-demeton and Carbofuran treatments afforded best control of shootfly damage followed by Quinolphos, Phosphamidon, Dimethoate and Dichlorovos (Table IV.8). The best grain yield was recorded in Methyl-demeton and Carbofuran treated plots where the percentage of shootfly was significantly lesser than the other treatments.

5. HIGHLIGHTS OF RESEARCH

5.1 Varietal Improvement

The performance of early varieties like Dindori 1, Umaria and Koraput local was better than late varieties like K 2.

5.2 Management of Inputs

Early plantings with the onset of monsoon had given higher yields. Delaying the date of sowing by 10 days resulted in 41 per cent reduction in yield.

Inter row spacing of 10 to 20 cm and intra row spacing of 5 to 10 cm had given maximum grain yields.

Little millet-pigeonpea intercropping system was not as profitable as pure little millet planting.

5.3 Pest Management

Very early (June 9) and very late (August 28) plantings had similar shootfly incidence.

Methyl Demeton 0.05 % a.i./ha reduced the incidence of shootfly, in addition to returning high grain yields.

CHAPTER V

PROSO OR COMMON MILLET - PANICUM MILIACEUM L.

1. INTRODUCTION

1.1 General

Except little millet, proso millet, barnyard millet, foxtail millet or Italian millet and kodo millet are grown in North and Central Bihar. The centre for the improvement of these crops is located at Dholi. Besides, ragi which forms the staff of life of a larger section of poor farmers and down-trodden people is also grown in Bihar. The millets are chiefly grown during kharif season, except proso millet which is mainly cultivated during summer season. Multi-disciplinary approach forms the basis for millet improvement at Dholi.

1.2 Weather Condition

Though the total rainfall received during the season was more than normal, the distribution was quite abnormal (Table V.1).

Table V.1 : Weather Data, Dholi

Met Week	Dates	Rainfall (mm)	Rainy Days	Temperature (°C)		Humidity (%)	
				Min	Max	Min	Max
22	May-June 28-3	5.8	2	23.0	31.5	44.6	72.7
23	June 4-10	33.8	1	24.7	36.7	37.6	63.0
24	June 11-17	0.0	0	26.0	30.8	32.8	55.4
25	June 18-24	6.3	1	26.8	36.0	43.5	54.3
26	June-July 25-1	30.0	3	26.2	32.4	46.0	57.1
27	July 2-8	235.0	5	24.4	29.7	44.3	58.6
28	July 9-15	44.3	1	25.7	32.7	44.4	62.0
29	July 16-22	254.0	7	25.1	30.4	52.0	65.3
30	July 23-29	43.0	4	26.6	33.3	41.7	59.4
31	July-Aug. 30-5	100.0	5	25.6	31.1	43.7	60.0
32	August 6-12	4.3	1	27.3	33.0	46.4	56.7
33	August 13-19	25.3	1	26.5	33.7	47.3	64.0
34	August 20-26	263.8	6	24.3	33.5	48.8	66.7
35	Aug.Sept. 27-2	37.5	2	26.0	31.7	33.0	58.8
36	Sept. 3-9	151.8	6	24.4	31.7	49.0	62.5
37	Sept. 10-16	44.3	3	25.0	31.0	49.4	65.3
38	Sept. 17-23	5.5	2	24.8	32.3	47.6	72.8
39	Sept. 24-30	1.3	1	25.9	33.7	44.1	69.0
40	Oct. 1-7	0.0	0	22.9	32.5	47.5	73.7
41	Oct. 8-14	0.0	0	20.0	32.6	45.7	76.3

2. GENETIC RESOURCES

2.1 New Collections

Thirty five new proso millets were collected from three districts of Bihar.

2.2 Maintenance and Evaluation

Genetic stocks numbering 510 were planted in an augmented randomised block design for simultaneous evaluation and multiplication.

3. VARIETAL IMPROVEMENT

3.1 Pure Line Selections

Selected single plant selections of Shyam Cheena (17), BR (15), MS 4872 (13) and PM 29 (17) were evaluated in separate trials. Each trial was planted in a randomised block design replicated three times. The gross plot (3 m x 1.5 m) was fertilized with 40 kg N, 20 kg P_2O_5 and 20 kg K_2O/ha.

The differences among the treatments were insignificant. However, 5 selections of Shyam Cheena, 9 selections of BR 7 and 4 selections of PM 29 exceeded their parental checks in grain yield (Table V.2), emphasising the individual performance and residual variability. None of the selections of MS 4872 excelled the parent, indicating the population rather than individual performance.

3.2 Station Trial

3.2.1 Performance of New Selections : Twelve new selections were compared in a randomized block design four times using Shyam Cheena, Ram Cheena and MS 4872 as checks. The gross plot of size 3 m x 1.5 m was fertilized with 40 kg N, 20 kg P_2O_5 and 20 kg K_2O/ha.

The varietal differences were significant. The performance of selections that excelled the lowest yielding check is listed (Table V.3). Two selections, 5013 and 5136 excelled all the checks in their performance giving a per day productivity of 35 to 39 kg.

Table V.2 : Performance of Pure Line Selections of Proso Millet

Entry	Maturity (Days)	Yield (q/ha)	Production/Day (kg)
1. Shyam Cheena Selections			
BR 7	71	17.2	25.7
MS 4872	72	17.5	24.3
5830	70	17.3	24.8
5764	70	17.1	24.4
5823	69	16.4	23.8
5789	69	16.2	23.5
5792	70	14.9	21.3
Shyam Cheena	70	14.9	21.3
2. BR 7 Selections			
5524	67	18.2	27.2
5451	69	17.7	25.6
MS 4872	74	16.7	22.5
5475	69	16.3	23.7
5460	69	16.2	23.5
5454	68	16.1	23.7
5458	67	15.7	23.4
5521	67	15.7	23.4
5483	69	15.6	22.6
5506	69	15.6	22.6
BR 7	69	14.9	21.1
3. PM 29 Selections			
BR 7	71	18.2	25.7
MS 4872	72	17.5	24.3
5754	68	17.3	25.5
5688	69	17.1	24.8
5720	74	16.8	21.9
5726	68	14.9	21.9
PM 29	69	14.9	21.6
4. MS 4872 Selections			
MS 4872	72	18.4	25.6
BR 7	70	18.1	25.9
5641	70	17.7	25.2
5681	68	17.3	25.5

Table V.3 : Performance of Selected Proso Millets

Entry	Maturity (Days)	Yield (q/ha)	Production/Day (kg)
5013	71	27.6	39.0
5136	70	24.2	34.5
Shyam Cheena	67	23.9	35.7
MS 4872	72	23.1	32.1
5061	71	23.0	32.4
5245	78	22.1	28.3
5406	66	21.8	33.0
5014	69	21.7	31.4
5125	66	20.6	31.2
Ram Cheena	66	20.6	31.2
C D 5 %	-	3.0	

4.MANAGEMENT OF INPUTS

4.1 General

During the year 1981, fifteen experiments (8 in proso millet, 2 in Echinochloa, 2 in Setaria and 2 in ragi) were conducted. The experimental plots were sandy loam in nature. The proso millet experiments were conducted during February to April, and September to October, 1981. Proso millet mixed cropping and residual fertility trials were conducted during September to November, 1981, the results of which are still awaited. As and when required, life saving irrigation was provided.

4.2 Identification of Ecotypes for Dholi

This trial was conducted with the objective of identifying a suitable variety of proso millet for the agroclimatic conditions of Dholi. Six varieties were planted in a randomized block design with four replications in 5 m x 4 m plots. The net plot size was 4.5 m x 3.5 m . Seeds were sown in rows 25 cm apart.

The differences in grain yield between varieties of proso millet were non-significant during 1981 (Table V.4). However BR 7 recorded the highest grain yield over a 3 year period, followed by Shyam cheena.

Table V.4 : Performance of Selected Proso Millets

Varieties	1979	1980	1981	Mean
MS 4872	8.8	25.2	20.3	18.1
MS 1914	9.3	24.0	19.7	17.7
PM 29	9.7	26.3	20.2	18.7
Shyam Cheena	11.1	28.3	19.4	19.6
BR 7	15.4	29.0	21.8	22.1
Local	9.0	23.5	20.0	17.5
Mean	10.5	26.0	20.2	18.9
SE m/plot(q/ha)	1.9	1.3	1.0	
CD 5 % (q/ha)	2.9	3.9	N.S.	
CV %	18.2	10.0	9.72	

4.3 Sowing Dates x Varieties

4.3.1 Summer : The trial consisted of 20 treatment combinations of five dates (15 February, 1st March, 15th March, 1st April and 15th April) and four varieties (BR 7, PM 29, MS 4872 and BR 9). They were laid out in a split plot design with three replications in plots having a gross size of 1.6 m x 5 m (sub plot) and net size of 1.2 m x 4.5 m. Seeds were sown in rows 20 cm apart.

Table V.5 : Effect of Planting Time on Proso Millets

Sowing Date	Grain Yield (q/ha)				
	BR 7	PM 29	MS 4872	BR 9	Mean
February 15	27.2	26.5	27.8	19.1	25.2
March 1	28.4	22.8	27.8	24.7	25.9
March 15	33.3	28.2	27.8	27.8	29.3
April 1	22.2	13.0	11.7	22.8	17.4
April 15	16.7	11.7	12.9	10.6	12.8
Mean	25.6	20.5	21.5	21.0	22.1

Variety BR 7 gave significantly higher grain yield than PM 29, MS 4872 and BR 9 (Table V.5). The latter three varieties were at par. Grain yield increased till 15th March and then declined. March 15 sowing was found significantly superior to 15th February, 1st March, 1st April and 15th April plantings.

4.3.2 Rabi : The trial with four dates of sowing (10-9-81, 20-9-81, 30-9-81 and 10-10-81) and three varieties (RAU M-1, BR 7 and MS 4872) was conducted in a randomised block design with three replications in plots measuring 2.25 m x 4.5 m. The crop is still standing in the field.

4.4 Response to Nitrogen, Phosphorus and Potash

This trial consisted of three levels (0, 20, 40 kg/ha) each of nitrogen, phosphorus and potash. The objective was to find out the response of BR 7 to varying levels of N, P_2O_5 and K_2O combinations. All these treatment combinations were laid out in a 3^3 confounding design with two replications in plots having a gross size of 2.4 m x 4.0 m and net size of 1.95 m x 3.5 m. Seeds were sown in rows 22.5 cm apart.

Table V.6 : N, P and K Fertilization Effect (q/ha) on Proso Millet

Fertilizers/ Dose	MS 4872	BR 7		
	1979	1980	1981	Mean
N 0	10.8	17.1	12.5	13.5
N 20	10.7	21.9	19.1	17.2
N 40	12.4	23.2	22.5	18.4
C D 5 %	1.4	2.4	1.7	
P 0	10.6	20.2	17.0	15.9
P 20	11.3	20.1	17.4	16.4
P 40	11.7	21.9	19.6	17.7
C D 5 %	N.S.	N.S.	1.7	
K 0	11.1	20.4	18.2	16.6
K 20	10.9	20.4	17.8	16.4
K 40	11.8	21.3	18.0	17.0
C D 5 %	N.S.	N.S.	N.S.	
C.V. %	17.3	16.6	13.2	

The grain yield increased with increasing levels of nitrogen and phosphorous. The differences between N 0 and N 20, N 0 and N 40, N 20 and N 40, P 0 and P 40 and P 20 and P 40 were significant during 1981 (Table V.6). The effect of nitrogen was more substantial over a 3 year period than P_2O_5 and K_2O in BR 7.

5. DISEASE MANAGEMENT

5.1 Screening

5.1.1 Germplasm : Among the 429 genetic stocks tested against Helminthosporium panici-miliacai, only 25 were found moderately resistant (Table V.7).

5.1.2 Cultivars : Among the 37 cultivars of proso millet screened for Helminthosporium panici-miliacai, 3 (BR 1, BR 2 and PV 27) were resistant (Table V.8).

Table V.7 : Proso Millet Screening for Leaf Blight

Reaction Class	Numbers
Resistant	Nil
Moderately resistant	9594, 9608, 9623, 9641, 9643, 9656, 9679, 9723, 9784, 9787, 9791, 9808, 9896, 9903, 9904, 9905, 9910, 9944, 9947, 9948, 9949, 9950, 9951, 9953, 9954 and 9956.
Moderately susceptible	9567, 9568, 9571, 9574, 9578, 9582, 9583, 9584, 9585, 9586, 9598, 9600, 9603, 9605, 9606, 9607, 9609, 9615, 9618, 9620, 9621, 9622, 9624, 9625, 9628, 9631, 9639, 9645, 9650, 9652, 9655, 9657, 9658, 9662, 9663, 9667, 9668, 9669, 9671, 9672, 9673, 9674, 9675, 9678, 9680, 9682, 9683, 9684, 9685, 9686, 9687, 9691, 9692, 9695, 9696, 9697, 9700, 9701, 9704, 9706, 9707, 9708, 9709, 9713, 9715, 9718, 9721, 9722, 9724, 9725, 9727, 9728, 9730, 9731, 9732, 9733, 9734, 9736, 9737, 9741, 9746, 9748, 9749, 9751, 9752, 9753, 9755, 9756, 9757, 9760, 9762, 9763, 9764, 9766, 9768, 9769, 9772, 9773, 9775, 9776, 9777, 9779, 9783, 9785, 9786, 9788, 9789, 9790, 9792, 9793, 9794, 9796, 9797, 9798, 9799, 9800, 9801, 9804, 9805, 9807, 9809, 9810, 9811, 9812, 9813, 9814, 9815, 9816, 9817, 9820, 9821, 9822, 9825, 9826, 9827, 9828, 9830, 9831, 9834, 9839, 9840, 9841, 9842, 9843, 9852, 9853, 9856, 9866, 9869, 9870, 9871, 9874, 9876, 9877, 9878, 9880, 9881, 9882, 9883, 9884, 9885, 9887, 9890, 9894, 9895, 9897, 9898, 9899, 9902, 9907, 9908, 9909, 9911, 9912, 9915, 9916, 9917, 9918, 9920, 9921, 9924, 9925, 9927, 9929, 9931, 9934, 9937, 9939, 9940, 9941, 9943, 9945, 9946, 9952, 9955, 9963, 9964, 9966, 9967, 9968, 9969, 9970, 9971, 9973, 9975, 9976, 9977, 9980, 9981,
Susceptible	9596, 9569, 9570, 9573, 9575, 9576, 9577, 9581, 9587, 9588, 9589, 9592, 9593, 9595, 9599, 9602, 9604, 9613, 9614, 9616, 9617, 9619, 9626, 9627, 9630, 9632, 9635, 9637, 9638, 9640, 9642, 9644, 9646, 9647, 9648, 9649, 9651, 9653, 9654, 9659, 9660, 9661, 9664, 9665, 9666, 9670, 9676, 9677, 9681, 9688, 9689, 9693, 9694, 9698, 9699, 9702, 9703, 9705, 9710, 9711, 9712, 9714, 9716, 9717, 9726, 9729, 9738, 9739, 9740, 9743, 9744, 9745, 9747, 9750, 9758, 9759, 9761, 9764, 9767, 9770, 9771, 9774, 9778, 9780, 9781, 9782, 9795, 9802, 9803, 9806, 9819, 9823, 9824, 9829, 9832, 9833, 9835, 9836, 9837, 9838, 9844, 9845, 9846, 9848, 9849, 9851, 9854, 9855, 9857, 9858, 9860, 9861, 9862, 9864, 9865, 9867, 9868, 9872, 9873, 9879, 9886, 9888, 9889, 9892, 9900, 9901, 9906, 9913, 9914, 9919, 9922, 9923, 9926, 9928, 9930, 9932, 9935, 9936, 9938, 9942, 9957, 9958, 9959, 9960, 9961, 9965, 9972, 9974, 9978, 9979, 9982.

Reaction Class	Numbers
Highly susceptible	9572, 9679, 9590, 9591, 9596, 9597, 9601, 9610, 9611, 9612, 9629, 9633, 9634, 9636, 9690, 9719, 9720, 9735, 9742, 9754, 9818, 9847, 9859, 9863, 9875, 9891, 9893, 9933 and 9962.

Table V.8 : Evaluation of Breeding Material of Proso Millet

Variety	Leaf Blight (%)	Reaction
BR 1	1.50	R
BR 2	1.50	R
PV 27	1.60	R
MS 1914	1.66	MR
PM 1685	3.50	MR
PV 17	3.80	MR
BR 3	3.80	MR
GV 1	3.88	MR
GV 2	3.90	MR
BR 9	4.00	MR
BR 11	4.50	MR
PV 161	4.50	MR
PV 225	4.50	MR
78 1	4.55	MR
V 6.1	4.00	MR
BR 7	10.00	MR
V 19	10.00	MR
V 42	10.00	MR
MS 4872	10.00	MR
BR 5	12.00	MS
VP 346	12.00	MS
CO 1	13.00	MS
PM 29	13.00	MS
P 162	20.00	MS
V 8	20.00	MS
MS 1	20.00	MS
PV 196	20.00	MS
V 19	30.00	MS
V 13	30.00	MS
BR 4	40.00	MS
MS 4806/2	40.00	MS
BR 8	40.00	MS
PV 38	45.00	MS
V 12	45.00	MS
BR 12	50.00	S
Shyam Cheena	50.00	S

Note

R = Resistant
MR = Moderately resistant
MS = Moderately susceptible
S = Susceptible

5.2 Seed Dressing

Five fungicides were used to check leaf blight in PM 29 in a randomized block design replicated four times. The net plot size was 3 m x 1 m with a row to row spacing of 23 cm, and plant to plant 8 cm. Besides 1981 data, previous results are also indicated (Table V.9). Captan had given the best control during 1981 as well as the three years of experimentation and maximum grain yield per plot.

Table V.9 : Fungicidal Control of Leaf Blight in Proso Millet

Fungicide	Dose (%)	Incidence (%)				Yield/ Plot (kg)			
		1979	1980	1981	Mean	1979	1980	1981	Mean
Hinosan	0.25	52	50	55	52	0.82	0.83	0.80	0.82
Blue Copper	0.20	39	39	41	40	0.88	0.82	0.78	0.83
Bavistan	0.05	47	48	40	45	0.83	0.85	0.82	0.83
Captan	0.20	29	28	30	29	0.84	0.86	0.82	0.84
Ceresan Wet	0.20	40	48	48	45	0.79	0.75	0.70	0.75
Control		75	72	80	76	0.59	0.60	0.58	0.59

5.3 Micro Nutrients

The variety PM 29 was treated with four fungicides through seed, soil and foliage for controlling leaf blight, consecutively for three years. The experiment was laid out in a randomized block design replicated 3 times. The net plot size was 3 m x 1 m with a row to row spacing of 23 cm, and plant to plant difference of 8 cm.

Although foliar treatment marginally reduced leaf blight than seed and soil treatments, high grain yields were obtained with soil treatment (Table V.10). Among the soil treatments, zinc sulphate had given better control and high grain yield, followed by ferrous sulphate.

5.4 Seed Microflora

Planting of seeds of 37 varieties of proso millet in a randomized block design replicated 3 times revealed the occurrence of Helminthosporium panici miliacei in 33, H.hawaiiense in 5, Alternaria sp in 22, Cercospora sp. in 17 and Fusarium sp. in 13 varieties during 1981. The results of 1980 and 1981 are given in Table V.11.

Table V.10 : Effect of Micronutrients on Leaf Blight of Proso MMillet

Nutrient	Dose	Incidence (%)				Yield (kg/Plot)			
		1978-79	1979-80	1980-81	Mean	1978-79	1979-80	1980-81	Mean
			1. Seed Treatment						
Zn So_4	2.50 %	49	50	50	50	0.62	0.72	0.52	0.62
Mn So_4	0.25 %	55	56	56	56	0.48	0.58	0.40	0.49
Cu So_4	0.10 %	47	53	55	52	0.59	0.64	0.56	0.60
Fe So_4	0.25 %	46	47	47	47	0.58	0.64	0.55	0.59
Control	-	63	63	64	63	0.52	0.58	0.48	0.53
Mean		52	54	54	54	0.59	0.63	0.50	0.57
			2. Soil Treatment						
Zn So_4	25 kg/ha	47	47	48	47	0.78	0.80	0.70	0.76
Mn So_4	25 kg/ha	57	57	58	57	0.65	0.74	0.56	0.65
Cu So_4	12.5 kg/ha	51	50	52	51	0.70	0.72	0.66	0.69
Fe So_4	25 kg/ha	46	43	47	45	0.69	0.75	0.65	0.70
Control	-	64	63	66	64	0.57	0.58	0.56	0.57
Mean	-	53	52	54	53	0.68	0.72	0.63	0.67
			3. Foliar Treatment						
Zn So_4	1.0 %	42	40	45	42	0.59	0.65	0.55	0.60
Mn So_4	0.5 %	45	43	48	45	0.56	0.63	0.51	0.57
Cu So_4	0.25 %	56	53	60	56	0.53	0.58	0.49	0.53
Fe So_4	1.0 %	42	40	46	43	0.58	0.65	0.55	0.59
Control	-	67	63	70	67	0.57	0.58	0.57	0.57
Mean	-	50	48	54	51	0.57	0.62	0.53	0.57

Table V.11 : Organisms Associated with Different Proso Millet Varieties

Variety	Germi-nation (%)		H.panici-miliacei		H.hawaiiense		Alterna-ria sp.		Cercos-pora sp.		Fusarium sp.	
	'80	'81	'80	'81	'80	'81	'80	'81	'80	'81	'80	'81
MS 1914	60	62	-	+	-	-	+	+	+	+	-	+
CO 1	73	74	+	+	-	-	-	-	+	+	-	-
MS 1	59	60	-	+	-	-	+	+	+	+	-	-
PV 17	70	70	-	-	-	-	-	+	+	+	+	+
GV 1	64	65	-	+	-	-	-	+	-	-	+	+
GV 2	35	58	-	+	-	+	+	+	+	+	-	+
PV 196	73	75	+	+	-	-	+	+	+	+	-	-
MS 4806/2	75	80	+	+	-	-	+	+	+	+	-	-
BR 5	62	70	-	+	-	-	-	+	+	+	-	-
BR 4	65	70	-	+	-	-	+	+	-	-	+	+
BR 7	71	72	+	+	-	-	-	-	-	-	-	-
BR 8	70	71	-	+	-	+	+	+	-	-	-	-
BR 9	69	70	-	+	-	+	+	+	+	+	-	-
BR 12	70	70	-	+	-	-	+	+	+	+	+	+
PM 29	80	85	+	+	-	-	+	+	+	+	-	+
PV 1685	71	72	+	+	-	+	+	+	+	+	-	-
MS 4872	77	78	-	+	-	-	+	+	-	+	-	-
Shyam Cheena	79	80	-	+	-	-	+	+	-	+	-	-
BR 11	60	70	+	+	-	-	+	+	+	+	-	-
BR 3	80	85	-	+	-	-	+	+	+	+	-	-
BR 10	60	65	+	+	-	-	-	-	+	+	-	-
PV 27	66	70	+	+	-	-	+	+	-	-	-	+
BR 1		85		+	-	-	-	-	-	-		+
BR 2		88		+		-		-		-		+
PV 161		80		-		-		+		-		-
PV 295		75		-		-		+		-		-
78-1		70		+		-		-		-		-
V 6-1		70		+		-		-		-		-
V 19		72		+		-		-		-		+
V 42		84		+		+		-		-		-
PV 346		80		-		-		-		-		-
P 162		70		+		-		-		-		-
V 8		65		+		-		+		-		-
V 19		66		+		-		+		-		-
V 13		69		+		-		-		-		+
PV 38		70		+		-		-		-		+
P 12		68		+		+		-		-		-
			9	33	1	5	16	22	16	17	4	13

Note: * Average of 3 replications; + Presence of Organism;
- Absence of Organism

6. PEST MANAGEMENT

6.1 Screening

Three randomly selected plants were tested in 13 proso millet entries. Total number of tillers and the number of dead hearts were counted 28 days after germination. White earheads were also estimated. The dead hearts percentage varied from 11.8 to 38.6 (Table V.12). The white earheads ranged from 3.2 to 11.3 per cent. None were resistant, but MS 1487 exhibited relative seedling and adult plant resistance.

Table V.12 : Incidence of Shootfly in Proso Millet

Entry	Dead-hearts per cent (28 DAG)	White Earheads (%)
MS 1387	16.6	7.3
MS 1487	11.8	3.2
MS 1595	27.7	11.3
MS 4887	33.3	4.1
PV 1685	22.6	6.6
S 224	38.6	6.9
CO 1	16.6	9.3
BR 1	27.7	4.3
BR 2	22.6	6.4
BR 7	24.6	6.8
BR 8	23.3	4.6
BR 9	22.6	4.6
BR 11	23.3	6.7

6.2 Insecticidal Control of Shootfly

Five insecticides @ 0.2 kg ai/ha were sprayed once after the occurrence of shootfly on BR 8. The experiment was conducted in a randomized block design replicated 4 times.

Phosphamidon and Methyl-demeton were found effective in considerably reducing the shootfly infestation and increasing productivity (Table V.13).

Table V.13 : Control of Shootfly in Proso Millet

Treatment	Dead hearts (%)	White Earheads (%)	Yield (q/ha)
Carbaryl	15.4	12.8	14.8
Malathion	15.8	17.1	15.3
Fenitrothion	17.2	16.1	16.8
Phosphamidon	6.1	6.7	22.5
Methyl-Demeton	8.2	7.6	20.5
Control	24.2	26.7	12.7
S E (Mean)	1.1	1.4	0.6
C D 5 %	3.3	4.1	1.8

7. HIGHLIGHTS OF RESEARCH

7.1 Genetic Resources

Thirty five new collections were added and 510 genetic stocks were evaluated for various qualitative and quantitative characters.

7.2 Varietal Improvement

Three year yield trials established the superiority of BR 7 with an yield of 22.1 q/ha, 22.1 per cent more than MS 4872, the released variety. Two selections superior in performance to BR 7 had been identified, revealing residual variability.

Yield evaluation trials revealed two more promising selections 5013 (27.6 q/ha) and 5136 (24.2 q/ha) with a per day productivity of 39.0 and 34.5 kg, as compared to 32.1 kg of MS 4872 (23.1 q/ha).

7.3 Management of Inputs

March 15 planting appears to be ideal for summer proso millet cultivation. Plantings before March 15 suffered marginally, while the grain yield in later plantings was drastically reduced.

The response to nitrogen application was substantial, while it was marginal for P_2O_5 and K_2O. 20 kg N/ha had given a response of 18.5 kg grain/kg N as against 12.25 kg at 40 kg N/ha.

7.4 Disease Management

Germplasm screening revealed 25 moderately resistant stocks to leaf blight. Captan 0.2 % not only effectively checked leaf blight over a 3 year period, but also produced maximum grain yield.

Although foliar treatment marginally reduced leaf blight than seed and soil treatments, high grain yields were obtained with soil treatment. Among the soil treatments, zinc sulphate (25 kg/ha) had given better control and high grain yield, followed by ferrous sulphate (25 kg/ha).

Helminthosporium panici miliacei and Alternaria sp. occurred more frequently on seed surface than H.hawaiiense and Cercospora sp.

7.5 Pest Management

MS 1487 exhibited relative seedling and adult plant resistance to shootfly.

Phosphamidon and Methyl-demeton reduced shootfly infestation to 6.1 and 8.2 per cent dead hearts from 24.2 per cent in control, and increased productivity by 77.2 and 61.4 per cent respectively over control (12.7 q/ha).

CHAPTER VI

BARNYARD MILLET - ECHINOCHLOA FRUMENTACEA (ROVB) LINK

1. INTRODUCTION

1.1 General

The cropping pattern in the hills of Uttar Pradesh revolves around barnyard millet which forms the staple food.

2. GENETIC RESOURCES

2.1 Collection, Cataloguing, Characterisation and Classification of Germplasm

A total number of 955 genetic stocks were evaluated for different morphological and agronomical characters, and disease pest incidence. These included 870 stocks evaluated during 1979 and a few more collections obtained during the period. A few more characters like ear length and tillering which were not taken in 1979 were evaluated. The data are summarised in Table VI.1.

3. VARIETAL IMPROVEMENT

3.1 Creation of New Materials

3.1.1 Selection of Elite Materials from Nurseries: Twenty desirable stocks were selected for testing in preliminary yield evaluation trials, during next kharif season.

Ninetysix single plant selections were isolated for identification of superior progenies.

3.1.2 Recombination Breeding: 17 F_1 combinations, involving elite materials like VL 8, VL 11, VL 18, PC 49, EF 2, K 7201, RAU 6 were attempted by contact method using marker characters like pigmentation (pink) of stem base, node, stigma and husk.

Out of the 16 combinations attempted last year, hybrids could be identified in 8 combinations which had been advanced to F_2 generation for further selection.

Table VI.1: Frequency Distribution of Kodo Millet Genetic Stocks

Height (cm)		Maturity (Days)		Ear Length (cm)		Ear Compactness(1-3)*		Ear Nature		Ear Colour *		Smut (0-9) *		Stem Borer *	
Class	Frequency	Class	Frequency	Class	Frequency	Class	Frequency	Class	Frequency	Class	Frequency	Class	Frequency	Class	Frequency
Below 110	206	Below 100	99	Below 10	15	1	323	Erect	879	Purple (P)	290	0	-	0	721
111-130	122	101-105	248	11-15	356	2	551	Drooping	76	Light purple (LP)	619	3	20	1	176
131-150	96	106-110	345	16-20	406	3	81			Pale green (PG)	46	5	385	2	58
151-170	395	111-115	222	21-25	152							7	316	3	-
171-230	136	116-119	41	26-28	26							9	234		

* Ear Compactness
1= Compact
2= Intermediate
3=Lax

* Ear colour
P-Purple
LP- Light purple
PG- Pale green

*Smut disease Scale = 0-9
0= Immune
3= Moderately resistant
5= Moderately susceptible
7= Susceptible
9= Highly sisceptible

Stem borer
0=Immune
1=Upto 5% damage
2=6 to 15% damage
3= 16 & above damage

3.1.3 Mutation Breeding: M_2 generations of VL 8 and VL 11 produced by three doses of gamma rays (15, 30, 45 Kr) and EMs (0.1%) were raised.

Abnormalities in morphological characters like bifurcation of ear heads, as reported earlier, did not occur in the M_2 generation.

A number of chlorophyl mutants were recorded at seedling stage but there was not much variability at adult plant stage. However, 46 selections in VL 11 and 51 selections in VL 8 mainly for ear compactness, length, earliness and tillering capacity were retained for further work.

3.2 Yield Evaluation Trials

Four yield evaluation trials namely, two coordinated trials, VL advance and preliminary trials were conducted during kharif, 1981.

VL 21 and VL 24 performed well in both the coordinated as well as VL advance trial (Table VI.2). Other strains which performed better were, RAU 6, RAU 7, VL 20 in coordinated trial, and VL 13, VL 24 in VL advance trial. The performance of VL 13 was good, in the past year also.

Fortyeight new strains were tested in a multilocational trial from coordinating unit. The first five high yielding selections were Pune No.2286-80K, 2384, 2389, 2388 and 2301-80K. These gave 94 to 110 per cent higher yield than the check K 1 (11.77 q/ha). In the station preliminary trial with 41 new selections, VHC 5119-1, VHC 5325-2, VHC 5307-1, VHC 5363-2, VHC 5116-2, Syali local 1-3, Somashwar Sel.-2, and VHC 5244-2 produced higher yield than the released variety VL 8 (22.10 q/ha) and had desirable maturity. These have been selected for further advance testing.

Table VI.2: Performance of Selected Yield Trial Entries

Varieties	Grain Yield (q/ha)		Maturity (Days)		Disease			
	Coordinated	VL Advance	Coordinated	VL Advance	Coordinated Smut*	Coordinated Leaf spot	VL Advance Smut*	VL Advance Leaf spot
RAU 6	24.7	22.4	81	103	7/3	7	9/2	8
RAU 7	21.9	-	89	-	9/2	7	-	-
VL 21	20.6	37.2	86	103	5/2	7	5/2	7
VL 20	19.9	34.3	84	102	5/2	8	5/2	8
VL 24	19.4	44.3	86	104	5/2	7	7/2	7
VL 13	-	48.6	-	-	-	-	7/2	7
VL 23	13.81	37.7	83	90	5/2	8	5/2	7
K 1	14.2	-	98	-	3/2		-	-
VL 8	-	35.1	-	99	-	-	7/2	8
C.D. at 5%		5.39	C.D. 5%	NS				

* Smut = % of infected plants/ % of grains infected in an earhead

Leaf spot - 1-9
Smut - 0-9

3.3 Cytological Investigations

In the previous year meiotic studies were carried out in a number of collections of Echinochloa. The chromosome number was found to be 2n = 54 in all the collections investigated. No abnormal meiosis or accessory chromosomes were observed in any of the collections. Karyotypic studies in all the available collections were made.

Karyotype of chromosomes of VL 8 was prepared using relative measurements of the two arms of each chromosomes.

During 1981, more specimens of wild Echinochloa of various species viz., Echinochloa crusgalli var. Crusgalli, E. crusgalli var.breviseta and E.colonum (Bor, 1973) were collected and fixed for meiotic studies. Emerging spikes of elite varieties, viz., VL 2, VL 7, VL 18, EF 2, VHC 5324, B 117, B 186, B 187, Pune collection nos. 2381 and 2389 were also fixed for meiotic studies.

Two varieties (VL 7 and EF 2) were investigated cytologically and meiosis was found to be regular with chromosome number 2n = 54, as recorded previously. Further studies on chromosomal associations at metaphase-I and chiasmats frequency per PMC and per bivalent are in progress.

4. MANAGEMENT OF INPUTS

4.1 Time of Planting

An experiments to find out suitable dates for sowing Echinochloa was repeated for the 3rd season.

Table VI.3: Effect of Date of Planting on Barnyard Millet Yield (q/ha)

Planting dates	1981	1980	1979
April 15	20.9	22.2	-
May 1	21.9	22.7	19.3
May 15	23.0	22.5	21.5
May 30	21.5	21.6	20.6
June 15	16.7	16.5	19.8
June 30	8.9	4.8	-
C.D. 5%	6.0	3.3	-

As in previous years, there were no significant differences in yield for the sowings between 15th April to 15th June, except 15th May (Table VI.3). The yields were reduced significantly on 30th June sowing. Thus, it was confirmed that by using short duration varieties like VL 8 the Echinochloa can be planted any time upto the middle of June without any significant decline in yield potential.

4.2 Studies on Plant Densities

This experiment with 3 row to row spacings (20, 25 and 30 cm) and 3 plant spacings (10, 15 and 20 cm) was repeated for the third season during 1981 (Table VI.4).

Table VI.4: Grain Yield (q/ha) under Different Row and Plant Spacings

Row to row (cm)	Plant to plant (cm)			Mean			
	10	15	20	1981	1980	1979	1979-82
20	25.2	25.2	23.7	24.7	9.5	43.0	25.7
25	23.0	25.3	25.6	24.6	9.4	41.0	25.0
30	27.4	23.5	21.8	24.1	5.7	45.5	25.1
Mean 1981	25.2	24.6	23.6				
1980	9.7	8.6	6.3				
1979	37.4	46.5	45.5				
1979-82	24.1	26.6	25.1				

Differences among the treatments were non-significant. During 1979 also, the differences were non-significant. However, in 1980 the differences in yield between row spacings were significant.

On the average, an inter-plant spacing of 10 to 15 cm and a row to row spacing of 20 to 25 cm produced the highest grain yield.

4.3 Fertilization

4.3.1 Effect of Organic and Inorganic Response:- An experiment to find out the most suitable combination of inorganic fertilizers and organic manure was repeated again for the third year using the same plots as during 1979 and 1980. However a slight modification was done in the control plot and P_2O_5 at the rate of 20 kg/ha was applied.

The yields increased significantly with the increased rates of nitrogen from 0 to 60 kg/ha, and also the organic manures from 0 to 100 q/ha (Tablve VI.5). The highest yield of 33 q/ha was obtained by the application of 60:20:0, N:P:K + 100 q/ha FYM. It is evident that the crop benefitted from the application of inorganic fertilizer and manures either alone or in combination and the best results were achieved when a combination was used.

Table VI.5: Grain Yield (q/ha) as Affected by Varying Levels of Inorganic Fertilizers and FYM

Fertilizer (kg/ha)			FYM (q/ha)				Mean
N	P	K	0	50	100	Mean	1979-81
0	20	0	9.5	11.8	14.5	12.0	12.0
20	20	0	14.6	17.1	20.3	17.4	20.8
40	20	0	17.8	21.2	24.8	21.3	25.2
60	20	0	20.8	26.0	33.0	26.6	29.9
Mean 1981			15.7	19.0	23.2		
	1979-81		17.0	22.7	26.2		

C.D. 5% Inorganic = 1.3 FYM = 1.0
Inorganic X FYM = 2.3

4.3.2 Response of Echinochloa Varieties to Varying Doses of Nitrogen and Phosphorus: An experiment was carried out to study the response of Echinochloa varieties to varying doses of N (0, 20, 40 and 60 kg/ha) and P_2O_5 (0 and 20 kg/ha).

Table VI.6: Grain Yield (q/ha) as Affected by varying Doses of Nitrogen and Phosphorus

N/P	0	20	Mean
0	7.0	7.1	7.6
20	8.7	9.9	9.3
40	12.2	12.5	12.3
60	16.3	17.1	16.7
Mean	11.0	11.7	

The yield was found to increase significantly with increasing doses of nitrogen (Table VI.6). Phosphorus application affected yield very marginally. Although the general yield levels were low, it is clear that nitrogen application can be beneficial in enhancing grain yields. The experiment requires to be repeated.

4.4 Weed Control

The experiment on weed control was continued for the second year with slight modifications.

Table VI.7: Effect of Weeding on Echinochloa

Age (Days)	Grain Yield (q/ha)				
	No Weeding		Weeding		
	1980	1981	1980	1981	Mean
30	-	6.8	13.0	12.8	12.9
45	-	7.2	14.5	18.2	16.4
60	-	4.1	16.1	21.4	18.8
75	-	0.4	16.7	24.4	20.6
Harvest	10.2	0.4	18.4	25.1	21.8

Keeping the fields free from weeds for the first 30 days is very crucial for obtaining good yields (Table VI.7). The losses caused during this period, average around 50 per cent. If the crop is not weeded for about 75 days, there may be almost cent per cent loss in grain yield.

4.5 Echinochloa Based Rotation

Data from a trial continued from 1979 to 1980 are summarised below alongwith financial implications of different rotations. Echinochloa-pea and Echinochloa - Gram are the most productive rotations (Table VI.8). These two rotations gave the maximum net as well as gross profits and the cost benefit ratio. These rotations were followed by Echinochloa -Wheat from the production point of view, and Echinochloa-Lentil from the cost benefit ratio point of view.

All these rotations were much superior to the traditional rotation of Ragi-fallow-Echinochloa-Wheat. In general, highest net returns were obtained when a legume was included in the rotation.

Table VI.8: Average Grain Yield (g/ha) and Annual Monetary Returns (Rs/ha) under Different Crop Sequences

Crop Sequence		Kharif Mean (1979&80)	Rabi Mean (1979-80 and 80-81)	Annual Production	Annual Gross Returns Rs/ha.	Annual net Return/ ha C.S.	Cost Benefit Ratio
Kharif	Rabi						
Echinochloa	Wheat	16.3	19.1	35.4	4090.88	826.59	1:1:26
Echinochloa	Lentil	19.8	10.0	27.8	4355.63	1440.57	1:1:50
Echinochloa	Gram	19.4	17.9	37.3	7260.00	4077.35	1:2:29
Echinochloa	Pea	19.8	18.8	38.6	7119.75	4078.25	1:2:34
Echinochloa	Rati	18.5	6.9	25.4	3623.88	617.82	1:1:21
Ragi	Fallow	19.6 ***					
Echinochloa	Wheat	16.0 **	16.1*	25.8	2834.18	319.17	1:1:13

*** Yield of ragi for one year ** Yield of Echinochloa for one year.

* Yield of wheat one year.

N.B. The economics of the various rotations were worked out on the basis of the grain produce and the prevailing market rates of inputs and output during 1980.

5. DISEASE MANAGEMENT

5.1 Screening

5.1.1 Natural Epiphytotics: Nine hundred and fifty five cultures were screened under natural epiphytotic conditions for different types of grain smuts and brown leaf spots infection in various nurseries and trials. Most of the strains were found susceptible to these two diseases. However, a relatively lesser infection was recorded in twentyeight entries for smut, and twenty entries for brown spots. These cultures will be rescreened during the next kharif season.

5.1.2 Artificial Epiphytotic Conditions: Sixty selected Echinochloa lines including those which had shown tolerance in the previous years were screened under artificial epiphytotic conditions for smuts. An attempt was made to create artificial epiphytotics by treating the seed of these entries with smut spores.

No entry was found free from smuts on the basis of three years observations. However, VHC 5142 and VHC 5219 had relatively lesser disease incidence.

Khatyari Local-2, Kakrighat Sel - 2 and L 3 also showed some degree of tolerance.

5.2 Mycopathological Investigations

5.2.1 Studies on Mode of Perpetuation of Smuts: Pot experiments were conducted to determine the role of seed, soil and air borne spores in infection by smuts of Echinochloa. For chemical control systemic and non-systemic fungicides were used.

It was observed that both seed and soil borne spores caused disease infection. Secondary infection with fresh sporidia was also observed.

The experiment, will be repeated in the next kharif season with certain modifications to confirm the results.

5.2.2 Epidemiological Studies on Smuts: Observations were made on the effect of different dates of sowings on the development of smuts of Echinochloa in a trial with variety VL 8. Six sowing dates at 15 days interval between 15th April to 30th June were used.

It was observed that upto 3rd sowing (i.e. 15th May) the disease incidence increased continuously when the maximum incidence was recorded. Thereafter the disease intensity gradually decreased in later sowings.

5.3 Chemical Control of Echinochloa Smut

As the smuts of Echinochloa may be primarily seed borne, a chemical control trial by seed treatment was initiated in 1979. The trial was repeated in 1980 and 1981 also. On the basis of three years observations, none of the chemicals was found to control the disease completely. However, systemic fungicides Vitavax and Benlate in 1979 and Vitavax in 1981 (Table VI.9) reduced the disease incidence significantly.

These results indiate that soil borne and probably air borne spores also play a significant role in creating disease incidence. However, further investigations are in progress in this direction.

Table VI.9: Fungicidal Control of Barnyard Millet Smuts

Fungicide	Disease Incidence		
	VL 8	EF 2	Mean
Agrosan GN	8.33/2.67	8.33/2.00	8.33/2.39
Dithane M-45	8.33/2.33	6.33/2.67	7.33/2.50
Vitavax	3.67/2.00	3.67/2.00	3.67/2.00
Blitox-50	7.67/2.33	5.67/2.33	6.67/2.33
Difolatan	7.00/2.33	7.00/2.33	7.00/2.33
Copper sulphate	7.67/2.00	7.00/2.33	7.34/2.17
Formaldehyde	6.33/4.00	6.33/2.33	6.33/3.17
Check	8.33/3.00	8.33/2.67	8.33/2.84
C.D. at 5%	1.78	2.145	

Note: 1. Benlate was not included in 1981.
2. Average of 3 replications.
3. Disease rating scale = Percentage of plants infected(1-9)/ Percentage of grains converted into smut sori in an earhead (1-5 scale).

6. PEST MANAGEMENT

6.1 Field Screening

6.1.1 Stemborer: A toal of 955 cultures in the nurseries and trials were screened for the incidence of stem borer Sesamia inferens Wlk. under natural conditions. The borer infestation was not very heavy and only 251 cultures were found to be infested.

Fifteen cultures which were found to be free in different nurseries and trials during previous years under natural infestation were rescreened this year. Two entries, VL 22 and Bageshwar local-2, were free from stem borer incidence over the two years. Bageshwar local-2 was also found free from the attack of pink borer during 1980 and 81. These will be further tested along with new cultures and artificial conditions.

6.2 Pest Monitoring Pest Survey

6.2.1 Cataloguing of Pests: Twentysix new collections were sent to Commonwealth Institute of Entomology, London for identification. Till to date thirty specimens including twelve reported last year and 18 new ones have been identified. The additional insect pests identified are given in the Table VI.10.

Table VI.10: Pests of Millets at Almora

Common Description	Zoological Name	Host Crops
Coloured bug	Callitettix versicolor	Barnyard millet
Rutelid beetle	Mimela fulgidivitteta	Barnyard millet, Ragi and Panicum
June beetle	Anomola dimidiata	Barnyard millet & Ragi
Cetonid beetle	Hetarorrhina Porphryretica	Barnyard millet
Earhead beetle	Idgia assimilia	Barnyard millet
Flat beetle	Dichronychus sp.	Barnyard millet
Spotted beetle	Basitepta sp.	Barnyard millet
Leaf beetle	Mimastra cyanena	Barnyard millet
Dung beetle	Cistelomorpha sp.	Barnyard millet & Ragi
Ear wig	Elaunon bipanitus	Barnyard millet, Ragi Setaria and Panicum.
Bush cricket	Euconocephalus sp.	"
Leaf beetle	Xylotrupus gidaon	Barnyard millet & Ragi
Leaf defoliator	Lepidiota sp.	Barnyard millet & Ragi
Leaf catterpillar	Euproctis sp.	Barnyard millet, Ragi, Amaranthus & Setaria
Brown bug	Dalpada sp.	Barnyard millet & Panicum.
Cow bug	Hysteropterum sp.	Barnyard millet & Panicum.
Leaf hopper	Psammotettix striatus	Barnyard millet & Panicum.
Root grub	Holotrichia seticollis	all minor millets.

6.2.2 Seasonal Incidence of Insect Pests: Seasonal variation in the incidence of pests of barnyard millet is being studied since 1979. This year the study was repeated by taking all the same six sowing dates of 1980 i.e. 2nd May, 12th May, 22nd May, 2nd June, 12th June and 22nd June.

The results revealed that the incidence of shootfly Atherigona sp. was in the same pattern as in the last year. This year also the

the maximum damage 52 per cent during 2nd fortnight of June was recorded in 2nd May sowing. In the later sowings, there was a decline in damage.

The pink borer Sesamia inferens damage was maximum (17.7%) in 2nd May sowing as in the last year's experiment. Thereafter there was a decline in the damage.

Grass hopper damage was quite high at early stage of plant growth in all the sowings. Aphids were also present in traces in all the sowings during later stages of plant growth.

6.2.3 Investigations on White Grub: White grub damage was found to be very serious in Echinochloa crop on cultivators fields. Investigations on various aspect of white grub controll were started in very comprehensive manner and will be reported in due course.

6.3 Insect Pest Control

Experiment on stem borer control by chemical insecticides was initiated in 1979. Carbofuran and Phorate were found to be most effective. The experiment was repeated in 1980 with different doses of these two chemicals. In 1981, the trial was conducted with five chemicals including these two. As the crop suffered due to heavey weed competition yield data were not recorded and only comparative scores for insect infestation were noted.

Table VI. 11: Stem Borer Infestation in Barnyard millet

Chemical	Dose	Infestation
BHC	10% dust @ 40 kg/ha	9.2
Aldrin	5% dust @ 40 kg/ha	7.0
Sevin	50 W.P. @ 0.1% concen.	4.2
Phorate	10 G @ 25 kg/ha	2.2
Carbofuran	3 G @ 25 kg/ha	3.3
Control		15.7

Carbofuran 3G @ 25 kg/ha and phorate 10 G @ 25 kg/ha were again found to be the most effective in controlling the stem-borer incidence (Table VI.11).

7. HIGHLIGHTS OF RESEARCH

7.1 Genetic Resources

955 genetic stocks of barnyard millet were evaluated for various descriptors.

7.2 Varietal Improvement

VL 21 and VL 24 did well in Coordinated and VL Advanced Trials. In addition, VL 13, VL 20, RAU 6 and RAU 7 were also found promising. Several promising selections had also been made from breeding nurseries, F_2 progenies and M_3 generation.

Karyotype of VL 8 was prepared.

7.3 Management of Inputs

Barnyard millet could safely be planted till the middle of June starting from April 15.

A row to row spacing of 20 to 25 cm and a plant to plant spacing of 10 to 15 cm was recommended.

Positive response to nitrogen application upto 60 kg/ha and to farm yard manure upto 100 q/ha was evident. High grain yields could however be obtained with a combination of inorganic and organic fertilizers. Phosphorous application affected the grain yields marginally.

The barnyard millet fields should be kept weed free till 30 days. Otherwise, the loss could be 50 per cent. 75 days delay resulted in complete loss.

Barnyard millet-pea and barnyard millet-gram proved to be the best productive rotations followed by barnyard millet - wheat and barnyard millet - lentil.

7.4 Disease Management

Cultures showing less susceptibility to smut (28), and brown leaf spot (20) were identified. VHC 5142 and 5219 were also relatively less vulnerable to smuts.

Seed and soil borne spores were responsible for initiating smuts. Early planting before May 15 escaped smut incidence.

None of the chemicals tested controlled smuts completely. However, Vitavax reduced the incidence significantly.

7.5 Pest Management

Survey and identification led to establishment of 18 pests on barnyard and other millets.

VL 22 and Bageshwar Local 2 were free from stem borer. Carbofuran 3G (25 kg/ha) and Phorate 10G (25 kg/ha) effectively controlled stem borer incidence.

CHAPTER VII

NATIONAL BUREAU OF PLANT GENETIC RESOURCES

1. GENETIC RESOURCES

1.1 General

The S-1 post provided in this scheme at the Bureau remained vacant because there was no recruitment by the ASRB since the scheme started functioning. The exploration for the collection of germplasm of minor millets was, therefore, undertaken by Scientists of this Bureau in collaboration with the AICMIP and the Agricultural Universities.

1.2 New Collections

During the year, one crop specific exploration was undertaken in March-April, 1981 to the drier areas of Western Andhra Pradesh. The districts of Mahbubnagar, Kurnool, Guddapah and Anantapur ($13^{o}.50'-17^{o}.0$ N lat. and $77^{o}.0'-79^{o}.5$ E long.) were surveyed and seed materials from fields, threshing floors/farmer's stores were collected at 153 collection sites. The collections included a total of 448, ragi (102), Setaria (155), Panicum miliaceum (14), P.miliare (60), Paspalum (67) and Echinochloa (8). Tribal pockets in hilly terrains and remote areas were also surveyed.

The Bureau staff also contributed towards the germplasm collection of minor millets in eight separate explorations undertaken during the year (Table VII.1).

Table VII.1: Minor Millets Germplasm Collections

Area and Districts	Millets and Number
Eastern Karnataka Bidar	Ragi (2)
U.P.Hills Pithorgarh	Panicum miliaceum (10), Ragi (7).
Eastern Maharashtra	Echinochloa (24), ragi (8), Panicums (24).
Maharashtra Ratnagiri Distt.	Setaria (2), P.miliare (12), Paspalum (2), ragi (19), P.miliaceum (10).

Contd...

Table VII.1: Contd..

Area and Districts	Millets and Number
West Bengal Darjeeling Distt.	Ragi (12)
Himachal Pradesh Kinnaur Distt.	P.miliaceum (20), P.maximum (1), Setaria (4), ragi (3).
Tamilnadu Hilly terrains	Ragi (44), P.miliaceum (13) P.miliare (8), Setaria (5), Paspalum (12) Echinochloa (10).
Total	253

Thus, during this year (1981), in 9 explorations a total of 701 collections were made.

1.3 Extent of Variability

Much variability was observed in Setaria collections made from Mahbubnagar, Kurnool and Anantapur for panicle length (10-23 cm), bristles (long to almost insignificant) tiller number (5-13), glume colour (cream, dark orange and purple) and seed colour (light cream to orangish brown). In collections from Prodatur, much variability was observed for panicle length (8-23 cm), Panicle characters (loose to compact), ear thickness (3-5.3 cm) and for glume colour. Anantapur is main area for Setaria but not much variability could be gathered from there as mostly the improved strain 'Arjuna' is under cultivation. North of this district, Panicums and Paspalum are not grown for personal preference of Setaria. Echinochloa is grown in very limited patches and not much variability was observed in this case.

Both P.miliaceum and P.miliare were collected from all the collection sites. Except for seed colour (yellow to greyish black) and size (small to bold) not much variability could be obtained in P.miliaceum. Great variability could be seen for seed colour (light cream to yellow) in P.miliare. In Echinochloa too, very little variability was noticed for panicle length and seed colour. In ragi, much variability was represented for seed colour (brown to red) and seed size (medium to small in many cases).

2. HIGHLIGHTS OF RESEARCH

2.1 Genetic Resources

New collections of ragi (102), kodo millet (67), foxtail millet (155), little millet (60), proso millet (14) and barnyard millet (8) were added from Karnataka, and parts of Uttar Pradesh, Maharashtra, West Bengal, Himachal Pradesh and Tamil Nadu.

CHAPTER VIII

RESEARCH AT COORDINATING UNIT, PUNE

A. INTRODUCTION

Kodo, foxtail, little and barnyard millet multilocational trials were conducted during the year under report. In addition, shootfly on little millet and smut on barnyard millet received special attention.

B. KODO MILLET

1. VARIETAL IMPROVEMENT

1.1 Pure Line Selections

Twenty two pure lines were tested across Pune, Dindori and Coimbatore in a 2 times replicated randomized block design. Ten rows per entry were planted at 22.5 cm x 7.5 cm. IPS 147-1 and CO 2 were included as checks.

2762, 2770 (PSC 8), 2772, 2798 (PSC 1), 2805, 2806 (PSC 4), 2807, 2808 (PSC 5), 2810, 2811 (PSC 2), 2812 (PSC 3), 2813 (PSC 6), 2814 (PSC 7) had given more grain yield than the best national check, IPS 147-1 (Table VIII.1). PSC 1 to 8 are currently undergoing advanced testing in all India trials.

C. FOXTAIL MILLET

1. VARIETAL IMPROVEMENT

1.1 Pure Line Selections

A multilocational trial consisting of 35 pure lines and 2 checks was organized at Pune, Bangalore and Nandyal. The experiment was conducted in a randomized block design replicated 2 times with 10 rows spaced at 22.5 cm x 7.5 cm.

The grain yields were low at Nandyal (Table VIII.2). The trial mean was higher than the check means. 464 (SIC 11), 521, 1294, 1312, 1327 (SIC 9), 1334, 1337 (SIC 12), 1339 (SIC 10), 1349, 1354 (SIC 8), 1363, 1373, 2879 (SIC 6), 300 (SIC 7), 548 (SIC 3), 592 (SIC 4) and 765 exceeded the trial mean of 12.4 q/ha.

SE 21-1 was the dwarfest and the earliest to mature.

Table VIII.1 : Performance of Selected Kodo Millets

Entry	Height (cm)	Maturity (Days)	Grain Yield (q/ha)			
			Pune	Dindori	Coimba-tore	Mean
2759-80K	54	105	44.5	13.9	35.9	31.4
2760-80K	56	103	37.0	13.0	32.4	27.5
2762-80K	54	107	56.7	16.2	46.1	39.7
2763-80K	57	107	45.7	10.9	34.9	30.5
2768-80K	53	103	48.8	7.9	48.0	34.9
2770-80K	54	106	44.8	20.7	54.6	40.0
2772-80K	58	105	42.1	11.7	54.6	36.1
2774-80K	56	106	35.4	12.1	53.6	33.7
2776-80K	58	103	31.5	12.1	47.7	30.4
2797-80K	50	107	33.4	6.2	53.3	31.0
2798-80K	57	102	48.5	16.3	46.4	37.1
2805-80K	58	106	45.4	18.9	51.3	38.5
2806-80K	57	106	49.4	12.8	57.8	40.0
2807-80K	58	103	43.7	12.0	55.7	37.1
2808-80K	60	104	47.1	14.7	65.3	41.7
2809-80K	61	103	39.5	8.2	56.1	34.6
2810-80K	63	106	52.0	10.2	50.5	37.6
2811-80K	63	107	43.5	8.4	66.2	39.0
2812-80K	61	104	53.2	12.3	63.1	42.9
2813-80K	56	106	59.6	15.5	48.3	41.1
2814-80K	59	103	45.2	15.1	59.9	40.0
2815-80K	62	105	22.4	12.4	54.7	29.8
IPS-147-1	64	104	40.3	18.5	48.8	35.9
CO 2	95	123	24.1	10.3	29.8	21.4
Mean	59	106	43.1	12.9	50.6	35.5

Table VIII.2 : Performance of Selected Foxtail Millet

Variety	Height (cm)	Maturity (Days)	Grain Yield (q/ha)			
			Pune	Bangalore	Nandyal	Mean
464-80K	116	90	23.9	12.4	9.1	15.1
473-80K	108	91	11.5	6.5	8.4	8.8
513-80K	107	91	15.9	13.0	7.0	12.0
521-80K	112	86	15.4	16.2	9.3	13.6
1051-80K	108	93	11.2	13.0	7.9	10.7
1294-80K	100	91	8.6	13.0	8.0	13.2
1226-80K	110	92	10.8	13.8	7.0	10.6
1298-80K	106	92	13.4	11.2	7.8	10.8
1309-80K	120	92	12.2	10.4	10.5	11.0
1312-80K	105	93	15.1	14.7	8.2	12.6
1327-80K	117	90	21.0	16.8	10.7	16.2
1328-80K	109	89	13.1	11.8	10.0	11.6
1329-80K	108	90	13.9	15.5	7.0	12.1
1331-80K	100	95	19.3	13.7	6.5	9.8
1334-80K	103	91	19.0	12.7	11.1	14.3
1337-80K	104	90	21.3	14.1	9.0	14.8
1339-80K	107	88	25.1	11.1	10.1	15.4
1349-80K	115	89	17.5	15.2	8.6	13.8
1352-80K	113	90	8.7	5.9	13.3	9.3
1354-80K	123	91	20.7	11.6	17.2	16.5
1357-80K	110	90	17.1	11.8	7.0	12.0
1363-80K	105	90	18.0	16.9	9.3	14.7
1373-80K	101	90	19.3	11.0	8.9	13.1
1402-80K	108	93	11.4	11.8	10.6	11.3
1470-80K	103	90	14.0	11.7	11.5	12.4
2879-80K	110	89	19.2	13.0	10.8	14.3
2884-80K	112	88	11.2	12.4	6.7	10.4
2885-80K	105	89	15.4	16.4	3.9	11.9
300-79K	111	93	16.7	16.1	10.3	14.4
548-79K	108	90	17.2	11.5	15.7	14.8
563-79 K	108	90	15.7	11.5	10.0	12.4
592-79K	105	88	16.2	13.3	8.1	12.5
685-79K	110	93	12.2	17.8	6.1	12.0
764-79K	120	94	12.5	14.5	6.8	11.3
765-79K	105	91	13.5	17.3	8.5	13.1
SE-21-1	78	79	11.5	6.5	1.3	6.4
Arjuna	127	84	10.5	10.6	7.6	9.6
Mean	109	87	15.4	12.9	8.9	12.4

Table VIII.3 : Canopy Competition Studies in Foxtail Millet (Grain Yield q/ha)

Genotype	Densities			Mean
	22.5 cm x 7.5 cm	33.75 cm x 7.5 cm	cm x 7.5 cm	
SE 21-1	19.3	21.7	17.5	19.51
Arjuna	29.5	27.4	27.2	28.0
Nagthana	21.9	33.8	24.9	26.9
Mean	23.5	27.7	23.2	24.8

2. PHYSIOLOGICAL INVESTIGATIONS

2.1 Canopy Analysis

The three distinct genotypes SE 21-1, Arjuna and Nagthana were grown in a split plot design with genotypes in the main plots and plant densities (22.5 cm x 7.5 cm, 33.75 cm x 7.5 cm, 45 cm x 7.5 cm) in subplots. The gross and net subplot sizes were 5.4 m x 3.6 m, and 3 m x 1.35 m. The experiment was replicated 4 times, but difficult soil conditions permitted observations only in two replications.

Arjuna produced higher grain yield at high plant density, while SE 21-1 and Nagthana produced the highest yields at intermediate plant densities (Table VIII.3).

3. NUTRITIONAL QUALITY

3.1 Protein, Fat and Minerals

Foxtail millet germplasm was analysed for seed protein (6.68 to 15.73 %), seed fat (4.0 to 7.1 %) and minerals (1.10 to 4.86 %). The frequency distribution is given in Table VIII.4.

Fatty acid composition was also studied in two high (GS 26 and GS 527) and two low (GS 156 and GS 245) fat accessions. The foxtail millet oil compares favourably with other traditional oils like safflower and sunflower with high poly unsaturated fatty acids (75 to 85 %). Genotypic differences were also evident in fatty acid composition (Table VIII.5).

D. LITTLE MILLET

1. VARIETAL IMPROVEMENT

1.1 Pure Line Selections

The performance of 36 little millet selections was compared in a randomized block design replicated 2 times with 2 checks (K selection and CO 2) at Pune, Ranchi and Sunabeda. Ten rows were planted at 22.5 cm x 7.5 cm spacing.

The data were returned from Pune and Ranchi only (Table VIII.6). 1563 (PRC 6) and 1574 had given more grain yield than the check CO 2 (10.6 q/ha).

Table VIII.4 : Frequency Distribution for Seed Protein, Fat and Millets in Foxtail Millet

Seed Protein			Seed Fat			Mineral		
Class Internal (%)	Mean (%)	Frequency (No.)	Class Internal (%)	Mean (%)	Frequency (No)	Class Internal (%)	Mean (%)	Frequency (No)
6.01-7.00	6.50	2	4.00 - 4.50	4.25	89	1.01 - 1.25	1.13	1
7.01-8.00	7.50	17	4.51 - 5.00	4.75	253	1.26 - 1.50	1.38	1
8.01-9.00	8.00	49	5.01 - 5.50	5.25	492	1.51 - 1.75	1.63	1
9.01-10.00	9.50	85	5.50 - 6.00	5.75	381	1.76 - 2.00	1.88	1
10.01-11.00	10.50	109	6.01 - 6.50	6.25	131	2.01 - 2.25	2.13	0
11.01-12.00	11.50	133	6.51 - 7.00	6.75	52	2.26 - 2.50	2.38	41
12.01-13.00	12.50	66	7.01 - 7.50	7.25	2	2.51 - 2.75	2.63	151
13.01-14.00	13.50	30				2.76- 3.00	2.88	189
14.01-15.00	14.50	10				3.01 - 3.25	3.13	84
15.01-16.00	15.50	1				3.26 - 3.50	3.30	18
						3.51 - 3.75	3.63	6
						3.75 - 4.00	3.88	3
						4.01 - 4.25	4.13	1
						4.26 - 4.50	4.38	0
						4.51 - 4.75	4.63	0
						4.76 - 5.00	4.88	3
6.68-15.73	10.82	502	4.0 - 7.1	5.45	1330	1.10 - 4.86	2.84	502

Table VIII.5 : Fats and Fatty Acid Composition of Foxtail Millet

Accession	Total Seed Fat Content (%)	Fatty Acid Composition (%)			Iodine Value
		Total Saturated	18:1	18:2	
GS 26	7.00	6.00	11.0	81.0	148.3
GS 156	4.57	24.0	12.0	62.0	114.6
GS 245	4.00	15.0	13.0	72.0	140.3
GS 527	7.10	3.0	7.0	89.0	149.7

Table VIII.6 : Performance of Selected Little Millets

Entry	Height (cm)	Maturity (Days)	Grain Yield (q/ha)		
			Pune	Ranchi	Mean
1560-80K	70	89	6.9	7.0	7.0
1563-80K	109	98	15.7	7.0	11.4
1564-80K	97	96	6.9	6.7	6.8
1566-80K	113	98	8.3	7.4	7.9
1574-80K	113	96	12.0	7.0	9.5
1575-80K	107	96	9.0	5.9	7.5
1579-80K	110	94	12.8	6.3	9.6
1592-80K	80	80	13.5	6.7	10.2
1598-80K	79	80	6.4	6.3	6.4
1608-80K	66	76	6.0	7.4	6.7
1609-80K	52	76	4.8	4.4	4.6
1619-80K	70	95	12.0	4.4	8.2
1627-80K	75	95	12.7	5.9	9.3
1634-80K	99	94	11.3	3.7	7.5
1637-80K	101	94	8.2	4.4	6.3
1653-80K	135	101	4.5	5.6	5.0
1683-80K	125	95	12.6	4.8	8.7
1701-80K	92	90	4.4	5.2	4.8
1706-80K	104	94	5.8	4.1	4.9
1721-80K	96	95	12.3	5.6	9.0
1749-80K	61	76	6.1	6.3	6.2
1752-80K	85	88	10.2	8.9	9.6
1783-80K	94	101	4.3	-	4.3
1860-80K	56	75	11.4	7.4	9.4
1865-80K	82	88	6.7	6.3	6.5
1879-80K	115	100	12.6	6.7	9.7
1883-80K	103	94	14.1	5.6	9.9
1574-80K	117	96	15.2	7.0	11.1
1596-80K	81	80	8.7	5.9	7.3
1609-80K	85	86	6.9	4.4	5.7
1651-80K	68	91	8.0	9.3	8.7
1595-80K	77	80	6.4	4.4	5.4
1622-80K	85	86	9.8	5.6	7.7
1862-80K	64	77	9.7	4.1	6.9
1847-80K	72	80	12.0	8.2	10.1
1670-80K	69	90	6.9	6.7	6.8
K-Selection	79	83	4.4	9.3	6.9
CO 2	74	76	11.1	10.0	10.6
Mean	88	83	9.0	6.3	7.7

2. PEST MANAGEMENT

2.1 Rescreening

Thirty six lines that showed resistance to shootfly were rescreened in a randomized block design replicated three times. Four highly susceptible (1651, 1772, 1789 and 1797) lines were also added. Each plot was a row of 3 m long. Total number of tillers and the tillers damaged by shootfly were recorded at random in 5 plants, and the infestation per cent was calculated.

1654 recorded minimum infestation (4.8 per cent), confirming its relative resistance (Table VIII.7)

2.2 Seasonal Incidence of Shootfly

CO 2 was planted 7 timesi in a randomized block design replicated three times. Five rows of 3 m length were planted at 45 cm x 10 cm spacing and fertilized with 40 kg N, 20 kg P_2O_5 and 20 kg K_2O/ha.

Significant differences were observed in shootfly damage and grain yield on different plantings (Table VIII.8). There was an increase in shootfly infestation and damage, and decrease in grain yield with delay in sowing, the maximum occurring on 3-9-81 planting. The infestation was less, and the grain yield maximum in the crop planted on 29-6-1981.

2.3 Compatibility between Carbofuran and Azotobacter

Carbofuran checks shootfly incidence. Azotobacter is a biofertilizer. Both are seed treatments. Their compatibility was therefore studied in a randomized block design replicated 5 times in the variety, CO 2.

Carbofuran 5 % in association with Azotobacter reduced shootfly incidence in comparison with the untreated plot, indicating their compatibility (Table VIII.9). Maximum grain yield was also recorded in combination treated plot, indicating synergistic effects of Carbofuran and Azotobacter.

Table VIII.7: Rescreening of Little Millet against Shootfly

Incidence (%)	Total (No)	Pedigree
0 - 10	1	1654
11 - 20	6	1667, 1673, 1686, 1726, 1687 and 1677
21 - 30	9	1556, 1704, 1720, 1648, 1566, 1706 1703, 1550 and 1723
31 - 40	19	1651, 1789, 1634, 1724, 1752, 1645, 1756, 1693, 1664, 1675, 1665, 1551, 1651, 1772, 1797, 1749, 1565, 1579 and 1567
41 and above	5	1701, 1743, 1751, 1553 and 1688

Table VIII.8 : Effect of Shootfly Incidence on Little Millet

Date of Planting	Dead Hearts (%)	Yield (g/Plot)
29-6-81	5.1	458
12-7-81	16.9	264
23-7-81	25.9	243
3-8-81	28.3	202
13-8-81	30.7	175
23-8-81	36.2	125
3-9-81	42.9	72
S.E.	1.4	31
C D 5 %	4.4	96

Table VIII.9 : Effect of Seed Dressings on Little Millet

Treatment	Dead Hearts (%)	Yield (q/ha)
Carborufuran	3.2	24.1
Carbofuran 5 % + Azotobacter	2.6	27.1
Azotobacter	5.9	15.3
Untreated	14.5	2.7
S E	1.3	2.1
C D 5 %	4.0	6.5

E. BARNYARD MILLET

1. VARIETAL IMPROVEMENT

1.1 Pure Line Selections

Forty six pure lines of barnyard millet were compared in a randomized block design replicated 2 times at Pune, Almora and Coimbatore. Ten rows were planted at 22.5 cm x 7.5 cm spacing. Two checks, K 1 and CO 1 were also included.

The trial mean was higher than the mean of the checks (Table VIII.10). 2301, 2308, 2313, 2324, 2325, 2326, 2330, 2348 (ECC 9), 2375, 2384, 2385 (ECC 8), 2386, 2388 (ECC 6), 2389 (ECC 10), 2392, 2400 (ECC 7), 2401 and 1585 (ECC 5) had given more grain yield than the trial mean. ECC 5, 6, 7, 8, 9 and 10 were included in all India trials. Many cultures were dwarfer and earlier than the checks.

2. DISEASE MANAGEMENT

2.1 Screening for Smut

281 barnyard millet collections were screened in an augmented randomized block design with 4 checks after every 40 rows. Smut spores were mixed with the seeds before sowing for creating artificial epiphytotics. Four selections were free from smut incidence (Table VIII.11). The incidence was less than 5 per cent in 13 more selections in comparison with the checks (33 to 39 per cent). Twelve entries had registered 60 per cent infection, maximum in the experiment.

F. HIGHLIGHTS OF RESEARCH

1. Varietal Improvement

Promising single plant selections of kodo (2770-80K, 2806-80K, 2808-80K, 2812-80K, 2813-80K), foxtail (464-80K, 1339-80K, 1354-80K), little (1563-80K), 1592-80K, 1574-80K, 1847-80K) and barnyard (2385-80K, 2388-80K, 2400-80K) millets substantially surpassing the leading checks had been identified. Some of them are in early and advanced all-India trials for large scale performance and adaptation evaluation.

2. Disease Management

Four pure line selections of barnyard millet (2132-10, 2152-3, 2208-31, 2227-10) were found free from smut incidence under artificial inoculation. The smut percentage ranged from 0 to 60.

Table VIII.10 : Performance of Selected Barnyard Millets

Entry	Height (cm)	Maturity (Days)	Grain Yield (q/ha)			
			Pune	Almora	Coimbatore	Mean
2301-80K	95	94	25.7	22.9	6.3	18.3
2368-80K	77	86	26.5	20.2	7.7	18.1
2313-80K	85	86	23.5	18.9	3.1	15.2
2316-80K	86	86	23.9	17.1	3.7	14.9
2319-80K	107	92	21.1	17.1	3.8	14.0
2321-80K	107	93	22.2	17.1	6.1	15.1
2324-80K	99	97	30.0	14.0	8.6	17.5
2325-80K	104	100	28.3	17.8	4.6	16.9
2326-80K	105	99	26.0	12.7	6.9	15.2
2327-80K	101	99	28.2	15.8	3.4	13.1
2330-80K	111	100	24.8	19.1	7.9	17.3
2332-80K	98	98	16.9	17.8	5.2	13.3
2333-80K	113	98	19.1	11.8	6.6	12.5
2343-80K	111	100	17.4	14.9	6.2	12.8
2345-80K	131	101	18.7	16.7	7.2	14.2
2346-80K	107	100	16.3	10.0	7.2	11.2
2348-80K	110	100	32.4	15.6	8.9	19.0
2350-80K	112	100	24.3	14.4	6.3	15.0
2375-80K	106	93	23.3	19.6	5.9	16.3
2381-80K	75	86	16.7	18.2	2.6	12.5
2384-80K	65	86	23.3	25.8	6.2	18.4
2385-80K	96	92	30.4	22.9	6.5	20.0
2386-80K	108	99	23.3	25.8	7.5	18.9
2387-80K	94	94	17.4	21.8	3.7	14.3
2388-80K	98	91	30.9	25.1	7.2	21.1
2389-80K	92	94	27.4	25.3	4.0	18.9
2392-80K	121	100	30.6	13.6	8.4	17.7
2394-80K	111	98	23.0	11.1	8.1	14.1
2395-80K	127	100	17.2	17.1	7.9	14.1
2396-80K	110	101	23.7	15.1	5.6	12.8
2400-80K	111	98	30.2	24.2	6.3	20.2
2401-80K	114	98	28.3	21.8	5.6	18.6
2426-80K	113	99	17.8	10.7	5.0	11.2
2432-80K	110	101	17.0	10.9	4.6	10.8
1499-79K	94	90	26.3	14.0	3.3	14.5
1500-79K	104	89	21.7	15.3	4.8	13.9
1554-79K	86	91	18.7	12.4	2.9	11.3
1585-79K	101	90	27.2	14.4	5.5	15.7
1588-79K	93	87	19.8	13.1	4.7	12.5
1589-79K	88	87	21.9	17.3	6.0	15.1
1593-79K	81	87	23.0	14.7	3.8	13.8
1596-79K	76	87	20.4	15.3	4.5	13.4
1597-79K	78	88	22.4	14.2	3.9	13.5
1598-79K	82	89	27.0	14.9	2.9	14.9
1603-79K	75	97	22.0	14.9	2.9	13.3
1604-79K	77	89	19.8	14.2	2.7	12.2
K 1	114	101	23.3	11.8	5.2	13.4
CO 1	94	98	17.4	12.0	5.0	11.5
Mean	96	94	23.3	16.7	5.5	15.1

Table VIII.11 : Screening for Smut Resistance in Barnyard Millet

Class/ Score	Pedigree
Highly Resistant (Disease score 0 %)	2132-10, 2152-3, 2208-31 and 2227-10
Resistant (Disease score 5 %)	2116-9, 2128-21, 2132-12, 2134-14, 2139-13, 2146-9, 2147-1, 2154-7, 2170-17, 2218-1, 2259-16, 2268-2 and 2286-1.
Highly Susceptible (Disease score 60 %)	2126-24, 2138-18, 2138-20, 2139-15, 2158-1, 2159-24, 2221-10, 2237-12, 2242-14, 2244-4, 2250-8 and 2271-3.
Checks	2125: 33%, 2529: 39 % 2214: 36 %, 2222 : 36 %

3. Pest Management

Rescreening of little millet lines against shootfly revealed the stability of relative resistance of 1654 over a two year period (1980-82). 1654 recorded an infestation of 4.8 per cent against more than 40 per cent dead hearts in the highly susceptible lines.

Early planting of little millet, with the onset of monsoon, recorded less shootfly damage, and more grain yield. June-end planted little millet showed 5.1 per cent dead hearts as against 42.9 per cent in September first week planting.

Carbofuran and Azotobacter were found compatible in reducing shootfly incidence and enhancing grain yields.

4. Physiological Investigations

Foxtail millet genotypes produced maximum grain yields at higher plant densities ranging from 395 to 593 thousand plants/ha.

5. Nutritional Quality

The seed protein (6.68 to 15.73 %), seed fat (4.0 to 7.1 %) and minerals (1.10 to 4.86 %) were analysed in foxtail millet.

Foxtail millet has a high prop rtion (75 to 85 %) of poly unsaturated fatty acids, revealing that its oil too compares favourably with sunflower and safflower oil quality.

CHAPTER IX

ALL INDIA COORDINATED PROGRAMME

A. INTRODUCTION

All the minor millet centres actively participated in cooperative programme planning and execution.

B. KODO MILLET

1. GENETIC RESOURCES

1.1 Maintenance and Evaluation

Rewa centre planted 560 kodo millets in 3 m rows spaced 50 cm apart and fertilized with 20 kg N and 20 kg P_2O_5/ha. Quantitative and qualitative characters were evaluated.

2. VARIETAL IMPROVEMENT

2.1 Trials

2.1.1 Trial XVIII + XIX : A national kodo millet trial consisting of new and advanced material was organised in a randomized block design replicated 3 times. The gross plot size was 3.75 m x 2.75 m and the net plot was 3.30 m x 2.60 m. Nitrogen was applied at the rate of 20 kg/ha in two splits. The plants were spaced at 22.5 cmx 7.5 cm.

PSC 1 had given maximum grain yield (18.9 q/ha) at minor millet centres (Table IX.1), which is in conformity with all India performance. PSC 1 is a dwarf maturing in 102 days.

2.1.2 Regional Trials : Twenty one selections of kodo millet were tested against three checks (IPS 147-1, Keharpur, JNK 364) in a randomized block design replicated 3 times. The gross and net plot sizes were 3.75 m x 1.75 m, and 3.75 m x 0.90 m respectively. The plants were spaced at 22.5 cm x 7.5 cm, and planted on 27-6-81. The plots were fertilized with 20 kg N, 20 kg P_2O_5 and 10 kg K_2O/ha. The yield differences were significant, but no selection outyielded the check significantly (Table IX.2). However, RPS 128-1, an early maturing selection gave the highest yield of 19.3 q/ha. RPS 119-1, JNK 364, RPS 183-1, RPS 123 and RPS 65-1 were least damaged by shootfly.

2,2 Recombination Breeding

Heterosis was observed for plant height, flag leaf length and width, and ear length in kodo millet crosses, RPS 34-2 x Wild Kodo and RPS 76 x Wild Kodo (Table IX.3). Days to 50 % bloom and maturity were delayed than either of the parents.

Table IX.1 : Performance of Kodo Millet in All India Trials XVIII + XIX

Entry	Origin	Grain Yield (q/ha) Dindori	Rewa	Nandyal	Dholi	Mean	All India Yield (q/ha)	Maturity (Days)	Height (cm)
PSC 3	Pune	5.5	12.1	20.8	26.5	16.2	27.5	101	55
PSC 4	Pune	5.3	13.6	18.0	27.9	16.2	27.1	101	57
RPS 1-1	Rewa	10.5	13.8	12.0	16.3	13.2	26.7	112	65
RPS 107-1	Rewa	10.0	12.1	15.6	19.9	14.4	26.5	109	64
RPS 62-3	Rewa	9.1	15.3	11.6	27.4	15.9	26.6	103	57
PSC 1	Pune	7.0	19.3	24.5	24.6	18.9	28.0	102	54
PSC 2	Pune	6.4	19.3	17.2	28.4	17.8	28.2	101	54
RPS 41	Rewa	13.1	24.2	15.3	16.8	17.4	26.4	107	64
RPS 76	Rewa	11.8	19.5	14.8	17.4	15.9	23.7	97	54
RPS 123	Rewa	10.5	23.0	15.3	19.4	17.1	27.0	105	66
IPS 147-1	Jabalpur	11.3	15.8	12.2	27.1	16.6	26.1	104	58
CO 2	Coimbatore	6.7	8.4	3.1	12.7	7.7	15.2	120	70
Mean		8.9	16.4	15.0	22.0	15.6	25.8	105	60
S E 5 %		1.1	2.5	0.6	0.8	-	-	-	-

Table IX.2 : Performance of Kodo Millet Varieties, Rewa

Variety	Height (cm)	50 % flowering (Days)	Maturity (Days)	Yield (q/ha)	Per cent check	Shoot fly (%)
RPS 107-1	77.3	62	109	12.1	107	4.8
RPS 1-1	71.0	68	109	11.4	100	6.3
RPS 34-2	60.2	61	104	10.9	96	6.0
RPS 183-1	66.6	61	105	14.3	126	2.2
RPS 105-2	73.9	61	106	15.3	135	8.6
RPS 75-2	74.1	61	106	16.7	148	6.1
RPS 128-1	70.2	48	81	19.3	170	29.0
JNK 364	69.1	61	109	14.5	128	2.1
RPS 41	70.4	62	108	15.8	140	3.6
RPS 69-1	69.7	68	110	13.8	122	3.6
RPS 76	64.7	51	84	15.8	140	11.2
RPS-21-3	57.3	71	110	11.9	105	3.5
RPS 119-1	60.7	69	110	12.9	114	1.0
RPS 123	59.2	68	109	14.3	127	2.9
RPS 127-1	64.4	67	108	10.6	94	11.6
RPS 63-1	68.8	53	100	16.1	141	6.2
IPS 147-1	67.6	61	101	11.3	100	4.0
RPS 75-1	66.8	52	87	10.4	92	8.2
RPS 357-1	67.5	68	110	9.9	87	14.0
RPS 22-1	65.3	54	100	14.3	127	6.2
RPS 40-1	64.5	68	110	11.9	105	4.4
RPS 62-3	63.4	53	99	16.3	144	13.1
RPS 136-1	62.2	55	100	15.6	138	7.6
Keharpur	77.8	60	103	14.8	131	8.4

Table IX.3 : Heterosis for Selected Characters in Kodo Millet, Rewa

Character	RPS 34-2 x Wild Kodo			RPS 76 x Wild Kodo			IPS 147-1 (Check)
	F_1	P_1	P_2	F_1	P_1	P_2	
50 % Bloom (Days)	70	0	69	82	52	69	55
Maturity (Days)	129	114	121	130	87	121	94
Height (cm)	68	58	51	57	36	51	62
Flag Leaf Length (cm)	33	29	9	31	26	9	17
Flag Leaf Width (cm)	1.5	1.8	0.6	1.5	0.6	0.6	0.6
Ear Length (cm)	11.0	9.0	6.5	11.0	8.0	6.5	7.6

2.3 Mutation Breeding

RPS 76, an early maturing strain of kodo millet, was treated with 6 doses of gamma rays and was sown separately in 14 m x 2.3 m plots on 20-7-81.

Germination per cent was affected in the plots treated with higher doses of gamma rays (Table IX.4). Tiller number and sterility increased and height decreased with gamma treatment.

Table IX.4 : Morphological Variation in Gamma Treated Kodo Millet, Rewa

Treat-ments (kR)	Germi-nation (%)	Height (cm)	Ear Length (cm)	No.of Tillers	Sterility (%)
25	70	24.6	9.4	14.6	44
30	68	18.8	6.6	12.2	32
35	62	19.4	6.6	7.6	53
40	54	25.2	6.4	7.8	28
45	51	25.6	6.2	12.0	31
50	48	22.6	6.2	9.4	12
0	68	30.6	7.8	6.0	11

2.4 Demonstration Trials

Demonstrations were laid out on farmers fields at Samra, Mankeshar and Rewa in 25 m x 16 m plots fertilized with 20 kg N and 20 kg P_2O_5/ha. The results are incorporated in Table IX.5.

Table IX.5 : Performance of Kodo Millets on Farmers' Fields

Variety	Grain Yield (q/ha)		
	Samra (1980-81)	Mankeshar (1981-82)	Rewa
RPS 76	4.2	15.2	14.0
RPS 62-3	-	22.0	
IPS 147-1	3.0	18.4	-
Dindori 73	3.4	-	-
Kheharpur	1.8	-	-

3. PEST MANAGEMENT

3.1 Survey of Pests

The survey work was undertaken during August-October in Rewa district. Shootfly (0.1 to 17 %), delphacids (0.5 to 5 %), grey weevil (4.0 to 15 %), gundhi bug (3 to 12 %), phadka grass hopper (1 to 4 %), earbed bug (0.0 to 1 %), earhead caterpillars (5 to 30 %), stem borer (0.5 to 10 %), leaf rollers (1 to 6 %) and red and black hairy caterpillers (2 to 3 %) were recorded on kodo and little millets.

3.2 Screening for Shootfly

3.2.1 Germplasm : 613 genetic stocks were grown at Bangalore for rejuvenation. Shootfly and bacterial leaf blight were observed and scored in surviving lines (522).

Shootfly incidence was moderate to heavy (Table IX.6) ranging from 0 to over 70 per cent. 70 accessions were free from shootfly.

Bacterial leaf blight infection ranged from nil to low in a majority of the lines. Only few lines showed high blight incidence.

3.2.2 Selections : Forty three kodo selections with high grain yield potential were screened against shootfly damage in a randomized block design replicated 3 times. Each plot consisted of 4 rows. The differences among the varieties for shootfly incidence and grain yield were highly significant. RPS 1-1, RPS 69-2, RPS 72-2, RPS 64-1, RPS 370-1, RPS 127-1, RPS 218-1, RPS 41, RPS 357, RPS 75-2, RPS 129, RPS 107-1, RPS 211-1 and RPS 123 had shown less than 10 per cent vulnerability to shootfly and produced more than 10 q/ha (Table IX 7). RPS 123 produced 15.7 q/ha with an average of 7 per cent shootfly incidence.

3.2.3 Selected Stocks : Fifteen selections of kodo millet were planted in a randomized block design replicated 3 times and evaluated for shootfly incidence and grain yield. The plot size was 3.75 m x 2.25 m and fertilized with 30 kg N, 15 kg P_2O_5 and 15 kg K_2O/ha. The crop was planted on 26-8-81 and the shootfly damage was recorded on 8-9-81 at Semiliguda.

IPS 147-1 had given maximum yield with minimum incidence of shootfly (Table IX.8).

Table IX.6: Shootfly Infestation on Kodo millet Germplasm, Bangalore

Infestation (%)	Number	Pedigree
0	70	GPLM-6,11,20,21,29,32,37,39,42,45,50,52,54, 60,64,85,87,94,97,104,105,109,112,114, 122,125,133,135,140,171,178,179,180,182, 184,199,202,230,231,234,236,240,241,243, 245,246,251,252,253,258,260,261,262,263, 266,269,270,329,474,481,542,550,555,557, 572,573,580,590,592,596.
1-5	48	GPLM 23,89,195,198,220,247,292,304,330,336, 357,358,369,370,395,402,410,411,416,418, 454,466,470,475,478,483,485,[illegible],499,502, 514,543,547,548,560,568,569,571,586,589, 593, 595,597,598,599,601,605,612.
5.1-10	119	GPLM 15,17,18,36,48,51,65,68,69,73,77,78,108, 127,128,131,136,142,151,165,169,189,190, 209,218,223,224,237,242,256,257,268,271, 280,286,291,295,296,297,300,301,305,318, 323,324,325,339,340,341,342,349,351,353, 363,364,365,366,367,377,381,386,391,393, 401,404,406,407,415,419,428,438,442,453, 471,473,476,480,482,484,487,492,500,509, 510,512,516,517,519,520,521,527,531,532, 533,535,538,544,546,549,552,556,561,563, 577, 565,574,576,578,579,584,585,587,588,591, 603,604,606,607,608.
10.1-15	141	GPLM 3,12,16,19,43,46,61,66,67,75,76,83,90, 92,93,102,111,113,115,118,123,126,129, 143,144,145,155,156,168,174,191,194,197, 201,207,208,210,214,215,216,221,222,233, 238,275,276,277,278,289,293,294,298,311, 316,317,319,320,321,327,328,333,335,343, 345,346,347,350,352,354,355,356,359,360, 361,362,368,371,372,380,382,383,384,385, 389,396,397,399,400,405,408,409,412,420, 423,424,429,432,433,434,437,455,459,462, 465,467,468,472,477,479,489,490,495,501, 503,504,505,507,513,515,518,523,534,536, 537,539,541,545,551,553,558,559,567,570, 581,582,583,594,600,602,609,610.

Contd..

Table IX.6:

Infestation (%)	Number	Pedigree
15.11-20	67	GPLM 10,47,62,74,103,116,117,152,153,157, 159,173,176,193,205,211,212,235,255 265,272,273,287,288,303,307,308,309, 315,322,337,344,378,388,390,392,394, 403,413,414,417,421,427,435,439,441, 444,451,452,456,460,486,488,491,493, 496,511,522,524,526,528,529,530,562, 564,575,613.
20.1-25	33	GPLM 1,13,14,91,95,148,158,200,248,264, 279,299,302,306,326,331,332,338,348, 398,425,426,430,443,446,458,461,469, 494,497,508,540,554.
Over 25.1	44	GPLM 9,41,44,57,71,80,96,120,141,177,213, 217,225,250,254,282,290,310,312,313, 314,334,373,374,375,376,379,387,422, 431,436,440,445,447,448,449,450,457, 463,464,506,525,566,611.

Table IX.7 : Screening for Shootfly Resistance in Kodo Millet, Rewa

Entry	Dead Hearts (%)		Yield (q/ha)
	14 Days	28 Days	
RPS 233-1	13.3	9.7	10.2
JNK 236	15.0	11.3	12.4
RPS 105.2	15.0	8.3	17.9
RPS 1-1	7.7	6.3	13.5
RPS 119-1	7.3	6.3	8.1
RPS 69-2	7.0	7.3	10.7
RPS 102-2	17.0	10.3	13.4
RPS 40-1	12.0	8.0	13.4
RPS 76	15.3	11.0	13.3
IPS 147-1	12.3	12.3	13.9
RPS 117-1	15.0	8.3	10.1
RPS 72-2	7.7	5.6	12.7
RPS 128-1	12.3	9.7	8.7
RPS 120-1	20.0	15.3	14.8
RPS 64-1	5.7	6.3	14.0
RPS 370-1	7.0	7.3	12.5
RPS 62-3	9.7	10.7	11.7
RPS 127-1	8.7	7.0	12.7
RPS 63-1	13.0	7.0	15.7
RPS 136-1	12.3	5.3	16.1
RPS 34-2	15.7	9.0	12.4
RPS 218-1	8.0	7.3	10.9
RPS 135-1	15.3	10.0	12.9
RPS 197-1	12.0	9.3	10.0
RPS 41	8.0	6.3	12.2
RPS 13-1	15.7	7.7	13.2
RPS 31-3	11.0	16.3	9.8
RPS 69-4	16.0	11.0	13.0
RPS 357-1	9.7	8.7	10.7
Keherpur	6.3	8.3	6.7
RPS 22-1	15.3	10.3	13.1
RPS 240-2	15.0	11.0	11.2
RPS 75-2	6.3	6.0	12.0
RPS 231-1	10.0	9.7	9.2
RPS 129-1	8.3	7.3	11.7
RPS 75-1	12.7	9.7	9.5
RPS 107-1	6.3	8.3	10.7
RPS 211-1	9.7	8.3	11.7
RPS 32-2	12.3	8.3	12.7
RPS 343-2	14.3	9.3	13.0
RPS 131-1	13.6	9.0	12.9
JNK 364	14.3	17.0	13.8
RPS 123	6.0	8.0	15.7

Table IX.8 : Shootfly Damage in Kodo Millet, Semiliguda

Germplasms	Dead Hearts (%)	Yield (q/ha)	Height (cm)	Maturity (Days)
PSC 1	26.7	12.3	31	130
PSC 2	42.5	6.1	32	130
MS 1065	14.5	19.4	71	128
CO 2	16.7	22.4	70	129
RPS 62-3	10.8	20.5	47	121
JNK 236	10.8	21.2	51	121
JNK 117	5.8	20.6	64	120
PES 175	4.7	22.0	60	128
IPS 147-1	4.2	23.2	65	119
Keharpur	4.2	20.7	65	121
JNK 364	7.5	20.5	63	119
RPS 123	6.8	24.3	60	118
RPS 117	6.8	24.0	72	119
RPS 76	7.7	18.6	52	110
RPS 41	5.2	21.8	69	116
C D 5 %	4.7	N.S.		

3.3 Date of Planting Vs Shootfly

Five high yielding early, medium and late duration kodo varieties were planted on four different dates at 10 days interval to assess the incidence of shootfly and its effect on yield. The experiment was laid out in a split plot with 3 replications and fertilized @ 20 kg N and 20 kg P_2O_5/ha.

The differences in shootfly incidence and yield were highly significant. Shootfly infestation was maximum in plots sown on July 23 (Table IX.9). RPS 40-1 was less susceptible, and the remaining varieties showed moderate susceptibility. First date of planting and RPS 76 together produced maximum grain yield.

3.4 Effect of Interculture Operations on Shootfly

The effect of weeding (3, 2, 1 and 0 times) in reducing shootfly incidence was studied in two varieties of kodo millet (RPS 76 and RPS 117). The 8 treatment combinations were laid out in a randomized block design replicated 4 time . The crop was planted on 4-7-1981.

Weedings reduced the incidence of shootfly and increased grain yield (Table IX.10).

Table IX.9 : Effect of Date of Planting on Shootfly and Grain Yield in Kodo Millet

Variety		Dead Hearts (per cent)			
		3-7-81	13-7-81	23-7-81	2-8-81
RPS 76	a)	22.0	11.7	8.0	13.7
	b)	25.7	17.7	25.0	14.3
	c)	22.5	20.2	15.9	9.8
RPS 117	a)	11.0	14.3	7.3	10.7
	b)	12.0	14.7	29.0	11.7
	c)	13.5	16.7	15.3	9.8
RPS 40	a)	10.0	8.7	6.7	9.7
	b)	14.0	11.0	25.0	10.0
	c)	16.9	15.9	15.3	5.7
RPS 41	a)	15.3	6.3	8.7	10.3
	b)	14.7	8.0	31.3	10.3
	c)	20.2	14.6	18.6	9.6
IPS 147	a)	13.3	8.0	6.0	10.7
	b)	15.7	13.7	20.7	16.0
	c)	19.6	18.5	15.6	9.5

a: 14 DAG b: 28 DAG c: Yield (q/ha)

Table IX.10 : Effect of Interculturing on Shootfly in Kodo Millet

Weedings (No)	Dead Hearts (%)		Yield (q/ha)	
	RPS 76	RPS 41-1	RPS 76	RPS 41-1
3	1.3	1.4	11.6	10.8
2	3.6	2.4	9.8	8.3
1	9.1	5.8	8.2	6.9
0	7.8	5.8	5.4	4.5

SE Dead Hearts : 0.7
Yield : 0.6

3.5 Effect of Nitrogen and Plant Spacing on Shootfly

The effect of 4 nitrogen levels and 3 plant spacings on shootfly incidence was studied in a split plot design replicated 3 times. RPS 76 was planted on 4-7-81.

The differences among nitrogen doses and plant spacings on shootfly incidence and grain yield were highly significant. Nitrogen fertilization increased shootfly incidence and also the grain yield (Table IX.11). Increasing plant densities also contributed to increasing incidence of shootfly. Considering grain yield and shootfly incidence, medium spacing (7.5 cm) and high nitrogen (30 kg N/ha) appeared beneficial.

Table IX.11 : Effect of Nitrogen and Plant to Plant Spacing on Kodo Millet

N (kg/ha)	Spacing (cm)	Dead Hearts(%) 14 Days	28 Days	Yield (q/ha)
0	5	4.0	2.7	2.7
	7.5	2.0	1.7	2.2
	10.0	1.3	0.7	2.8
	Mean	2.4	1.7	2.6
10	5.0	17.0	11.3	6.6
	7.5	12.7	8.3	6.2
	10.0	9.0	5.7	6.2
	Mean	12.9	8.4	6.3
20	5.0	20.3	14.0	8.4
	7.5	16.0	10.3	7.9
	10.0	13.0	7.3	6.4
	Mean	16.4	10.5	7.6
30	5.0	24.7	17.3	11.2
	7.5	18.3	13.0	10.7
	10.0	15.7	10.7	9.7
	Mean	19.6	13.7	10.5

3.6 Insecticidal Control of Shootfly

Five contact insecticides (BHC 10%, Parathion 2%, Carbaryl 10%, Triforine 15% (EC), Dithianon 75 % (W.P.) were applied in three variable concentrations on RPS 76 to test their comparative efficacy in reducing shootfly infestation. The experiment was conducted in a split plot design with 3 replications.

All treatments effectively controlled the pest population, but differed significantly among themselves (Table IX.12). Parathion followed by Dithianon were most effective. The high concentrations of all the insecticides were significantly superior to lower concentrations and to control. The yield recorded in main treatments was non-significant, while different concentrations of each insecticide showed their effectiveness through increased yields. Maximum grain yield of 27.9 q/ha was harvested with Carbaryl 10 % (25 kg/ha) with an average shootfly incidence of less than 10 per cent, in comparison with 15 q/ha of control with 22 per cent incidence.

4. PROCESSING

4.1 Hulling

Two kilograms of RPS 76, RPS 123, RPS 41, RPS 62-3 and IPS 147-1 were dehusked. RPS 76 gave the maximum yield of rice (dehusked grain) followed by IPS 147-1 and RPS 41 (Table IX.13).

Table IX.12 : Insecticidal Control of Shootfly in Kodo Millet

Dose	Dead Hearts (%) 14 Days	28 Days	Yield (q/ha)
	1. BHC 10 %		
25 kg/ha	11.6	10.0	20.6
20 kg/ha	14.3	13.3	19.9
15 kg/ha	18.3	15.3	16.9
Control	22.7	21.7	14.6
	2. Parathion 2 %		
25 kg/ha	8.0	7.7	22.9
20 kg/ha	11.0	10.0	18.8
15 kg/ha	14.7	12.0	16.3
Control	20.3	22.3	15.3
	3. Carbaryl 10 %		
25 kg/ha	10.3	8.3	27.9
20 kg/ha	12.3	10.3	22.7
15 kg/ha	15.3	13.0	21.4
Control	20.0	24.0	15.0
	4. Triforine 15 %		
0.06 %	12.3	10.7	22.0
0.05 %	13.7	12.3	20.6
Control	22.7	22.7	14.9
0.04 %	16.7	15.0	17.6
	5. Dithianon 75 % W.P.		
0.125 %	11.0	8.7	23.3
0.100 %	13.0	9.3	18.0
0.075 %	13.3	11.7	16.4
Control	18.0	23.7	15.3

Table IX 13 : Processing of Kodo Millet

Variety	Grain (g) Unhulled	Hulled	Rice (%)
RPS 76	2000	1100	55
IPS 147-1	2000	1050	53
RPS 41	2000	1000	50
RPS 123	2000	950	48
RPS 62-3	2000	900	45

C. FOXTAIL MILLET

1. GENETIC RESOURCES

1.1 Characterisation and Classification

1.1.1 Dholi : Altogether 432 genetic stocks were planted in an augmented block design alongwith two checks, namely, RAU 1 and Arjuna for their evaluation. Pre and post harvest observations in respect of most of the yield components were recorded, and are being processed for statistical analysis. On the basis of the performance of the individual genotypes, the high yielding lines would be used in hybridization as well as testing programmes.

1.1.2 Bangalore : The data collected on 1350 accessions during kharif, 1980 had been subjected to principal component analysis using 20 descriptors.

2. VARITAL IMPROVEMENT

2.1 Trials

2.1.1 Trial XII + XIII: The performance of 18 entries was evaluated at all India level in a randomized block design replicated 3 times. The gross plot size was 3.75 m x 2.75 m and fertilized @ 20 kg N and 20 kg P_2O_5 /ha.

The grain yields at Rewa, Dindori and Dholi were less than at Nandyal, the traditional (Table IX.14). Based on averages, ITS 25 and 60, SIC 2,3 and 4 AS 1 had given more grain yield than the check, Arjuna (7.4 q/ha). However, at all India level, SIC 1 (16.5 q/ha) only had given more yield than Arjuna (15.6 q/ha), SIC 4 and 6 had also given more than 15 q/ha.

2.1.2 Nandyal Trial : A similar trial as above, but consisting of 11 entries from Nandyal and 3 checks was conducted at all India level.

The grain yields at Nandyal and all India level were comparable (Table IX.15). SIA 67, 242, 326, 805, 1135, 1142 and 1842 had given more grain yield than the trial mean (16 q/ha) at National level. The performance of SIA 326 in particular is consistent over years.

Table IX.14 : Performance of Foxtail Millet in All India Trial XII + XIII

Entry	Origin	Grain Yield (q/ha)					All India		
		Nandyal	Rewa	Dindori	Dholi	Mean	Yield (q/ha)	Maturity (Days)	Height (cm)
VL 16	Almora	9.1	3.0	5.8	0.9	4.7	6.6	84	127
VL 17	Almora	6.5	3.6	5.0	2.6	4.4	6.1	85	129
ITS 2	Coimbatore	17.9	2.2	3.6	4.1	7.0	14.0	88	120
ITS 25	Coimbatore	18.2	3.7	4.9	5.5	8.1	14.7	89	116
ITS 60	Coimbatore	14.5	4.2	6.5	5.8	7.8	11.8	87	102
AS 2	Aurangabad	14.9	4.4	4.9	2.6	6.6	11.5	84	123
SIC 3	Pune	16.4	3.7	5.8	5.5	7.9	13.6	87	120
SIC 4	Pune	18.7	7.6	7.1	4.0	9.4	15.3	84	115
SIC 5	Pune	11.5	3.5	8.3	3.6	6.7	13.8	87	114
SIC 6	Pune	16.9	2.6	6.7	3.0	7.3	15.3	86	113
SIC 7	Pune	10.6	3.9	3.9	3.6	5.5	11.5	87	114
S 46	Jodhpur	11.2	6.4	3.8	4.9	6.6	9.1	77	99
ITS 69	Coimbatore	14.5	4.5	6.9	3.6	7.4	14.0	92	103
SIC 1	Pune	16.3	2.8	3.8	2.8	6.4	16.5	91	115
SIC 2	Pune	19.7	3.6	4.3	3.4	7.8	13.8	88	116
AS 1	Aurangabad	19.5	5.7	5.4	3.4	8.5	12.6	84	117
CO 3	Coimbatore	19.1	0.9	3.6	3.7	6.8	13.5	92	119
Arjuna	Guntur	13.6	5.4	5.2	5.4	7.4	15.6	84	131
Mean		14.9	4.0	5.3	3.7	7.0	12.8	86	116
SE ± 5 %		0.6	0.8	0.3	0.4	-	-	-	-

Table IX.15 : Performance of Foxtail Millets

Entry	Origin	Grain Yield (q/ha)		Maturity (Days)	Height (cm)
		Nandyal	All India		
SIA 36	Nandyal	16.6	15.7	75	107
SIA 67	Nandyal	16.7	17.0	83	109
SIA 242	Nandyal	17.0	17.4	80	105
SIA 326	Nandyal	17.9	17.8	84	112
SIA 395	Nandyal	17.5	13.4	78	109
SIA 805	Nandyal	16.0	18.0	87	118
SIA 1062	Nandyal	17.9	15.0	85	113
SIA 1135	Nandyal	15.5	17.0	81	110
SIA 1142	Nandyal	16.5	16.8	85	109
*SIA 1253	Nandyal	17.4	15.5	81	112
GK 22	Guntur	13.8	13.8	79	103
ISE 377	Guntur	15.9	15.6	82	109
Arjuna	Guntur	14.7	14.8	83	125
* SIA 1842	Nandyal	15.6	16.2	84	105
Mean		16.3	16.0	82	110
SE 5 %		0.7	-	-	-

2.1.3 Regional Varietal Trial : New foxtail millet selections were compared with the local in a randomized block design replicated 3 times. The gross and net plot size were 3.75 m x 2.25 m and 3.75 m x 1.80 m. The plant to plant spacing was 22.5 cm x 7.5 cm. Nitrogen, phosphorous and potash @ 40, 20 and 10 kg/ha were applied.

Significant differences were detected among the 8 selections (Table IX.16). RSE 28-1 and RSE 53-1 gave significantly higher yield of 8.4 and 8.2 q/ha, respectively, recording 101.4 and 96.4 per cent superiority over the check.

Table IX.16: Performance of Foxtail Millet Selections, Pune

Variety	Height (cm)	50 % Flower-ing (Days)	Maturity (Days)	Yield (q/ha)	Per cent Check
RSE 67-1	118	49	76	7.3	173.9
RSE 28-1	99	42	64	8.4	201.4
RSE 11-1	104	42	64	7.9	189.2
RSE 62	97	45	80	5.4	130.2
RSE 42-2	100	44	68	7.7	183.5
RSE 53-1	106	47	67	8.2	196.4
RSE 21-2	93	46	67	6.3	151.1
RSE 45-1	108	41	62	6.0	143.9
Local	112	49	69	4.2	100.0
S.E.				1.2	

2.1.4 Evaluation : The performance of 55 foxtail millets was evaluated in a randomized block design replicated 3 times, for identifying the best variety. The plot size was 3.75 m x 2.25 m and fertilized with 30 kg N, 15 kg P_2O_5 and 15 kg K_2O/ha. The crop was planted on 27-6-81.

The grain yield ranged from 0.1 to 5.9 q/ha (Table IX.17). ITS 58 and ITS 69, two medium dwarf varieties had given maximum yield.

2.2 Production of Breeder's Seed

Seeds of 11 varieties were produced to maintain the genetic purity and to meet the needs of the experiments. Three promising genotypes were to be tested on farm.

3. MANAGEMENT OF INPUTS

3.1 Date of Sowing x Plant Population

An experiment with three dates of sowing (25-6-81, 8-7-81 and 27-7-81) and three plant populations (22.5 cm x 7.5 cm, 22.5 cm x 7 cm, and 22.5 cm x 5 cm) was conducted in a randomized block design with three replications in plots 6 m x 2.2 m. The yield was estimated from an area of 9.45 m^2 (5.25 m x 1.8 m). The test variety was RAU 1.

The effect of first date of planting was highly significant. Delay in sowing significantly decreased grain yield (Table IX.18). Plant population had no significant effect on grain yield.

Table IX.18 : Grain Yield (q/ha) in Dates x Density Experiment of Foxtail Millet, Dholi

Date	22.5 x 7.5	22.5 x 7	22.5 x 5	Mean
25-6-81	11.9	10.6	12.6	11.7
8-7-81	7.6	7.0	7.4	7.4
27-7-81	5.9	5.3	5.9	5.7
Mean	8.5	7.6	8.7	8.3

S.Em. (q/ha) D = 0.5

3.2 Nitrogen x Phosphorous x Variety

This experiment consisting of four levels of nitrogen (0, 20, 40 and 60 kg/ha), two levels of phosphorous (0 and 20 kg/ha) and three varieties (RAU 1, SI 89/2 and SI 76/4) was conducted in split plot design with N x P_2O_5 in main plots and varieties in sub-plots. The treatments were replicated three times. The sizes of main and sub plots were 7.0 m x 4.5 m and 2.25 m x 4.5 m, respectively. The yield was estimated from an area of 7.20 m^2 (1.8 m x 4.0 m).

Table IX.17 : Evaluation of Foxtail Millet, Sunabeda

Variety	Total Tillers (No)	Effective Tillers (No)	50 % Bloom (Days)	Maturity (Days)	Height (cm)	Panicle Length (cm)	Yield (q/ha)
Arjuna	5	5	60	94	68	9.3	0.8
CO 3	5	5	61	98	75	9.3	2.1
ISe 119	5	5	63	103	78	11.2	2.6
ISe 185	5	6	59	94	73	10.1	0.8
ISe 323	5	6	59	96	78	10.3	1.3
ISe 377	5	5	59	94	71	9.9	1.0
ISe 480	5	7	60	98	85	11.7	2.2
ISe 670	5	5	59	89	59	6.6	1.8
ISe 700	5	5	61	98	73	9.4	3.0
ISe 701	5	5	61	99	77	10.5	3.0
ISe 702	5	6	62	99	86	13.3	3.8
ISe 703	5	6	63	100	90	12.1	3.8
ISe 704	5	7	62	99	83	11.6	3.4
ISe 709	5	7	62	99	84	11.5	3.6
ISe 358	5	6	61	96	93	13.1	3.0
JNSE 78	5	5	56	85	61	9.4	1.8
JNSE 97	5	5	56	88	74	10.6	2.4
JNSE 56	5	5	57	94	91	10.6	3.0
KHS 1	5	5	59	91	69	8.5	0.7
K 3048	5	5	68	101	77	11.9	2.0
K 7235	5	5	63	103	76	11.1	2.6
K 2	5	5	64	89	59	8.9	0.7
HS 1	5	5	64	96	72	8.9	2.0
SI 76/4	5	5	67	100	78	9.8	2.4
SI 80/2	5	5	62	99	89	12.1	2.0
SI 5303	5	7	60	96	76	10.3	2.5
S 1	5	6	54	76	56	9.2	0.3
SE 21-1	5	5	54	77	77	13.7	0.8
S 9	5	5	54	76	60	9.9	0.7
Sel No.26	5	5	56	76	59	10.2	0.6
288 A	5	5	61	90	71	10.4	2.4
410 B	5	5	60	92	78	8.8	2.0
RAU 1	5	5	64	90	70	8.2	0.8
RAU 2	5	5	59	91	72	10.7	2.2
RAU 5	5	5	64	99	87	11.1	3.8
RAU 6	5	5	59	85	76	11.6	1.2
RAU 7	5	5	59	91	71	11.8	1.7
RAU 8	5	5	61	94	91	12.9	3.8
RAU 9	5	5	62	103	81	10.3	3.6
SIA 5	5	5	63	98	83	10.9	2.8
SIA 36	5	5	62	83	50	6.8	0.1
SIA 67	5	5	69	96	69	10.2	0.7
SIA 242	5	5	66	94	68	11.9	0.9
SIA 326	5	5	59	83	59	7.2	1.1
SIA 395	5	5	59	85	61	8.3	2.1
SIA 805	5	6	73	105	92	10.6	4.5
SIA 1062	5	5	73	104	90	10.4	3.0
SIA 1625	5	6	66	96	86	9.6	3.2
SIC 1	5	5	64	93	84	10.7	2.0
SIC 2	5	5	64	93	80	8.9	2.2
GK 20	5	6	59	90	66	8.9	1.3
GK 22	5	5	59	94	75	11.1	2.2
ITS 58	5	5	59	94	68	9.4	5.7
ITS 66	5	5	59	94	75	10.6	5.9
ITS 69	5	5	59	90	78	9.7	3.2

Increasing levels of nitrogen increased grain yield upto 40 kg/ha. (Table IX.19). The difference between any two nitrogen levels was significant. Application of 20 kg P_2O_5/ha was found to be superior to 0 kg P_2O_5/ha level. Maximum grain yield was recorded by RAU 1 (7.6 q/ha) followed by SI 80/3 (6.7 q/ha) and SI 76/4 (6.1 q/ha) and the difference between any two varieties was significant. Nitrogen x variety interaction was also found to be significant.

Table IX.19: N x P x V Interactions in Foxtail Millet, Dholi

Fertilizer	Grain Yield (q/ha)					
	P0	P20	Mean	RAU 1	SI 80/3	SI 76/4
N0	4.6	5.1	4.9	4.6	4.8	5.1
N20	5.8	7.1	6.4	7.9	5.7	5.7
N40	7.9	8.6	8.4	9.6	8.5	7.0
N60	7.0	8.1	7.5	8.2	8.0	6.6
Mean	6.3	7.3	6.8	7.6	6.7	6.1

SE N = 0.2, P = 0.1, V = 0.2 N x V = 0.4

D. LITTLE MILLET

1. GENETIC RESOURCES

1.1 Classification

1.1.1 Bangalore : Quantitative and qualitative characters were collected on 225 accessions of little millet. Based on the range of variability, all the accessions were grouped for easy identification (Table IX.20).

1.1.2 Dindori : A total number of 74 lines collected from different regions of Madhya Pradesh were grown in a randomised block design, replicated three times. The plot consisted of 2 rows of 5 m length. Dindori 1 was used as a check. The germplasm was grouped into open (46) and closed (28) panicle types. Eleven lines matured early (60-65 days) and 6 late (more than 75 days) with 57 falling in medium maturity (66-75 days) group. All the lines were screened for gallfly incidence (Table IX.21). Few lines (5) exhibited less susceptibility (1 to 10 %).

The performance of some top selections is given in Table IX.22.

Table IX.20 : Grouping of Little Millet Germplasm Various Descriptors

Group	Dry Matter 40 Days (g)		50 % Bloom (Days)		Maturity (Days)		Panicle Length (cm)		Tillers (No)		Primary/ Branches (No)	
	Range	No.	Range	No	Range	No	Range	No	Range	No	Range	No
I	0.50 - 1.50	39	30-50	212	60-70	73	10.0- 20.0	147	5.0- 15.0	105	1.0-10.0	155
II	1.51 - 2.50	156	51-70	12	71-80	137	20.1- 30.0	71	15.1- 25.0	114	10.1-20.0	68
III	2.51 - 3.50	30	71-90	1	81-above	15	30.1- 40.0	7	25.1- above	6	20.1-25.0	14

Group	Secondary/Primary (No)		Flag Leaf Length (cm)		Flag Leaf Width (cm)		Panicle Weight (g)		Seed Weight Panicle (g)		Volume Weight (g)	
	Range		Range	No	Range	No	Range	No	Range	No	Range	No
I	1.0 - 5.0	34	5.0-15.0	86	0.10-0.50	21	0.10-1.50	196	0.10-1.50	199	13.0-13.75	19
II	5.1 -10.0	187	15.1-25.0	127	0.51-1.00	17	1.51-3.00	19	1.51-3.00	25	13.76-14.50	149
III	10 1 -15.0	14	25.1-above	12	1.01-150	187	3.01-4.50	10	3.01-above	1	14.51- above	57

Table IX.20 Contd.

Group	Harvest Index (%)		Seed Yield (g)		Straw Weight (g)		Panicle Length (cm)		Height (cm)		Seeds/Secondary (No)	
	Range	No	Range	No	Range	No	Range	No	Range	No	Range	No
I	20.0-30.0	15	1.0-5.0	32	1.0-5.0	6	1.0-10.0	1	40.0-55.0	30	1.0-10.0	101
II	30.1-40.0	143	5.1-10.0	159	5.1-10.0	166	10.1-20.0	221	55.1-70.0	64	10.1-20.0	97
III	40.1-50.0	67	10.1-above	34	10.1-above	53	20.1-above	23	70.1-85.0	72	20.1-30.0	9
IV									85.1-100.0	50	30.1-40.0	12
V									100.1-above	9	40.1-50.0	6

Table IX.21: Screening for Gall Fly Incidence in Little Millet, Dindori

Score	Incidence (%)	No.
0	0	0
1	1 - 10	5
2	10 - 25	7
3	25 - 50	22
4	50 - 75	17
5	More than 75	23

Table IX.22 : Performance of Selected Little Millets, Dindori

Pedigree	Maturity (Days)	Grain Yield	
		g/2 Rows	g/Plant
32	70	126.6	1.23
38	69	131.6	1.30
39	87	125.0	1.22
40	69	180.0	1.21
44	85	143.3	1.47
65	69	121.6	1.58
66	69	123.3	1.32
67	68	138.3	1.58
68	66	143.0	1.70
69	70	128.3	1.40
89	67	121.6	1.57
92	65	121.6	1.44
124	68	123.3	1.34
127	68	120.0	1.35

2. VARIETAL IMPROVEMENT

2.1 Trials

2.1.1 Trial XVI + XVII : The performance of 12 entries of little millet including 5 from Pune and 3 from Rewa was compared in a randomized block design replicated three times. The gross and net plot sizes were 3.75 m x 2.75 m and 3.30 x 2.60 m respectively. The field was fertilized with 20 kg N and 20 kg P_2O_5/ha.

The grain yields at Nandyal were very low, but the Rewa yields were comparable with all India performance (Table IX.23). TNAU 1, RPM 85-1, and PRC 3 had given more than 10 q/ha at all India level. RPM 85-1 and PRC 3 matured in 80 days as compared to 103 days of TNAU 1. They were also dwarfer (78 to 83 cm) than TNAU 1 (113 cm).

Table IX.23 : Performance of Little Millet in All India Trials XVI + XVII

Entry	Origin	Grain Yield (q/ha)			All India		
		Nandyal	Rewa	Mean	Yield (q/ha)	Maturity (Days)	Height (cm)
TNAU 1	Coimbatore	1.8	-	1.0	10.1	103	113
RPM 85-1	Rewa	1.1	10.2	5.7	10.1	78	78
PRC 1	Pune	1.6	7.4	4.5	8.3	82	82
PRC 2	Pune	2.8	3.0	2.9	8.9	89	89
PRC 3	Pune	1.6	5.7	3.7	10.2	80	83
PRC 4	Pune	3.0	6.4	4.7	9.0	80	80
PRC 5	Pune	1.8	5.4	3.6	9.8	80	80
RPM 8-1	Rewa	1.8	6.7	4.3	10.0	81	81
RPM 124	Rewa	2.6	6.5	4.6	9.6	81	81
V 15	Ranchi	2.4	7.0	4.7	9.6	78	78
V 17	Ranchi	1.9	2.1	2.0	9.8	79	79
CO 2	Coimbatore	1.9	6.1	4.0	7.9	93	93
Mean		2.0	6.2	3.8	9.5	84	85
SE 5 %		-	0.7		-	-	-

2.1.2 Regional Varietal Trial : Twenty entries of little millet including a check (IPM 410) were compared in a randomized block design replicated 3 times. The gross plot of 3.75 m x 1.35 m was fertilized with 20 kg N, 20 kg P_2O_5 and 10 kg K_2O /ha. The plants were spaced 22.5 cm x 7.5 cm. The net plot size was 3.75 m x 0.90 m.

The yield differences amongst the varieties were significant (Table IX.24). RPM 12-1, RPM 1-1, RPM 7-1 and RPM 56-1 with yields of 9.4, 8.1, 7.9 and 7.9 q/ha respectively, were superior to all other varieties including control, IPM 410 (4.2 q/ha). The damage due to shootfly was least in RPM 7-1, RPM 60-1, RPM 56-1 and RPM 11-3 ranging from 3.5 to 5.3 per cent.

3. MANAGEMENT OF INPUTS

3.1 Response to N, P and K Fertilization

An experiment was conducted in split plot design replicated four times to determine optimum N, P and K doses. Four nitrogen levels (0, 5, 10 and 20 kg/ha) were the main treatments, while three levels of P_2O_5 (0, 10 and 20 kg/ha) and 2 levels of K_2O (0 and 10 kg/ha) were the sub treatments. The gross and net plot sizes were 4.0 m x 2.25 m and 3.5 m x 1.80 m respectively. Gariyaband was sown on June 27, 1981 and harvested on September 9, 1981.

Table IX.24 : Performance of Little Millet Varieties, Rewa

Variety	Height (cm)	50 % flowering (Days)	Maturity (Days)	Yield (q/ha)	Per cent check
RPM 1-1	84	40	63	8.1	191.7
RPM 7-1	94	47	72	7.2	188.3
RPM 9-4	103	48	73	6.7	158.8
RPM 2-1	102	46	72	6.9	164.8
Singrali 2-1	82	44	67	7.9	188.3
RPM 12-1	96	44	71	9.4	223.6
RPM 8-1	78	44	73	6.0	143.6
V 15	101	41	64	6.9	163.6
RPM 85-1	68	42	62	7.2	170.5
RPM 15-1	81	44	65	4.8	115.2
RPM 8-3	87	48	71	6.7	158.8
RPM 124	80	43	72	7.7	182.4
RPM 60-1	100	45	71	6.9	164.8
RPM 72-1	92	41	66	3.4	79.8
RPM 192-1	90	50	71	6.3	150.5
RPM 56-1	65	41	65	7.9	188.3
RPM 9-2	71	41	65	5.8	137.6
RPM 11-3	91	41	66	6.9	164.8
RPM 31-1	95	50	75	4.5	106.0
IPM 410 (Check)	107	63	94	4.2	100.0
S.E.	-	-	-	1.3	-

Nitrogen application increased the yield significantly in 1981 only (Table IX.25). An application of 5 kg N/ha gave 9.0 per cent increase of grain yield over no nitrogen. Further increase of N-level to 10 and 20 kg/ha resulted in production of 0.6 and 1.4 q/ha more grain than 5 kg N/ha. Phosphorus and potash applications at different levels did not influence the yield appreciably in both the years.

NxPxK interaction was significant only in the year 1981. Maximum grain yield of 7.9 q/ha was obtained with 20 kg/ha each of nitrogen and phosphorus during 1981. Based on 2 years average, 10 kg N/ha only had given as much as 7.2 q/ha.

Table IX.25 : Effect of Inorganic Fertilization in Little Millet

Treatment	Grain Yield (q/ha) 1980	1981	Mean
$N_0 P_0 K_0$	4.9	4.9	4.9
$N_0 P_0 K_{10}$	5.2	5.4	5.3
$N_0 P_{10} K_0$	6.4	6.0	6.2
$N_0 P_{10} K_{10}$	5.1	4.9	5.0
$N_0 P_{20} K_0$	4.4	4.9	4.7
$N_0 P_{20} K_{10}$	5.0	7.4	6.2
$N_5 P_0 K_0$	5.1	4.9	5.0
$N_5 P_0 K_{10}$	3.9	5.9	4.9
$N_5 P_{10} K_0$	4.6	6.9	5.8
$N_5 P_{10} K_{10}$	4.2	7.0	5.9
$N_5 P_{20} K_0$	4.9	5.8	5.4
$N_5 P_{20} K_{10}$	4.9	6.0	5.5
$N_{10} P_0 K_0$	6.7	7.6	7.2
$N_{10} P_0 K_{10}$	5.8	6.3	6.1
$N_{10} P_{10} K_0$	5.5	6.6	6.1
$N_{10} P_{10} K_{10}$	5.6	7.1	6.4
$N_{10} P_{20} K_0$	5.0	6.3	5.7
$N_{10} P_{20} K_{10}$	4.9	6.2	5.6
$N_{20} P_0 K_0$	5.7	7.2	6.5
$N_{20} P_0 K_{10}$	5.9	7.8	6.8
$N_{20} P_{10} K_0$	5.3	7.7	6.5
$N_{20} P_{10} K_{10}$	5.3	7.8	6.6
$N_{20} P_{20} K_0$	5.3	7.9	6.6
$N_{20} P_{20} K_{10}$	5.5	6.7	6.1

Mean				
	N_0 : 5.4	N_5 : 5.4	N_{10} : 6.2	N_{20} : 6.5
	P_0 : 5.8	P_{10} : 6.1	P_{20} : 5.7	
	K_0 : 5.9	K_{10} : 5.9		

4. PEST MANAGEMENT

4.1 Screening

4.1.1 Germplasm : Fifty genetic stocks of little millet received from Bangalore were sown on 16-7-81 in two row plots of 3 m length without replication. Nitrogen and phosphorus were applied @ 40 kg/ha each.

Gall and shootfly incidences were recorded on 19th August, 1981. Only two entries were free from gall fly (Table IX.26). All other entries were susceptible to shootfly (22 to 62 % dead hearts) and gall fly (25 to 100 %).

4.1.2 All India Entries : Twelve entries of little millet were planted in a randomized block design replicated 3 times at Nandyal.

The shootfly incidence was very heavy and ranged from 50 per cent in PRC 4 to 86.6 per cent in TNAU 1 (Table IX.27). PRC 4 had also given maximum yield of 3 q/ha.

Table IX.27 : Shootfly Incidence in Little Millet

Entry	Dead Hearts (%)	Yield (q/ha)
TNAU 1	86.6	1.0
RPM 85-1	75.0	1.1
PRC 1	78.3	1.5
PRC 2	70.0	2.8
PRC 3	56.6	1.6
PRC 4	50.0	3.0
PRC 5	76.6	1.8
RPM 8-1	73.3	1.8
RPM 124	71.6	2.6
V 15	60.2	2.4
V 17	68.3	1.9
CO 2	65.0	1.9

4.1.3 Selections : Four promising varieties of little millet (RPM 8-1, CO 2, RPM 124 and Gariyaband) were sown in a randomized block design, replicated thrice in two row plots of 3 m length. A basal dose of 40 kg N and 20 kg P_2O_5/ha was applied uniformly in the field.

Table IX.26 : Screening of Little Millet Germplasm for Insect Incidence, Dindori

Variety GPM:	Days to			Damage		Grain Weight
	Flowering	Maturity	Harvesting	Gallfly	Shootfly	g/2 ows
88	54	79	98	25	34	80
82	49	79	98	-	44	45
83	34	63	83	50	36	30
85	48	67	88	100	45	27
86	34	65	88	55	62	30
87	34	63	82	57	44	70
93	36	64	82	50	33	55
94	42	65	83	100	22	30
96	64	79	98	-	42	50
97	48	77	98	-	42	35
98	40	77	98	-	41	40
99	40	65	82	100	42	50
101	40	63	82	100	38	55
107	39	78	98	100	30	40
110	37	78	98	-	31	60
112	36	65	83	50	36	45
113	40	67	83	33	40	65
118	36	65	83	57	40	90
126	36	65	83	92	38	60
127	40	77	83	100	43	100
130	42	77	83	100	40	20
133	35	77	83	100	31	65
134	35	77	83	90	30	85
135	36	77	83	100	38	40
137	54	69	83	-	25	45
143	40	73	83	100	43	70
144	35	65	83	80	34	115
147	40	73	83	71	35	70
149	36	67	83	72	38	95
154	40	73	83	83	31	100
158	42	77	83	-	39	100
159	40	77	83	71	38	95
162	50	78	98		24	85
164	40	77	88	100	47	75
165	35	64	83	67	42	150
174	51	79	90	-	33	40
175	34	63	83	44	36	140
181	40	77	88	67	46	65
184	36	65	88	75	52	80
185	40	77	88	100	38	105
186	34	67	83	67	43	40
191	48	73	83	-	41	40
209	63	81	122	75	38	68
211	50	95	122	-	32	70
214	65	97	122	-	34	70
215	54	78	98	-	31	45
217	50	77	122	-	35	60
219	36	52	82	80	36	47
223	65	81	98	-	40	40
224	63	81	122	-	34	50

The per cend dead hearts varied from 7.2 to 13.6, and 12.0 to 14.7 on 7-8-81 and 25-8-81, respectively (Table IX.28). Gall fly varied from 12.2 to 17.6 per cent on 25-8-81. Late lines were more susceptible to shoot and gall flies. RPM 8-1 had given maximum grain yield indicating recovery resistance.

Table IX.28: Selective Screening to Shoot and Gall Flies in Little Millet, Dindori

Variety	Dead Hearts (%)		Gall Fly (%)	Days to		Yield (g)	
	7-8-81	25-8-81		Flowering	Maturity	10 Plants	2Rows
RPM 8-1	13.6	13.1	17.6	39	75	85	397
CO 2	11.1	12.0	16.3	55	83	20	67
RPM 124	7.2	13.7	15.9	36	68	73	275
Garyaband	8.6	14.7	12.2	36	66	40	197

4.1.4 New Selections : Twenty little millets were planted in a randomized block design replicated three times. Fertilizer was applied at the rate of 20 kg N and 20 kg P_2O_5/ha.

The varietal differences for infestation percentage and yield per plot were highly significant (Table IX.29). RPM 41-1, RPM 12-1, RPM 29-1, RPM 192-1 and RPM 60-1 were less susceptible, while RPM 56-1 RPM 124, Dindori 1-2 and RPM 38-1 were highly susceptible. Remaining strains showed medium degree of resistance. Due to unfavourable climatic conditions, the yields were very poor, but less susceptible strain RPM 60-1 gave the highest yield of 2.2 q/ha.

4.2 Effect of Date of Sowing on Shootfly

Five little millets were sown on four dates with an interval of 10 days. The experiment was laid out in a split plot design with three replications in 10 row plots. The main treatments were dates of sowing and the strains were sub-treatments. A dose of 20 kg N and 20 kg P_2O_5/ha was applied, basally. Observations were recorded at an interval of two weeks. The total number of tillers and number of tillers with dead hearts were counted in one metre square in the centre of each plot.

Table IX.29 : Shootfly Incidence in Little Millet, Rewa

Entries	Dead Hearts (%)	Yield (q/ha)
V 17	13.8	0.5
Singroli 1-1	13.0	0.9
RPM 38-1	24.2	1.1
RPM 124	25.7	1.3
Singroli-2-1	13.3	1.3
RPM 66-1	14.2	1.2
RPM 60-2	20.2	1.2
Dindori-1-2	26.2	1.6
RPM 105-1	13.3	0.9
RPM 53-2	11.3	0.9
RPM 102-1	15.0	0.9
RPM 192-1	9.5	1.1
RPM 8-1	13.2	1.0
RPM 29-1	9.7	1.6
RPM 11-1	18.2	0.7
RPM 12-1	9.2	1.6
RPM 60-1	9.8	2.2
RPM 41-1	9.5	1.3
RPM 56-1	26.8	1.0
IPM 410	18.7	1.1

The data were analysed and found significant. Crops sown on July 13 were highly damaged and RPM 8-1 was highly susceptible. July 3 sowing was the safest, and V 17 and RPM 85-1 gave the highest yield when sown on that date (Table IX.30).

Table IX.30 : Effect of Dates of Planting on Shootfly in Little Millet, Rewa

Variety		3-7-81	13-7-81	23-7-81	2-8-81
RPM 85-1	a)	7.5	18.3	12.0	15.5
	b)	8.6	3.7	1.9	0.5
V 17	a)	4.5	22.5	12.0	16.2
	b)	8.9	5.0	2.4	0.4
RPM 8-1	a)	7.7	20.2	14.3	16.2
	b)	4.9	2.8	1.7	0.6
RPM 124	a)	6.5	18.0	12.3	14.0
	b)	4.9	2.6	2.0	0.4
IPM 410	a)	5.3	12.5	10.2	12.2
	b)	2.7	1.6	1.1	0.3

SE ±	Shootfly	0.9
	Yield	0.1

4.3 Estimation of Losses Caused by Shoot and Gall Flies

Five rows of Gariyaband were sown on 29-6-81 in 2 m x 1.25 m plots in a randomized block design with 4 replications. Six treatments (BHC 5%, DDT 5%, Malathion 5%, Carbaryl 5%, Ash + Kerosine (5%) and control) were given to assess the losses due to seedling and earhead pests. The rains were received next day after treatment. Insecticidal effects were therefore not reflected in control of shootfly 7 and 29 days after treatment (Table IX.31).

Table IX.31 : Control of Insects in Little Millet

Insecticides	Dead Hearts (%)			Gall Fly (%)		Yield
	11-8-81	28-8-81	19-9-81	28-8-81	19-9-81	g/5 rows
BHC 5 %	22.7	46.6	43.9	16.1	27.0	310
DDT 5 %	23.7	50.3	47.6	20.3	23.6	214
Malathion 5 %	19.7	53.8	51.3	19.3	22.1	350
Carbaryl 5 %	21.3	42.6	38.3	17.9	23.3	248
Ash + Kerosine 5 %	23.5	55.7	58.1	18.7	24.5	334
Control	22.2	52.6	45.9	16.6	26.5	202

Pre treatment : 11-8-81
Post treatment : 28-8-81 and 19-9-81

E, PROSO MILLET

1. VARIETAL IMPROVEMENT

1.1 Trial XIV + XV

Fourteen proso millet selections including 2 from Almora and 4 from Dholi were tested for their grain yield potential and adaptability in all India Trials. The experiment was laid out in a randomized block design replicated 3 times. The gross plot size was 3.75 m x 2.75 m and was fertilized at the rate of 20 kg N and 20 kg P_2O_5/ha. The net plot size was 3.30 m x 2.60 m with a plant to plant spacing of 22.5 cm x 7.5 cm.

The grain yields were low at Nandyal (Table IX.32) which is not a traditional tract for proso millet. All India performance indicated that MS 1316 (17.6 q/ha) and MS 1437 (14.4 q/ha) were superior to MS 4872 (12.7 q/ha).

Table IX.32 : Performance of Proso Millet in All India Trials XIV + XV

Entry	Origin	Grain Yield (q/ha) Nandyal	Grain Yield (q/ha) India	Maturity (Days)	Height (cm)
VL 1	Almora	1.4	5.6	66	58
VL 2	Almora	1.1	5.0	67	62
RAU M1	Dholi	2.1	6.0	70	57
RAU M2	Dholi	2.3	5.6	70	58
RAU M3	Dholi	1.5	6.5	67	60
RAU M4	Dholi	1.8	4.7	68	57
MS 1316	Coimbatore	5.7	17.6	72	63
MS 1307	Coimbatore	3.7	11.0	72	60
PM 29-1	Jodhpur	2.8	8.9	64	53
PM 31-1	Jodhpur	2.4	8.1	64	54
MS 1437	Coimbatore	3.9	14.4	71	65
MS 1595	Coimbatore	3.7	9.3	71	57
CO 1	Coimbatore	5.3	5.5	74	63
MS 4872	Coimbatore	2.6	12.7	70	63
Mean		2.9	8.6	69	59
S.E. 5 %		0.3	-	-	-

2. PEST MANAGEMENT

2.1 Screening

2.1.1 All India Entries : Fourteen entries were sown in a randomized block design replicated three times at Nandyal on 25-10-81.

The shootfly incidence ranged from 5 per cent in MS 1316 and MS 1595, to 20 per cent in VL 2 (Table IX.33). MS 1316 had given a grain yield of 5.7 q/ha as against 3.6 q/ha of MS 1595.

2.1.2 Promising Entries : Seven promising varieties (BR 1, BR 2, BR 7, BR 8, BR 9, BR 11 and BR 12) were sown on 17-7-81 in a non-replicated block. A basal dose of 40 kg N and 40 kg P_2O_5/ha was applied uniformly before sowing.

Observations were recorded on 10 randomly selected plants. There was severe damage of shootfly in early stages, and damage due to gall fly was also high during earhead stage (Table IX.34). Inspite of severe damage, BR 8 had given maximum grain yield, indicating compensatory mechanisms. It was followed by BR 1 which had shown resistance at early stages.

Table IX.33 : Shootfly Incidences in Proso Millet, Nandyal

Entry	Dead Hearts (%)	Yield (q/ha)
VL 1	18.2	1.4
VL 2	20.0	1.1
RAU M1	6.6	2.1
RAU M2	8.3	2.3
RAU M3	8.3	1.5
RAU M4	13.6	1.8
MS 1316	5.0	5.7
MS 1307	6.6	3.6
PM 29-1	8.3	2.8
PM 31-1	10.0	2.8
MS 1437	8.3	3.9
MS 1595	5.0	3.6
MS 4872	10.0	2.6
CO 1	6.6	5.3

Table IX.34 : Screening of Selected Proso Millets for Insect Incidence, Dindori

Variety	Dead Hearts (%)		Gall Fly	Days to		Grain Yield (q)
	10-8-81	4-9-81	4-9-81	Flowering	Maturity	
BR 12	19.7	60.3	20.2	29	54	720
BR 1	9.5	58.7	22.9	29	56	840
BR 9	30.5	69.5	25.0	30	54	390
BR 2	24.7	51.4	30.7	31	56	800
BR 11	20.3	54.5	31.7	31	56	83
BR 7	23.0	51.9	26.6	32	60	105
BR 8	26.5	54.7	28.0	31	60	965

F. BARNYARD MILLET

1. GENETIC RESOURCES

1.1 Collections of Germplasm

Eight new collections from Madhubani and Darbhanga districts were added to the germplasm pool at Dholi.

1.2 Characterisation and Classification

A total of 194 lines were evaluated with three checks namely RAU 2, 3 and local in an augmented block design at Dholi. Germination was very poor in most of the plots and consequently the desired plant population could not be maintained. Quantitative observations were recorded only in those plots in which plant populations was desirable and in the rest only the ten earheads were harvested. Data are being processed.

2. VARIETAL IMPROVEMENT

2.1 Trials

2.1.1 Trial XX + XXI : Fourteen entries were planted in a randomized block design replicated 3 times and fertilized with 20 kg N and 20 kg P_2O_5/ha. The gross and net plot sizes were 3.75 m x 2.75 m and 3.30 m x 2.60 m, respectively. The plants were spaced at 22.5 cm x 7.5 cm.

VL 24, RAU 5, 6, 7, 8 and 9 exceeded the trial mean (14.9 q/ha) at minor millet locations (Table IX 35). RAU 6 and 9 had given the maximum yield of 17.1 q/ha. This compared favourably with all India performance. Most of the lines tested matured in 79 to 86 days. Many of them, notably, all the RAU selections were dwarfer (87 to 103 cm) than the check, K 1 (132 cm).

Table IX 37 : Performance of Barnyard Millet, Rewa

Variety	Height (cm)	50 % Flowering (Days)	Maturity (Days)	Yield (q/ha)	Per cent check
REF 51-1	115	50	77	11.6	170.3
REF 10-1	100	41	68	8.2	120.3
REF 64	105	41	68	10.9	159.3
REF 18-1	73	43	71	9.1	134.2
REF 74-1	98	41	73	9.2	134.8
REF 79-1	110	47	77	10.4	152.3
REF 57-2	100	42	68	11.4	167.4
REF 16-1	136	46	75	8.9	130.4
REF 14-2	134	46	75	8.9	130.4
Local	116	45	75	6.1	100.0

2.1.2 Evaluation : The performance of 32 improved barnyard millets was compared with two locals in an yield trial. The entries were planted in a randomized block design replicated 3 times. The gross plot (3.75 m x 2.25 m) was fertilized @ 30 kg N, 15 kg P_2O_5 and 15 kg K_2O/ha. The crop was planted on 25-6-81.

The performance of barnyard millet was better than the performance of foxtail millet. The grain yields ranged from 3.8 to 14.2 q/ha (Table IX.36). K 2461 had given the maximum yield (14.2 q/ha) in 99 days as compared to 10.3 q/ha of Kotagarh local in 90 days.

Table IX.35 : Performance of Barnyard Millet in All India Trials XX + XXI

Entry	Origin	Grain Yield (q/ha)					All India		
		Almora	Rewa	N andyal	Dholi	Mean	Yield (q/ha)	Maturity (Days)	Height (cm)
VL 20	Almora	19.3	10.2	8.1	13.1	12.7	15.0	84	119
VL 21	Almora	20.5	12.8	8.5	14.4	14.1	16.3	84	118
VL 23	Almora	13.8	6.8	4.0	12.9	9.4	14.2	85	118
VL 24	Almora	19.4	11.8	3.8	17.8	13.2	16.8	84	110
VL 25	Almora	12.0	8.2	7.1	11.9	9.8	13.9	86	129
ECC 3	Pune	11.6	15.3	12.7	12.8	13.1	13.1	80	90
ECC 4	Pune	11.0	11.9	11.0	10.5	11.1	12.1	79	89
ECC 5	Pune	16.8	11.6	10.8	12.4	12.9	14.7	83	105
RAU 5	Dholi	17.4	10.2	10.7	17.8	14.0	16.1	82	88
RAU 6	Dholi	24.	8.9	14.6	20.3	17.1	16.0	82	98
RAU 7	Dholi	21.9	11.9	9.7	16.4	15.0	16.0	83	87
RAU 8	Dholi	12.0	11.6	15.9	18.2	14.4	15.6	84	96
RAU 9	Dholi	13.9	18.6	17.6	18.1	17.1	16.8	83	103
K 1	Kovilpatti	13.0	2.2	14.5	12.3	10.5	15.4	96	132
Mean		16.2	10.9	10.6	14.9	13.2	15.1	84	106
SE 5 %		1.8	1.2	0.4	1.5		-	-	-

Table IX.36 : Evaluation of Barnyard Millet, Sunabeda

Entry	Total Tillers (No.)	Effective Tillers (No)	50 % Bloom (Days)	Maturity (Days)	Height (cm)	Panicle Length	Yield (q/ha)
K 1	5	5	63	99	105	12.8	9.9
K 2	5	5	61	99	102	11.5	10.3
K 2461	5	6	60	99	110	13.0	14.2
KE 33	5	7	41	91	79	10.7	6.1
KE 6906	5	7	41	90	70	10.0	6.1
KE 7201	5	6	42	84	76	10.0	6.9
ECC 1	5	6	41	83	56	8.7	6.9
ECC 2	5	8	43	83	59	9.5	6.1
CO 1	5	7	67	101	91	11.3	8.3
VL 8	5	6	54	97	80	8.8	6.3
VL 10	5	6	54	95	90	10.3	11.6
VL 11	5	5	56	94	91	9.6	11.8
VL 12	5	5	56	93	85	11.6	7.3
VL 13	5	5	49	96	77	9.9	7.9
VL 14	5	6	51	91	83	12.3	3.8
VL 15	5	5	57	89	80	10.1	5.3
VL 16	5	7	54	93	85	11.1	7.5
VL 17	5	6	55	91	86	8.8	7.7
VL 18	5	5	54	91	88	10.6	8.5
VL 19	5	7	53	91	79	8.6	10.5
EF 2	5	6	46	98	79	10.1	8.1
RAU 1	5	9	48	83	73	9.6	6.3
RAU 2	5	5	47	91	77	9.9	11.5
RAU 3	5	6	47	90	68	10.3	9.1
RAU 4	5	7	46	93	68	10.8	5.3
RAU 5	5	7	54	89	65	9.7	7.1
RAU 6	5	8	45	92	79	9.7	4.7
RAU 7	5	8	47	82	75	11.3	7.5
RAU 8	5	9	45	92	76	11.3	8.5
RAU 9	5	6	48	87	75	9.5	5.9
REF 10-1	5	7	43	79	87	12.1	5.7
REF 64	5	8	41	79	86	9.9	6.9
Phulbani	5	6	57	87	88	12.9	9.3
Kotagarh	5	6	52	90	86	12.3	10.3

2.1.3 Regional Trial : Nine selections were planted in a randomized block design replicated 3 times. The gross and net plot sizes were 3.75 m x 2.25 m and 3.75 m x 1.80 m, 20 kg N and 20 kg P_2O_5/ha were applied. The plants were spaced at 22.5 cm x 7.5 cm and sowing was done on 29-6-81. The yield differences were not significant. However, REF 51-1, REF 57-2, REF 64 and REF 79-1 gave promising yields of 11.6, 11.4, 10.9 and 10.4 q/ha, respectively (Table IX.37).

2.1.4 Station Trial : An experiment comprising of 19 elite genotypes develod at Dholi centre was conducted in a randomized block design replicated three times. The plot size was 3.75 m x 2.25 m. Ten plants were selected to record quantitative competitive observation in each plot. Mean yield varied from 8.9 to 22.4 q/ha with the general mean of 16.8 q/ha (Table IX.38). Grain yield was statistically significant. Two varieties, RAU 8 and Sam 4 recorded the highest mean yield of 22.3 and 22.4 q/ha, respectively.

Table IX.38 : Station Trial of Barnyard Millet, Dholi

Variety	50 % flowering (Days)	Maturity (Days)	Height (cm)	Length of Ear (cm)	Effective Tillers (No)	Grain Yield (q/ha)
RAU 8	56	87	137	24.0	0.7	22.3
RAU 9	51	80	129	21.4	0.9	16.3
DH 9	56	82	140	24.8	1.0	13.5
DH 10	54	81	136	19.6	0.7	17.4
DH 12	54	81	137	23.5	0.6	16.7
DH 14	51	80	129	18.6	0.7	14.3
DH 16	51	80	132	22.6	1.1	8.9
Beni 1	54	81	133	20.5	0.7	14.8
RAU 5	57	87	119	22.2	0.8	13.7
RAU 6	55	82	148	23.1	0.7	17.5
Sam 4	57	82	130	21.9	0.7	22.4
Sam 6	58	82	136	23.3	0.6	14.8
Sam 9	53	81	144	25.4	1.0	14.4
Sam 12	57	87	136	23.7	0.8	17.8
EC 5	59	88	144	24.5	0.8	16.3
MUZ 1	58	88	129	23.4	0.7	18.7
RAU 7	56	87	118	23.6	0.8	17.4
Dholi local	58	87	128	23.6	0.9	16.7
Ara 25	59	88	139	24.3	0.8	20.6
RAU 1	57	87	131	23.9	0.5	18.4
RAU 2	61	88	149	24.9	0.5	17.7
RAU 3	58	88	136	22.9	0.5	19.7
SE (m)	-	-	-	-	-	2.2

2.2 Multiplication of Breeder's Seed

Since 9 varieties developed at this centre had been identified as the best on the basis of yield, the seed multiplication programme was undertaken to maintain the genetic purity. Single row plots were planted from the selected ear heads and on the basis of the phenotypic performance of the lines, high yielding progenies were selected. Two varieties, namely, RAU 2 and RAU 3 had been recommended for minikit demonstrations.

3. MANAGEMENT OF INPUTS

3.1 Date of Sowing x Plant Population

An experiment with three dates of sowing (16-6-81, 10-7-81 and 21-7-81) and three plant populations (22.5 cm x 7.5 cm, 22.5 cm x 7 cm and 22.5 cm x 5 cm) was conducted in a randomized block design with six replications in plots of 6.0 m x 2.25 m. The grain yield was estimated from an area of 9.45 m^2 (5.25 m x 1.8 m). The test variety was RAU 1.

The first two plantings were at par and both of them were significantly superior to the last date. 22.5 cm x 7.5 cm and 22.5 cm x 5 cm were at par and both of them were significantly superior to 22.5 cm x 7 cm (Table IX.39).

Table IX.39 : Effect of Date of Planting and Density in Barnyard Millet, Dholi

Date	22.5 cm x 7.5 cm	22.5 cm x 7 cm	22.5 cm x 5 cm	Mean
16-6-81	22.8	20.5	23.9	22.4
10-7-81	24.3	19.8	22.1	22.1
21-7-81	9.2	8.1	10.1	9.1
Mean	18.7	16.1	18.7	17.7

SE ± D or P : 0.6 D x P : 1.0

3.2 Nitrogen x Phosphorous x Varieties

An experiment consisting of four levels of nitrogen (0, 20, 40 and 60 kg/ha), two levels of phosphorous (0 and 20 kg/ha) and three varieties (K 1, RAU 1 and VL 11) was conducted in split plots having NxP in main plots, and varieties in sub-plots. The treatments were replicated three times. The sizes of main and sub plots were 7.0 m x 4.5 m and 2.25 m x 4.5 m, respectively. The yield was estimated from an area of 7.2 m^2 (1.8 m x 4.0 m).

The effects of nitrogen, phosphorous, varieties, and NxV were highly significant (Table IX.40). Increasing levels of nitrogen significantly increased grain yield upto the highest level (60 kg/ha) and differences between any two levels was significant. Phosphorous significantly increased grain yield. RAU 1 gave the highest grain yield and it was significantly superior to K 1 and VL 11. VL 11 was significantly superior to K-1. Yields of varieties increased with increasing levels of nitrogen, except K 1 which had slightly lower yield at N 40 as compared to N 20.

Table IX.40 : Nitrogen and Phosphorous Effect on Barnyard Millet, Dholi

Fertilizer	Grain Yield (q/ha)					
	P0	P20	Mean	K 1	RAU 1	VL 11
N0	6.0	6.6	6.3	5.6	6.8	6.5
N20	10.1	12.4	11.6	10.9	12.4	11.6
N40	13.8	15.8	14.8	10.7	18.4	15.3
N60	15.3	17.5	16.4	12.1	19.3	18.0
Mean	11.5	13.1	12.3	9.6	14.2	12.9

SE (q/ha): N = 0.2; P = 0.2; V = 0.3; NxV = 0.5

4. PEST MANAGEMENT

4.1 Screening for Shootfly

Fourteen entries were raised in a randomized block design replicated 3 times on 12-8-81 at Nandyal. Shootfly was recorded at seedling and earhead stages.

The shootfly incidence ranged from 8.3 per cent in VL 24 to 26.6 per cent in RAU 9 (Table IX.41). However, RAU 9 had given the maximum yield (17.6 q/ha) as against 3.8 q/ha of VL 25, indicating regional adaptation.

5. DISEASE MANAGEMENT

5.1 Screening for Leaf Stripe

Among the 36 lines tested against Helminthosporium frumentacei, 10 (RAU 6, RAU 5, Samastipur 4, Samastipur 12, ECC 5, Muzaffarpur 1, ARA 25, ARA 1, RAU 2 and RAU 3) proved to be resistant (Table IX.42).

Table IX.41: Shootfly Incidence in Barnyard Millet

Entry	Shootfly Incidence (%)		Yield (q/ha)
	Seedling	Earhead	
VL 20	13.3	0.0	8.4
VL 21	13.3	0.0	8.2
VL 23	16.6	5.0	4.0
VL 24	8.3	20.0	3.8
VL 25	16.6	0.0	7.2
ECC 3	25.0	10.0	12.5
ECC 4	25.0	0.0	10.9
ECC 5	21.6	0.0	10.8
RAU 5	21.6	5.0	10.7
RAU 6	20.0	10.0	14.6
RAU 7	21.6	0.0	9.7
RAU 8	25.0	20.0	16.0
RAU 9	26.6	5.0	17.6
K 1	21.6	5.0	14.5

Table IX.42 : Screening of Leaf Stripe in Barnyard Millet, Dholi

Variety	Disease (%)	Reaction
RAU 6	3.3	R
RAU 8	6.0	MR
RAU 9	5.3	MR
VL 24	7.7	MR
RAU 5	9.0	MR
RAU 7	12.7	MS
VL 21	14.0	MS
VL 20	22.3	MS
VL 23	27.7	MS
ECC 3	32.0	MS
ECC 5	32.7	MS
K 1	40.0	MS
VL 25	43.7	MS
ECC 4	48.7	S
SI 3 (RAU 8)	15.0	MS
Sabour 4 (RAU9)	13.3	MS
DH 9	16.7	MS
DH 10	31.7	MS
DH 12	25.0	MS
DH 14	26.7	MS
DH 16	33.3	MS
Benipatti 1	18.3	MS
RAU 5	5.0	MR
RAU 6	16.7	MS
Samastipur 4	9.7	MR
Samastipur 6	15.0	MS
Samastipur 9	13.3	MS
Samastipur 12	8.3	MR

Table IX.42 Contd.

Variety	Disease	Reaction
ECC 5	4.7	MR
Muzaffarpur 1	8.3	MR
Muzaffarpur 2	13.3	MS
RAU 7	21.3	MS
Arrah 25	8.3	MR
RAU 1	8.3	MR
RAU 2	3.7	MR
RAU 3	10.0	MR

G. HIGHLIGHTS OF RESEARCH

1. Genetic Resources

Kodo (560), foxtail (1782), little (225) and barnyard (194) millets were evaluated for various descriptors.

2. Varietal Improvement

Superior selections of kodo millet (PSC 1, RPS 128-1), foxtail millet (SIC 1, SIA 67, 242, 326, 805, 1135, 1142, RSE 28-1, RSE 53-1, ITS 58, ITS 69), little millet (RPM 85-1, PRC 3, RPM 12-1), proso millet (MS 1316, MS 1437) and barnyard millet (RAU 6, RAU 9, K 2461, REF 51-1, REF 57-2, REF 64, REF 79-1, RAU 8, Sam 4) were identified.

Heterosis was observed for plant height, flag leaf length and width, and ear length in kodo millet crosses.

3. Management of Inputs

Date of planting significantly influenced foxtail millet yields, but not plant spacings (22.5 cm x 7.5 cm to 22.5 cm x 5 cm). Early planting with the onset of monsoon returned maximum yields, but delay in planting even by 10 days adversely affected grain yields.

Planting with monsoon and even 25 days later did not affect grain yields of barnyard millet.

Nitrogen application significantly increased grain yields upto 20 kg N/ha in little millet, 40 kg N/ha in foxtail millet and upto 60 kg N/ha in barnyard millet.

Phosphorous had positive effect on grain yields of foxtail and barnyard millets upto 20 kg/ha, but did not influence grain yields of little millet.

4. Pest Management

Shootfly resistant lines were isolated in kodo (many), proso (MS 1316, MS 1595, BR 1) and barnyard (VL 24) millets.

Early plantings with the onset of monsoon escaped shootfly in kodo and little millets.

Weeding effectively reduced shootfly incidence in kodo millet.

Increased nitrogen fertilization and plant densities increased shootfly incidence in kodo millet.

Carbaryl 10 % (25 kg/ha) effectively checked shootfly incidence in kodo millet.

5. Disease Management

RAU 2, 5 and 6 and ECC 5 barnyard millets had shown less than 5 per cent leaf stripe (Helminthosporium frumentacei).

6. Processing

The hulling per cent varied from 48 to 55 per cent in kodo millet.