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Third National Seminar on Millets research and development - Future policy options in India

Vol. 3 : Finger millet

Proceedings

Organized by

All India Coordinated Pearl Millet Improvement Project
Agricultural Research Station, Mandor, Jodhpur 342 304, Rajasthan, India

In collaboration with

of Millets Development (Department of Agriculture & Cooperation)
Mini Secretariat, Bani park, Jaipur 302 016, Rajasthan, India

National Research Centre for Sorghum &
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Rajendranagar, Hyderabad 500 030, AP, India

All India Coordinated Small Millets Improvement Project
University of Agricultural Sciences, GKVK campus, Bangalore, India

कृषि मूलम् इदम् धान्यम्

Society for Millets Research

(Regd. No.395/2004)

Regd. Office: 11-127, National Research Centre for Sorghum (NRCS)
Rajendranagar, Hyderabad-500030, AP, India.

Millets as a group of crops are represented by sorghum (*jowar*), pearl millet (*bajra*), finger millet (*ragi*), and minor millets including banyard millet, proso millet, kodo millet and foxtail millet. Being excellent source of essential nutrients, they are also called as 'nutritious cereals'. Millets are the staple food for the world's poorest and most food insecure people across the semi-arid tropics. The three crop improvement programmes on millets, sponsored by the Indian Council of Agricultural Research(ICAR) and the National Research Centre for Sorghum (NRCS), and other institutions in both public and private sector are working to improve livelihood of dryland farmers through improvement of productivity and alternate uses of millets.

The "Society for Millets Research" (SMR) has therefore been formed to provide a common platform to all the individuals engaged in research and development efforts on Millets. This society endeavours to create a meaningful mandate for actions, and groups (both regional, national and international diasporas) to enhance global competitiveness of millets through efficient and environmentally friendly production technologies, value-addition and marketing as a significant food, feed, fodder, fuel (bioenergy) crops to ensure economic prosperity of resource-poor dryland farmers of tropics. The primary goal of developing this society is to serve the cause of millets through partnership with the industry and other interested stakeholders to promote their utilization.

GOALS

1. To promote research and development on millets and millet-based cropping systems.
2. To promote industrial utilization of millets to enhance economic threshold levels of rural livelihoods in the semi-arid tropics.
3. To disseminate knowledge on millets through lectures, seminars, symposia, publications and exchange programmes.

OBJECTIVES

1. Improving the quality and cost-effectiveness of millets production systems.
2. Improvement of nutritional and food quality of millets and promotion of millets as health-food, and industrial raw material.
3. Incorporation of durable resistances to various pests, diseases and parasites and promote integrated management of pests including post harvest technology.
4. Promoting industrial uses of millet grain and stalks, including millets as principal source of biomass and bio-energy.
5. Creating avenues to enhance export of millets and to create a viable researcher-industry interface for over all promotion of millets as industrial crops.

ACTIVITIES

The activities of the society will consist of organizing seminars and symposia in frontier areas on millets and publication of journals, bulletins, reports, newsletters and sponsored monographs.

OFFICE BEARERS

1. President	:	Dr. NGP Rao, Former Chairman: ASRB; Hyderabad
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Status of research and development in small millets in India

K.T.Krishne Gowda, Project Coordinator

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Introduction

Small millets - a group of six crops/minor coarse cereals, namely finger millet (*Eleusine coracana*), little millet (*Panicum miliare*), kodo millet (*Paspalum scrobiculatum*), foxtail millet (*Setaria italica*), barnyard millet (*Echniochola frumentacea*) and proso millet (*Panicum miliaceum*), representing the area grown in that order. These crops have traditionally been the indispensable component of dry farming system. On an average 4.0 million hectares are planted to these crops annually (Table 1).

Among small millets, finger millet is the most important crop grown in many states of Southern, Central, Eastern, Western and Northern India from sea level in coastal Andhra Pradesh to 8000 feet altitude in Himalayas. The loss of area under finger millet has been less (from 2.5 to 2 million hectares) during the past 3 decades but with significant improvement in productivity. The major ragi growing states are Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Maharashtra and Uttar Pradesh. Karnataka state has the largest area of around one million hectares (50% of total area) followed by Orissa, Maharashtra, Tamil Nadu, Andhra Pradesh and Uttar Pradesh each having 10-12 per cent of the total area.

On the contrary the area under other small millets has reduced by more than half with proportionate reduction in total production and the productivity remained low and stagnant around 450 kg per hectare. Though small millets are grown in almost every state/region, the distribution of individual millet is not uniform. The kodo, little and foxtail millets are grown widely in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Madhya Pradesh and Maharashtra. In Madhya Pradesh, both kodo and little millet are predominant, while foxtail millet is important in Andhra Pradesh and Karnataka. Barnyard millet and proso millet are grown largely in hills of Uttar Pradesh, North-Eastern region and plains of North Bihar and Western Uttar Pradesh and Maharashtra. The choice of particular small millet and stability of crop production and productivity are influenced by the vagaries of monsoon, scantiness of rainfall and its ill-distribution in the southern states while it is stable and evolved for the farmers to adopt themselves for less intensive agriculture in assured *kharif* situations in tribal belts, hill tracts of Eastern, Central, Western and Northern states.

These crops have all along received little emphasis and least attention. The situation somewhat improved with the launching of independent Coordinated Crop Improvement Project for Small Millets 1986. Since the launching of independent project, many high yielding varieties and other technologies have been developed for different agro climatic regions. As a result, it is possible now to extend the cultivation of these crops on scientific lines provided adequate resources are allocated towards development programmes which are too meager now (Seetharam *et.al.*).

Table 1 : Growth rate of finger millet and small millets (1951 to 2003)

	Finger Millet			Other Small Millets		
Year	**Area**	**Production**	**Productivity**	**Area**	**Production**	**Productivity**
1951-55	2274	1606	704	5290	2180	410
1956-60	2455	1872	764	5023	1944	389
1961-65	2555	1888	743	4677	1889	404

1966-70	2420	1887	779	4741	1784	375
1970-75	2442	2227	909	4489	1745	388
1976-80	2588	2650	1019	4326	1743	402
1981-85	2474	2613	1054	3459	1391	401
1986-90	2399	2509	1090	2748	1214	443
1991-95	1936	2574	1333	1920	867	453
1996-00	1722	2415	1401	1495	652	436
2001-03	1718	2273	1322	1092	519	475

** Area 000' hectares ; Production in 000'tones; Yield in kg/ha*

2. Salient research accomplishments

The AICRP on Small Millets with its project head quarters at GKVK Campus, UAS, Bangalore has been functioning with 13 other centers spread over in 10 states. In addition to these centers there are many voluntary/ collaborative centers participating in different activities related to crop improvement, crop production and protection. Improved varieties possessing higher yield, variable maturity, resistance/tolerance to various diseases, insect pests and abiotic stress have been evolved and released for general cultivation across the length and breadth of the country. There has been fair amount of stress on the development of region specific varieties/ technologies. Crop improvement has been receiving more important as seed encapsulated technology is not only cheap but also non polluting and a cost effective pivotal input in the overall crop production strategy. A concise account of progress made in different areas of crop production are presented here.

2.1. Varieties /strains with production potential identified region-wise to bridge the existing gaps in productivity

The list of recently released varieties of finger millet and other small millets recommended state wise is given in table 2.

Table 2. List of cultivers released for different states

Name of the crop/variety	Year of release	Adaptation Zone	Special features
Finger millet			
Indaf – 7	1986	Karnataka	Cold tolerant, suitable for rabi season
Indaf-8	1986	Karnataka	Late variety suitable for early kharif planting, high yield
Indaf – 9	1986	Karnataka	Early-variety, suitable for the kharif planting as well as for summer season
KM-13	1988	Plains of Uttar Pradesh & Madhya Pradesh	High seed yield
PES-400	1989	Uttar Pradesh Hills	Early maturity
Co-13	1989	Tamil Nadu	High yield
TRY-13	1989	Tamil Nadu	Tolerant to salinity
VL – 124	1989	Uttar Pradesh hills	Medium duration variety and high seed and fodder yield
RAU-8	19891	All states	Medium duration variety, high seed yield
VL – 149	1991	All states	Early variety, blast tolerant high yield, wide adaptation
MR-1	1992	Karnataka	High seed yield

A-404	1993	Bihar	High seed yield
Gautami	1993	Andhra Pradesh	High seed yield and tolerance to blast
Dapoli-1	1994	Konkan region of Maharashtra	-
VL 146	1995	Uttar Pradesh hills and Karnataka	Tolerance to blast and early maturity
KM 65	1995	Uttar Pradesh	Suitable for Usar soils
Pradamavathi	1995	Andhra Pradesh	Tolerant to blast
MR-2	1995	Karnataka	High seed yield
Barsa Marua-2	1995	Bihar	High seed yield
Gujarath Nagli-3	1993	Gujarath	—
GPU-28	1996	Karnataka	High yield and blast resistance
OUAT-2(Suvra)	1998	Orissa	White seeds and high protein
Maruthi(PR-23)	1999	Andhra Pradesh	—
BM 9-1	1999	Karnataka, Andhra Pradesh, Orissa, Madhya Pradesh & Maharashtra	High yield
L-5	2000	Karnataka	Late variety
GPU 26	2000	Karnataka	Early, blast tolerant.
GPU 45	2001	Madhya Pradesh, Gujarath, Jharkhand, Karnataka and Maharashtra.	Blast resistant and high grain yield.
OEB 10	2001	Orissa, Madhya Pradesh, Gujarath, A.P and T.N.	Moderate resistant to blast, resistant to stem borer.
VL 315	2004	Uttaranchal	Tolerant to finger and neck blast
Foxtail millet			
Nischal	1988	Uttar Pradesh	High seed yield
K-3	1989	Tamil Nadu	High seed yield
AK 132-1	1990	Andhra Pradesh	Drought tolerant, high seed yield
Krishnadevaraya	1993	Andhra Pradesh	High seed yield
Gavari (SR-1)	1995	Rajasthan	High seed yield
TNAU 43	1996	Tamil Nadu	—
PS 4	1998	All states	Wide adaptation and high yield
TNAU-43	1998	Tamil Nadu, Andhra Pradesh & Karnataka	—
SR 16 (Meera)	2000	Rajastan	Stay green character
Sri Lakshmi	2002	Andhra Pradesh	
SR 51	2003	Rajasthan	Bold seeds
Kodo millet			
JK 76	1989	Madhya Pradesh	Earliness
JK 62	1989	Madhya Pradesh	Earliness and high yield
GPUK 3	1991	All states	Yield, earliness and resistance to grain smut
AKP 1	1993	Tamil Nadu	High seed yield
GK 2	1993	Gujarath	—

Vamban – 1 (KMV 20)		1996	Tamil Nadu —
RBK 155	2000	Madhya Pradesh, Karnataka	Resistant to head smut and shootfly.
JK 48	2001	A.P., M.P., Chattisgarh, Karnataka & Gujarath.	Tolerance to head smut and high grain yield
KK 2	2002	Uttar Pradesh	Resistant to drought and lodging and suitable for saline condition
Proso millet			
CO 4	1989	Tamil Nadu	High seed yield
Nagarjuna	1989	Andhra Pradesh	High seed yield
Sagar	1989	Andhra Pradesh	High seed yield
Bhawna	1992	Uttar Pradesh	Earliness
GPUP 8	1999	Karnataka	High seed yield
GPUP 21	2003	Karnataka and Tamil Nadu	Suitable for late sowing

The new varieties are able to meet the specific regional needs in different states.

2.2. Regionally differentiated production and protection technologies.

Crop Management

In the field of agronomic research, the following cultural management/production practices have demonstrated their potential for realizing higher yields.

Finger millet

- Early planting with the onset of monsoon in June-July is beneficial.
- Transplanted crop produces higher seed yield compared to the broadcasted crop.
- Planting 20-25 days old seedlings is optimum for transplanted crop.
- Seed rate of 6-8 Kg/ha and row spacing of 25-30 cm is optimum.
- Seed treatment with Aspergillus awamuri and Azospirillum barasilense increases seed yield and the effect is equivalent to the application of 10 Kg N/ha. Appiication of p in the form of super phosphate and rock phosphate in 1: 1 proportion is found to improve seed yield.
- Line sowing is superior to other methods. In situations of non-availability of seed drill, opening furrows well in advance and broadcasting seeds when conditions are favourable is preferable.
- Application of 40-50 Kg N/ha in two splits; 50% at sowing and the rest 6- 7 weeks after. sowing give higher grain yield under rainfed/irrigated conditions.
- *Irrigated crop of Ragi responds upto 90 Kg N./ha.*
- Enriched compost application @ 2.5 tonnes/ha at sowing increases seed yield.
- 2,4-D @ 0.75 Kg/ha as post- emergence spray 15-20 days after sowing effectively controls weeds.
- Isoproturon @ 0.5 Kg/ha given as pre-emergence spray is also effective in rainfed Ragi for areas of labour scarcity.
- Ragi followed by groundnut + Pigeon pea (4:1 row proportion) crop rotation is most remunerative with higher monetary returns than solecropping of Ragi in Karnataka.
- Ragi and pigeon pea /fieldbean in 8:2 row proportion is found to give higher monetary returns in Karnataka. (Table 3).
- Ragi-soyabean mixed cropping was beneficial in Orissa, UP and Bihar than sole crop of Ragi.
- Ragi-soyabean inter-cropping in 4 : 1 or 8 : 1 proportion gives highest monetary returns in hills of Uttar Pradesh.
- Improved variety and management with recommended

fertilizer dose gives significantly higher seed yield (65% more) than in the case of local variety and management and without fertilizer application.

- Selection of short/medium duration variety and crop establishment by transplanting can minimize the reduction in yield under late sown condition. (Table 4).

Foxtail millet

- Seed rate of 10 Kg/ha for dry seeding and 7.5 Kg/ha for normal sowing is recommended.
- Seed inoculation with Aspergillus awamuri improves productivity.
- Application of 40 N and 20 Kg P205/ha is optimum.
- Foxtail millet +groundnut in 2:1 row proportion brings higher returns (Rs. 8685/- per ha) than sole crop of foxtail millet (Rs.2150/- per ha).
- Foxtail millet + pigeonpea in 5: 1 proportion is the next most remunerative alternative in Andhra Pradesh. (Table 3).
- Foxtail millet-mustard followed by foxtail millet-green gram crop sequences are better alternatives than growing foxtail millet after foxtail millet.
- Growing foxtail millet at 45 cm row spacing and introducing Rabi - Jowar as relay crop is feasible in years of normal kharif rainfall in Andhra Pradesh.

Kodo millet

- Sowing with the onset of monsoon in the last week of June and first week of July is optimum in Madhya Pradesh.
- In areas of assured rainfall in June, dry seeding 10 days before normal onset of monsoon is beneficial.
- Row spacing of 22-25 cm is optimum.
- Kodo millet responds upto 40 Kg N/ha under rainfed conditions.
- Kodo-Pigeon pea intercropping in 2:1 row proportion ensures higher profits (Rs. 2500/- per ha) than sole cropping (Rs. 898/-per ha).
- Once hand weeding after 20 days of sowing improves the seed yield by 50-60% over no weeding.

Little millet

- Sowing in the last week of June to first week of July with the onset of monsoon reduces damage by shoot fly and ensure higher seed yield.
- Seed rate of 10-12 Kg/ha with a row spacing of 20 cm and seeding at a shallow depth of 4-5 cm is found optimum.
- Opening furrows and broadcasting seeds after rain was as good as sowing by seed drill.
- One weeding at 20 days after sowing ensures good crop growth and yield.
- Economic optimum dose of fertilizers is 20:20:0 Kg NPK/ha. However, crop responds upto 40 Kg/ha.
- Little millet and green gram in 2:1 proportion in Orissa and Bihar; little millet and sesame/soyabean in 2:1 proportion in Madhya Pradesh is profitable than growing sole crop.
- Little millet-Niger crop gives higher monetary returns than little millet-toria sequence.

Proso millet

- Sowing proso millet during the first week of March is optimum for Bihar.
- Proso millet and green gram in 2: 1 row proportion is profitable than raising sole crop.
- Finger millet-potato-Proso millet is a profitable crop rotation for North Bihar .
- Fertilizer dose of 40:20:20 Kg. NPK/ha is optimum.

Barnyard millet

- Seed rate of 10 Kg/ha for dry seeding is optimum.
- Optimum plant stand establishment and yield could be obtained by sowing during 15th April to 30th May in hills of Uttar Pradesh.
- 40 Kg N and 20 Kg P per hectare are optimum.
- Barnyard millet-pea and barnyard millet-gram crop sequences are most remunerative in U .P .hills.
- Inter-cropping of barnyard millet and rice bean(4: 1) is profitable and 75% of recommended nitrogen is sufficient in such crop combinations in U .P hills.

Table 3 : Profitable small millets based inter cropping system

Crop	State	System
1. Ragi	Karnataka	Ragi + Pigeon pea 8 :2
		Ragi + Field bean 8 :1
	Tamil Nadu	Ragi + Pigeon pea 6-8 : 1
		Ragi + field bean 6-8 : 1
		Ragi + cowpea 4 : 1
	Andhra Pradesh	Ragi + pigeon pea 6-8 : 1
	Orissa	Ragi + Pigeon pea 8 : 2 or 8 : 1
	Jharkhand	Ragi + pigeon pea 6 : 1 or 6 : 2
2. Foxtail millet	Uttaranchal	Ragi + soybean /rice bean 90:10 mixing on weight basis
	Andhra Pradesh	Foxtail millet + pigeon pea 5 : 1Foxtail millet + *kharif* pulses – rabi jowar
3. Kodo millet	Karnataka	Foxtail millet + pigeon pea 4-6 : 1
	Madhya Pradesh	Kodo millet + pigeon pea 2 : 1 / 8:2Kodo millet + black gram 4 : 1
4. Little millet	Chattisgarh	Kodo millet + pigeon pea 8 : 1 / 8:2Kodo millet + black gram 4 : 1
	Madhya Pradesh	Little millet + pigeon pea 4 : 1
	Chattisgarh	Little millet + pigeon pea 4 : 1
	Karnataka	Little millet + pigeon pea 6 : 1
5. Barnyard millet	Jharkhand	Little millet + pigeon pea 4-6 : 1
	Uttaranchal	Barnyard millet + soybean / rice bean 90% 10 % by weight basis.

S.No.	Table 4 : Influence of graded production technology on yield of small millets under rainfed conditions Treatments	Yield (kg/ha) Finger millet	Foxtail Millet	KodoMillet millet	Little Millet	Barnyard Millet
1	Local variety with local practice	1067	1913	399	442	1036
2	Local variety with recommended practice	1577	1867	790	725	1439
3	Improved variety with local practice	1282	2531	554	532	1374
4	Improved variety with recommended practice (full fertilizer level)	2429	2701	926	817	2118
5	Improved variety with 1/3rd dose of recommended fertilizer	1761	-	708	563	1441
6	Improved variety with 2/3rd dose of recommended fertilizer	2014	-	790	719	1764
7	Improved variety with recommended dose of fertilizers and plant protection measures	2505	3241	1051	928	1483

2.3. Disease and Pest Management

Activities in plant protection discipline are concerned with identifying resistant sources, forecasting, loss estimation, identifying nature of resistance and epidemiological studies and chemical control for major diseases and pests. From the screening of 4624 accessions of world collection of Ragi germplasm over locations and years 54 resistant donors mainly for blast have been identified. They are in different stages of utilization in the resistance breeding programmes.

Of the several fungicides tested against ragi blast, Carbendazim (0.05%) alone or in combination with Captan/ Mancozeb (0.02%) is effective in controlling the disease. Two sprays- first spray at flowering and the second after 10 days are to be administered. Recently Tricyclazole (0.05%) has been found to be much more effective.

Epidemiological studies indicated that late sown crop (15-20 days later than the normal date) is more prone for blast damage in kharif grain smut of ragi prevailed mostly in the crop raised during rabi and summer while virus diseases are mainly seen on the summer crop in Karnataka.

The blast pathogen isolates collected from different parts of the country did not show much variation in the morphological characteristics although they differed in their virulence.

Pathogenic fungi species- *Drechslera* and *Pyricularia* -were noticed in the seed samples.

Resistant sources have been located in small millets for blast in foxtail millet; for head and grain smut in barnyard millet and for head smut in kodo millet.

Location of newer resistance sources to major diseases, understanding of host-pathogen environment interaction and search for more effective fungicides for control of diseases and seed pathology are some of the areas presently receiving attention.

Survey of pests of various small millets has been quite comprehensive. As many as 55 different pests have been noticed on small millets. However, major pests on ragi are earhead caterpillars, root/shoot aphids and a few predators. The root aphid incidence is mostly localized to Karnataka.

Shoot fly is an important pest on kodo millet, little millet and proso millet whenever these crops are grown and can cause significant yield reduction. Five different species of shoot fly specific to hosts are reported. Early sowing with the onset of monsoon helps in escaping the shoot fly damage in proso, little and kodo millets. Chemical spray schedules for the control of shoot fly in little, kodo and proso millets and earhead caterpillar in finger millet; army worm, leaf scrapping beetle and leaf minor in foxtail millet were formulated. All small millets are free of store pests and easy to store without any damage.

3.Technology Input -Output Assessment

There is large untapped potential in the technology available in small millets. Production gaps exist between yield obtained at various levels especially in dry land situations in experimental plots versus farmer's fields on one hand and large scale demonstration plots versus farmer's holding on the other hand. The productivity could be increased by more than 50% by adopting improved production technology as indicated by the results of frontline demonstrations. Growing improved varieties in place of local varieties is perhaps the most important component in the improved package. This is more so in small millets and adoption of this one single component alone can give an incremental yield benefit of around 25 per cent. Since seed rate is low for these crops (10 to 12 Kg/ha) the extra expenditure incurred on seeds of HYV s is not more than Rs. 50 per ha and could be regarded as low cost technology which is within the reach of farmers. The cost-benefit ratio works out very favourably for this component.

The volume of data obtained from the frontline demonstrations in various small millets organized through Department of Agriculture and Cooperation, Government of India, has validated the vast potential available in the improved technology .The increase in yield over the prevailing farmer's practices was high to very high. The yield increase was from 31 to 54% in Ragi; 42 to 136% in little millet: 42% in kodo millet; 36 to 38% in foxtail millet and 65% in proso millet in different States.(Table 5).

Being low energy crops they respond well to even small doses of fertilizers which can help overcome the adverse effects of moisture stress. In the States of Bihar, Orissa, Maharashtra, Uttar Pradesh and Madhya Pradesh, Jharkhand and Chattisgarh which account for more than 50% area under small millets, the crops suffer more for want of nutrition and much less for soil moisture as effective rainfall in the crop season is more than required. Obviously amelioration of nutrition stress through small fertilizer input can bring significant increase in productivity.

4. Development Strategies

Agricultural progress in India has been technology driven. In this endeavor, rapid and efficient dissemination of technology in the target areas is very critical. Wheat, rice and cash crops because of their importance have got greater attention of development agencies. Thus, the dissemination has been fast in major cereals, particularly in favourable environments. Coarse cereals have slower dissemination of technology due to less importance accorded by the development agencies, cultivation in unfavourable environments, multitude of farm holdings and production systems, rainfall dependent returns and lower apparent superiority of the improved technology under stress environments. Thus, the exploitation of available technologies has been limited and there is a vast untapped potential or productivity potential in different coarse cereals crops. The potential available in different agroclimatic zones for the various small millets based cropping systems is provided in Table 6 from this it is evident that there is still large potential available in the technology recommended now which could be bridged through the appropriate development strategies.

The components of technology consist of non-monetary inputs (optimum sowing time and plant population, timely and efficient farm operations etc.), low cost inputs (seed) and high cost inputs (agro-chemicals). The adoption of various inputs, even those on non-monetary nature, leaves much to be desired in coarse cereals.

The technology dissemination strategies in coarse cereals have to be different from those in major cereals and commercial crops, particularly in hilly, tribal and remote areas. Non-Governmental organizations may also needs to be involved in the process of technology transfer. The inputs, particularly seed, may be supplied on

Table 5 : Productivity (grain yield, kg/ha) of finger millet and other small millets in FLD's in different states during the 2001-02.

State		Finger millet Range	Mean	Foxtail millet Range	Mean	Little millet Range	Mean	Barnyard millet Range	Mean	Proso millet Range	Mean	Kodo millet Range	Mean
Karnataka	FP*	800-3433	1763										
	IP**	1741-4395	3175										
	% increase over FP	80											
Uttar Pradesh	FP*	600-1100	850					600-1000	732	800-700	750		
	IP**	950-1500	1225					780-1500	1097	1250-1400	1325		
	% increase over FP	44						50	77				
Orissa	FP*	1107-1580	1345										
	IP**	1713-2817	2475										
	% increase over FP	84											
Madhya Pradesh	FP*					333-1000	438					105-213	145
	IP**					730-970	892					113-333	175
	% increase over FP					103						21	
Andhra Pradesh	FP*			1710-1890	1890								
	IP**			2060-2490	2330								
	% increase over FP			23									
Uttaranchal	FP*							920-1060	1045				
	IP**							1180-1900	1616				
	% increase over FP							55					

barter. In the training of farmers, scientists should also be involved in addition to extension workers.

Technological dissemination and development strategies should focus on specific technology package for different farming situations, and intensive extension education on the package. Rainfed farming production technologies, particularly water management and usage, greater coverage under improved cultivars, efficient water use, integrated nutrient and pest management and good crop husbandry can result in a rapid progress in small millets productivity, provided appropriate guidelines are formulated and implemented for comprehensive development of these crops in harmony with other components of cropping systems. On farm experiments, frontline and other demonstrations need to be conducted on an extensive scale.

Production advances have been pivoted by high yielding varieties in which seed-capsule of improved technology has played a very useful role. It has been easy to convince farmers about the advantage of quality seed. But the area under high yielding varieties in small millets is lower than other crops. A large number of high yielding varieties are available and appropriate cultivar need to be chosen as per the cropping system, management and input supply level, season, etc. Further, quality seed needs to be produced in required quantity and made available in time. Contingency planning is required in case of excessive, scanty or delayed rains. Small millets are a better option under such situations. These are photo insensitive, early maturing and drought tolerant. Proso millet is the earliest maturing (60- 70 days) cereal.

Special development efforts should be undertaken in the States having low yields namely; Orissa, Maharashtra, Uttaranchal, Chattisgarh, Jharkhand and Madhya Pradesh. Concerted efforts accompanied by district or even lower level land planning would be required. Seed production and supply is not satistactory in general in coarse cereals and especially small millets. The coverage under high yielding varieties is very poor in those areas where vagaries of monsoon are high resulting in uncertain production. In many States ragi, small millets seed production and supply is non-existent. Therefore, it is necessary to evolve a mechanism for assured production and supply of newly bred varieties. The evolution of such a mechanism is also necessary for the efficient conduct of central minikit programme as well as State/Centrally Sponsored Developmental activities. This can be further be expanded and scope enlarged. Since seed is a critical input every effort should be made for efficient production and supply of seeds. Special seed programmes including Un- conventional methods of seed supply is also to be encouraged in coarse cereals.

Involvement of Non-Governmental Organisations (NGOs) working in tribal/hill and remote dry land areas should be encouraged to undertake production and supply of truthfully labelled seeds. If necessary seed subsidy to be enhanced and its scope enlarged.

Unfortunately the amount of extension/ developmental support provided to coarse cereals is meagre compared to many other commercial/cash crops. The situation in recent years has further aggravated and there are hardly any major programmes on these crops. Development activities in order to initiate corrective measures for the promotion and growth of coarse cereals in the country is urgently required. On farm adaptive research conducted under NATP in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa and Madhya Pradesh on intercropping of pigeon pea or field bean or black gram in small millets have shown the increase in grain yield as well as the monitory returns to the farmers besides augmenting the legume productions which also helped in minimizing the protein malnutrition. This technology can be further taken to other states as a developmental strategies to augment the pulse production in the country.

Character association and path coefficient analysis of grain yield components in finger millet *(Eleusine coracana* Gaertn*)*

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Abstract

Correlation and path coefficient analysis were estimated using 178 germplasm lines of finger millet for 15 quantitative characters. Except plant height, days to 50% flowering and days to maturity remaining characters showed highly significant positive correlation with grain yield. The characters like ear weight per plant and straw yield per plant had high positive direct effect on grain yield. Two characters viz., plant height and days to maturity had negative direct effect on grain yield. Selection based on ear weight per plant and straw yield per plant will be effective for grain yield improvement.

Introduction

Finger millet is one of the important small millet crop grown for food grain and fodder, especially in tribal predominant areas. The crop is hardly and well suited to upland farming ecosystems, because of its early maturity and quick growing nature. Grain yield is a complex character and is consider as the ultimate product of its component characters. The study of association among themselves and with grain yield is quite important in efficient selection for grain yield. The direct and indirect contribution of different yield components considerably alter the genetic architecture of a complex characters like yield. The analysis of inter dependent relationships among different characters provide a realistic basis for allocation of appropriate weightage to each of these attributes and in devising suitable technique for genetic improvement of complex character. Hence the present experiment was conducted to study the phenotypic and genotypic association between yield contribution characters along with path analysis for developing suitable selection criterion for improvement of yield in finger millet.

Material and Methods

A total of 178 accessions of finger millet received from International Crop Research Institute for Semiarid Tropics, Hyderabad, were grown in a randomized block design with two replications at the Agricultural Research Station, Hanumanamatti, University of Agricultural Sciences, Dharwad, Karnataka during *Kharif* 2002. Each entry in each of the replication was grown in a two rows of 3 m length with a spacing of 22.5 x 10 cm. Observation on 5 randomly selected plants were recorded in each entry of two replications for 15 quantitative characters viz., plant height, total number of tillers / plant, productive tillers / plant, days to 50% flowering, days to maturity, number of fingers per ear, length of ear head, length of finger, flag leaf length, florets number per spikelet, spikelet density, ear weight per plant, test weight, straw yield per plant and grain yield per plant. Correlation (Robinson *et al* 1951) and path coefficient analysis (Dewey and Lu 1959) were computed both at genotypic and phenotypic level.

Results and Discussion

There is ample evidence to show that selection directly for grain yield in plants is not easy. Thus, any morphological character that is associated with higher seed yield or which makes a significant contribution to yielding ability would be useful in the improvement of grain yield. Correlation coefficient for different combinations (Table-1 & 2) revealed that genotypic correlation values were higher than their respective phenotypic association, indicating that though there is strong inherent association between various characters studied, the phenotypic correlation is reduced under the influence of environment. In the present study, grain yield / plant had highly significant positive association with all the traits studied except plant height, days to 50 per cent flowering and days to maturity at both genotypic and phenotypic level. Fodder yield / plant also revealed highly significant association with all traits studied except with days to 50 per cent flowering and days to maturity. Similar correlations for these traits have been reported early by Kishan Reddy (1994) and Cauvery (1993). Studies on the relationship of grain yield with yield components revealed that straw yield, ear weight, flag leaf length and test weight shown very strong association with grain yield. So indirect selection for grain yield could be effectively be done through direct selection of straw yield, ear weight, flag leaf length and test weight as indicated above.

The cause and effect relationship between 15 character studied in the present germplasm accessions (Table 3 & 4) shown that ear weight / plant had the highest positive direct effect followed by straw yield whereas plant height and days to maturity had negative direct effect on grain yield at both levels. All the characters which are associated strongly with grain yield such as total number of tillers, productive tillers, fingers number, length of ear head, finger length, flag leaf length, florets number, spikelet density and test weight are contributed to grain yield indirectly through ear weight / plant and straw yield / plant. So path analysis has clearly demonstrated that due weightage given for ear weight / plant and straw yield / plant would be helpful in increasing the grain yield through selection.

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Table 1 : Phenotypic correlation coefficients between different yield components in finger millet

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	1	-0.123	-0.002	0.085	0.058	-0.066	-0.148*	0.086	0.024	0.055	0.028	0.013	0.012	0.153*	0.043
X_2		1	0.634**	-0.112	-0.086	0.105	0.054	0.072	0.305**	0.049	0.284**	0.408**	0.327**	0.316**	0.384**
X_3			1	-0.06	-0.026	0.133	0.169*	0.265**	0.514**	0.05	0.498**	0.659**	0.493**	0.589**	0.634**
X_4				1	0.800**	0.065	0.133	0.097	0.078	0.078	-0.043	0.073	-0.041	-0.001	-0.014
X_5					1	0.148*	0.127	0.073	0.096	0.051	-0.001	0.108	0.019	0.014	0.01
X_6						1	0.244**	0.196**	0.304**	0.008	0.087	0.239**	0.154**	0.182*	0.240**
X_7							1	0.601**	0.295**	-0.061	0.077	0.292**	0.011	0.240**	0.271**
X_8								1	0.387**	-0.099	0.101	0.344**	0.035	0.325**	0.352**
X_9									1	0.174*	0.462**	0.728**	0.533**	0.779**	0.820**
X_{10}										1	0.057	0.179*	0.179*	0.296**	0.225**
X_{11}											1	0.514**	0.472**	0.496**	0.559**
X_{12}												1	0.618**	0.796**	0.877**
X_{13}													1	0.652**	0.669**
X_{14}														1	0.889**
X_{15}															1

** significant at 5% probability level* *** Significant at 1% probability level*

X_1 = Plant height *X_2 = Number of tillers per plant* *X_3 = Number of productive tillers per plant* *X_4 = Days to 50% flowering*

X_5 = Days to maturity *X_6 = No. of fingers per ear* *X_7 = Length of earhead* *X_8 = Length of finger*

X_9 = Flag leaf length *X_{10} = Florets number per spikelets* *X_{11} = Spikelet density* *X_{12} = Ear weight per plant*

X_{13} = Test weight *X_{14} = Straw yield per plant* *X_{15} = Grain yield per plant*

Table 2 : Genotypic correlation coefficients between different yield components in finger millet

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	1	-0.170*	-0.031	0.104	0.057	-0.059	0.197**	0.11	0.033	0.039	0.041	0.024	0.034	0.179*	0.061
X_2		1	0.651**	-0.121	-0.094	0.137	0.048	0.075	0.339**	0.045	0.320**	0.457**	0.371**	0.340**	0.420**
X_3			1	-0.063	-0.022	0.154*	0.205**	0.288**	0.557**	0.051	0.555**	0.726**	0.565**	0.625**	0.693**
X_4				1	0.956**	0.067	0.163*	0.102	0.08	0.082	-0.047	0.077	-0.045	-0.002	-0.014
X_5					1	0.213**	0.158*	0.089	0.101	0.053	-0.01	0.14	0.022	0.02	0.013
X_6						1	0.312**	0.214**	0.332**	-0.002	0.109	0.263**	0.163*	0.193*	0.270*
X_7							1	0.743**	0.353**	-0.091	0.103	0.361**	0	0.289**	0.310**
X_8								1	0.405**	-0.097	0.119	0.376**	0.018	0.337**	0.383**
X_9									1	0.191*	0.502**	0.770**	0.593**	0.799**	0.868**
X_{10}										1	0.075	0.211**	0.225**	0.321**	0.259**
X_{11}											1	0.556**	0.545**	0.529**	0.621**
X_{12}												1	0.695**	0.829**	0.928**
X_{13}													1	0.715**	0.759**
X_{14}														1	0.930**
X_{15}															1

** significant at 5% probability level*

*** Significant at 1% probability level*

X_1 = Plant height | *X_2 = Number of tillers per plant* | *X_3 = Number of productive tillers per plant* | *X_4 = Days to 50% flowering*

X_5 = Days to maturity | *X_6 = No. of fingers per ear* | *X_7 = Length of earhead* | *X_8 = Length of finger*

X_9 = Flag leaf length | *X_{10} = Florets number per spikelets* | *X_{11} = Spikelet density* | *X_{12} = Ear weight per plant*

X_{13} = Test weight | *X_{14} = Straw yield per plant* | *X_{15} = Grain yield per plant*

Table 4 : Direct (diagonal) and indirect effects of yield components on seed yield at genotypic level in finger millet

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	**-0.023**	0.002	0.001	0.035	-0.024	-0.005	-0.016	0.009	0.005	0.000	0.003	0.011	0.004	0.058	0.061
X_2	0.004	**-0.010**	-0.025	-0.041	0.039	0.012	-0.004	0.006	0.053	0.000	0.027	0.209	0.039	0.111	0.420**
X_3	0.001	-0.007	**-0.039**	-0.021	0.009	0.013	-0.016	0.024	0.087	0.000	0.047	0.333	0.059	0.203	0.693**
X_4	-0.002	0.002	0.002	**0.339**	-0.394	0.006	-0.013	0.008	0.013	0.000	-0.004	0.035	-0.005	-0.001	-0.014
X_5	-0.001	0.001	0.001	0.324	**-0.412**	0.019	-0.013	0.007	0.016	0.000	-0.001	0.064	0.002	0.006	0.013
X_6	0.001	-0.001	-0.006	0.023	-0.088	**0.087**	-0.025	0.018	0.052	0.000	0.009	0.120	0.017	0.063	0.270**
X_7	-0.005	0.000	-0.008	0.055	-0.065	0.027	**-0.080**	0.062	0.056	0.000	0.009	0.165	0.000	0.094	0.310**
X_8	-0.003	-0.001	-0.011	0.034	-0.037	0.019	-0.059	**0.083**	0.064	0.000	0.010	0.172	0.002	0.110	0.383**
X_9	-0.001	-0.003	-0.021	0.027	-0.041	0.029	-0.028	0.034	**0.157**	-0.002	0.042	0.353	0.062	0.260	0.868**
X_{10}	-0.001	0.000	-0.002	0.028	-0.022	0.000	0.007	-0.008	0.030	**-0.003**	0.006	0.096	0.024	0.104	0.259**
X_{11}	-0.001	-0.003	-0.021	-0.016	0.004	0.010	-0.008	0.010	0.079	0.000	**0.085**	0.255	0.056	0.171	0.621**
X_{12}	-0.001	-0.005	-0.028	0.026	-0.058	0.023	-0.029	0.031	0.121	-0.001	0.047	**0.458**	0.073	0.271	0.928**
X_{13}	-0.001	-0.004	-0.022	-0.015	-0.009	0.014	0.000	0.001	0.093	-0.001	0.046	0.318	**0.104**	0.233	0.759**
X_{14}	-0.004	-0.003	-0.024	-0.001	-0.008	0.017	-0.023	0.028	0.125	-0.001	0.045	0.380	0.074	**0.325**	0.930**

Residual : 0.0175

*** Significant at 1% probability level*

X_1 = Plant height
X_2 = Number of tillers per plant
X_3 = Number of productive tillers per plant
X_4 = Days to 50% flowering
X_5 = Days to maturity
X_6 = No. of fingers per ear
X_7 = Length of earhead
X_8 = Length of finger
X_9 = Flag leaf length
X_{10} = Florets number per spikelets
X_{11} = Spikelet density
X_{12} = Ear weight per plant
X_{13} = Test weight
X_{14} = Straw yield per plant
X_{15} = Grain yield per plant

Studies on genetic variability for productivity traits in finger millet (*Eleusine coracana* Gaertn)

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Abstract

Genetic variability was studied in 178 genotypes of Finger Millet for fifteen quantitative characters. Significant difference among the genotypes were recorded for all the characters. The estimates of genotypic variances showed a considerable range of variation for most of characters. High heritability coupled with high genetic advance as per cent of mean was observed for number of tillers, productive tillers, days to 50 per cent flowering, fingers number per ear, length of ear head, length of finger, florets number per spikelet, spikelet density, ear weight, test weight, straw yield and grain yield indicating the presence of additive genetic effects for the manifestation of these characters. Plant height, days to maturity and flag leaf length exhibited high heritability with moderate genetic advance which indicates the presence of both additive and non additive genetic effects for these characters.

Introduction

Finger millet (*Eleusine coracana)* is one of the stable foods for million inhabiting the arid and semi arid tropics of the world. In India, finger millet has been grown over an area of 2.15 million hectares with an average production of 2.68 million tonnes. Finger millet is a third important food crop of Karnataka occupying an area of 1.02 million hectares with a production of 1.87 million tonnes accounting to 53.95 per cent area and 44.94 per cent production of crop in India. Due to its greater tolerance, plasticity and adaptability to different ecological condition, quick rejuvenation after moisture stress release, better suitability for different cropping systems and contingent plans, it is cultivated on varied soil and climatic conditions compared to other cereals. Ragi is indispensable to Indian Agriculture as a source of grain and straw in a vast dryland agriculture. It is commonly called as "nutritious millet" as the grains are nutritiously superior to many cereals providing fair amount of proteins, minerals, calcium and vitamins in abundance to the people. Its green forage is readily eaten by all kinds of livestock. In spite of these important attributes, this has been neglected by the plant breeders and no significant break through has been made so far in this crop. Therefore, the farmers are growing their own traditional low productive land varieties. So there is a need for identify the promising genotypes for grain yield and other yield attributes. In the recent years, new diverse finger millet germplasm has been collected and conserved at various national and international institutes. The important pre requisite for the utilization of the new germplasm is the assessment of there true genetic potential. So that this crop could be further improved and made economically more viable and competitive in the present dryland situation. Therefore an attempt was made in the present investigation to gather information on the extent of genetic variability present in 178 genotypes of this crop for fifteen quantitative characters for their further utilization in the crop improvement programme.

Material and Methods

The material used in present study consists of 178 diverse finger millet genotypes collected from different parts of world obtained from ICRISAT, Hyderabad. These genotypes were evaluated at Agricultural Research Station, Hanumanamatti, University of Agricultural Sciences, Dharwad, during *Kharif* 2002, under irrigated condition. The randomized block design was followed with two replications. Each entry was transplanted in two rows of three meters length with inter row spacing of 22.5 cm and inter row spacing of 10 cm. All recommended package of practices was followed to raise good crop. Five plants in each entry were tagged randomly in each entry to record the observation on fifteen quantitative characters namely plant height, number of tillers per plant, productive tillers per plant, days to 50% flowering, days to maturity, number of fingers per ear, length of ear head, length of finger, flag leaf length, florets number per spikelet, spikelet density, ear weight per plant, test weight, straw yield per plant and grain yield per plant. The observed variability on different characters was partitioned into its components following the standard statistical methods as suggested by Panse and Sukhatme (1967). Phenotypic, genotypic and environmental variances were estimated following Comstock and Robinson (1952) and the expected estimates of heritability and genetic advance according to Hanson *et al* (1956) and Johnson *et al* (1955).

Results and Discussion

The data obtained on various quantitative characters were subjected to statistical analysis for different estimates. The range, mean and mean sum of squares of different characters (Table-1) indicated significant differences (P<0.01) among the genotypes for all the characters. The estimates of phenotypic, genotypic and environmental variances also showed a considerable range of variation for most of characters (Table-2). Presence of narrow gap between phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) for all the characters studied indicated that, environment had played minor role in the manifestation of these characters. In the present study phenotypic and genotypic coefficient of variability were low for plant height, days to 50 per cent flowering, days to maturity, flag leaf length. Where as characters like number of tillers per plant, number of fingers per ear, florets number per spikelet, spikelet density registered moderate pcv and gcv values. Remaining characters showed high phenotypic and genotypic coefficient of variability. The highest phenotypic and genotypic coefficient of variability were recorded in case of grain yield per plant. These findings are corroborates with earlier reports of Goud and Lakshmi (1977) and Chunilal *et al* (1996). Interestingly all characters recorded the high heritability. Highest heritability of 99.10 per cent was observed in straw yield per plant. Similar heritability values were also obtained by Shanthappa (1979).

It was found that, high heritability coupled with high genetic advance as per cent of mean was observed for number of tillers, productive tillers, days to 50 per cent flowering, fingers number per ear, length of ear head, length of finger, florets number per spikelet, spikelet density, ear weight per plant, test weight, straw yield per plant and grain yield per plant. Thus these traits are most probably controlled by additive gene action. Hence, these characters can be improved by simple selection process. Characters like plant height, days to maturity and flag leaf length showed high heritability with moderate genetic advance as per cent of mean indicating the presence of both additive and non additive gene action, therefore simple selection process may not be useful. So to improve these character one should follow hybridization programme and exploit the phenomenon of heterosis.

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Table 1 : Mean sum of squares for 15 metric characters in Finger Millet Genotypes

Characters	Genotypes	Replication	Error
Plant height (cm)	213.44**	61.250	32.54
Number of tillers per plant	0.60**	0.1190	0.043
No. of productive tillers per plant	0.669**	0.133	0.037
Days to 50% flowering	97.65**	6.125	0.157
Days to maturity	170.629**	19.000	29.52
No. of fingers per ear	2.803**	0.004	0.134
Length of ear head (cm)	5.860**	0.176	1.127
Length of finger (cm)	4.055**	0.229	0.159
Flag leaf length (cm)	14.82**	0.750	0.323
Florets number per spikelet	1.038**	0.003	0.079
Spikelet density	10.96**	0.383	0.617
Ear weight per plant (g)	100.39**	9.015	3.547
Test weight (g)	0.6388**	0.153	0.550
Straw yield per plant (g)	61.325**	0.563	0.265
Grain yield per plant (g)	31.09**	4.859	1.311

** *Significant at 1% probability level*

Table 2 : Genetic parameters of 15 metric characters in finger millet

	Range			Variance						
Characters	Min.	Max	Mean	σ^2p	σ^2g	PCV	GCV	$h^2(bs)$	Genetic advance	Genetic advance (as % of mean)
Plant height (cm)	74	151.20	96.35	122.98	90.43	11.51	9.87	73.50	16.80	17.43
Number of tillers per plant	1.90	5.00	3.50	0.32	0.28	16.18	15.06	86.60	1.01	28.85
No. of productive tillers per plant	1.45	4.00	2.69	0.35	0.32	22.12	20.93	89.60	1.10	40.94
Days to 50% flowering	54.00	87.25	70.61	48.85	48.75	9.90	9.89	99.70	14.36	20.33
Days to maturity	89.50	127.00	108.60	100.02	70.45	9.21	7.73	70.50	14.53	13.38
No. of fingers per ear	4.10	11.70	6.70	1.47	1.33	18.10	17.25	90.80	2.27	33.89
Length of ear head (cm)	4.45	15.30	7.91	3.48	2.36	23.63	19.45	67.70	2.61	32.99
Length of finger (cm)	3.92	13.35	6.46	2.10	1.94	22.49	21.62	92.40	2.76	42.75
Flag leaf length (cm)	21.85	34.40	27.33	7.57	7.24	10.07	9.85	95.70	5.45	19.94
Florets number per spikelet	3.90	7.85	5.63	0.55	0.48	13.27	12.30	85.90	1.32	23.43
Spikelet density	5.25	19.40	13.76	5.78	5.16	17.48	16.52	89.30	4.43	32.18
Ear weight per plant (g)	10.60	45.15	24.95	51.95	48.41	28.90	27.90	93.20	13.84	55.47
Test weight (g)	1.22	4.27	2.62	0.34	0.28	22.49	20.63	84.10	1.02	38.94
Straw yield per plant (g)	7.45	35.55	21.48	30.77	30.49	25.84	25.72	99.10	11.33	52.74
Grain yield per plant (g)	4.00	23.60	12.68	16.19	14.87	31.76	30.44	91.90	7.62	60.11

Genotype environment interaction studies for yield and its component traits in finger millet

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Abstract

Eighteen finger millet genotypes were evaluated for grain yield and its components under three environments. Variance due to genotypes was significant for all the traits. G X E (linear) component was non significant for all traits and non linear component was significant for earhead length. The genotypes KM-225, PPR-2614 and PR-202 were found to be stable with higher mean grain yield. The genotype PPR-2614 was also found stable for fodder yield per plant with higher mean.

Introduction

Finger millet (*Elensine coracana* .) is one of the most important minor millet crop of the world. In India, the crop is limited to Karnataka, Andhra Pradesh and Tamil Nadu. Breeding efforts over the years have yielded many promising genotypes. However, phenotypically stable genotypes over environments are of great importance for successful cultivation of the crop. Although number of varieties have been recommended for the cultivation, the information on the Genotype X Environment interaction is lacking. Therefore, the present study was aimed to evaluate eighteen promising finger millet genotypes over three environments for grain yield and its important component traits.

Material and Methods

The experimental material consisted of eighteen promising genotypes of finger millet and they were grown in randomized complete block design with three replications at Agricultural Research Station, Hanumanamatti during the *Kharif* 1998-99, 1999-2000 and 2000-2001. Each plot comprised ten rows of 3 mts length with a row to row and plant and plant spacing of 22.5 cm and 10 cm, respectively. Recommended package of practices were followed to raise good crop. Observation were recorded a number of productive tillers per hill, earhead length (cm), fodder yield (kg/plot) and grain yield (kg/plot). Data were analyzed following the model proposed by Elerhast and Russell (1966).

Results and Discussion

The results of pooled analysis of valiance for all the traits studied are presented in Table-1. The variance due to genotypes was significant for all the traits justifying the selection of genotypes for the study. Environmental valiance component was also significant for all the traits. The G X E (linear) component was non significant for all the characters implying that the performance of the genotypes is unpredictable in nature. Pooled deviation component was found to be significant for earhead length revealing the importance of unpredictable course of variation for observed genotypes x environment interaction.

In the present study, genotypes with regression coefficient (bi) near to unity and non significant deviation from regression (S^2di) with high mean were considered as having average stability. The genotypes (Table-2) KM 225, PPR 2614 and PR-202 showed stable performance for grain yield with higher mean of 2.41, 2.35 and 2.22 kg/plot, respectively, the other genotypes GPU-34, MR-16, MR-12 and EC-50-90 with high mean grain yield and bi value less than unity were suitable for unfavourable environments. For number of productive tillers per plant, the genotype EC 50-90 exhibited stability across environments. The other genotypes with high mean number of productive tillers viz., MR-16, GPU-34, VR-696 were found to be suitable for favourable environments. The genotype GPU-32 found to be highly stable for earhead length with higher mean of 8.62 cm. Whereas the genotype GPU-34 was found to be suitable for favourable environments with respect to earhead length. For fodder yield per plant, the genotype PPR-2614 (2.28 kg/plot) was found to perform uniformly across environments where as MR-12, GPU-32 and MR-16 were suitable for favourable environments.

The stability analysis revealed that the genotypes showing stability for grain yield also simultaneously exhibited either average or above and below average stability for one or more characters. It can be suggested that while selecting genotypes attention should also be given to characters associated with grain yield.

Reference

Eberhart S.A. and Russell W.A (1966). Stability parameters for comparing the varieties. Crop Sci. 6:36-40

Table 1 : Analysis of variance for stability as per Eberhart and Russell (1966) for seed yield and its components in Finger Millet

Source of Variance	d.f.	Productive tillers/hill	Earhead length (cm)	Fodder yield (Kg/plot)	Grain yield (kg/plot)
Genotype (g)	17	0.59*	3.69*	1.26**	0.57**
Environment + GE	36	0.43	2.71	0.31	0.27
Environment (Linear)	1	2.04**	47.24**	3.35**	5.24**
GE (Linear)	17	0.24	1.36	0.24	0.17
Pooled deviation	18	0.52	1.51*	0.21	0.09
Pooled error	102	0.49	0.85	0.31	0.10

** & ** Significant at 5% & 1% levels, respectively*

Table 2 : Mean performance and stability parameters of selected genotype for different characters

Genotypes	Productive Tillers per hill			Earhead length			Fodder yield (kg/plot)			Grain yield (kg/plot)		
	X	b_i	S^2di	X	b_i	S^2di	X	b_i	S^2di	X	b_i	S^2di
EC 50-90	5.27	-1.13	-0.11	6.67	1.12	-0.28	2.97	-0.15	-0.04	2.28	0.33	0.05
TNAU 445	4.87	0.20	-0.11	5.99	0.44	2.18	3.24	0.68	-0.03	1.98	-0.22	-0.03
TNAU 467	4.56	1.31	-0.15	6.57	1.28	0.03	3.01	0.48	0.06	2.02	1.62	-0.03
Be. Local	4.04	1.34	-0.10	6.77	-0.15	-0.22	2.96	-1.21	0.02	1.82	-0.37	0.21
KM 221	4.60	2.06	-0.16	6.17	0.16	4.23*	3.01	0.99	-0.10	1.82	0.72	0.21
KM 225	4.26	-0.10	-0.04	7.10	1.78	-0.05	3.25	0.65	0.00	2.41	1.11	0.09
PPR 2614	4.31	2.81	0.13	6.73	0.43	1.65	4.28	-0.98	0.62	2.35	1.14	0.15
GPU 34	5.00	2.33	0.14	8.98	2.62	2.56	3.86	-0.03	-0.09	2.95	0.57	-0.03
MR 16	5.70	3.32	1.22	8.69	0.76	0.72	4.64	1.78	0.63	2.80	0.74	0.01
PR 202	4.39	-0.17	-0.15	5.96	0.07	1.01	3.39	0.63	-0.10	2.22	0.88	0.03
VR 695	4.32	0.55	0.22	5.62	1.47	0.22	2.56	1.83	0.08	1.48	2.48	0.03
VR 696	5.14	1.22	1.99*	7.02	2.10	0.24	3.04	1.54	-0.02*	1.56	1.56	0.12
HR 374	4.49	1.32	0.19	5.68	0.81	0.14	2.61	1.72	0.13	1.32	1.23	-0.02
RAU 8	4.04	-0.35	1.67	6.14	1.03	-0.28	3.24	0.87	0.21	1.68	1.96	0.22
GPU 32	4.17	2.63	0.03	8.62	0.97	0.23	4.38	2.47	-0.04	2.07	0.50	0.07
MR 12	4.79	2.72	1.49	8.88	1.09	5.12*	4.56	2.79	-0.10	2.47	0.53	-0.03
SRS 2	4.51	-0.97	-0.16	6.64	0.55	3.39*	3.05	2.53	0.05	1.80	1.02	-0.03
PS 110	4.56	-1.09	0.32	6.39	1.47	1.16	3.32	1.41	0.57	2.09	2.21	-0.02
Total	**4.64**			**6.92**			**3.41**			**2.06**		

* & ** Significant at 5% & 1% levels, respectively.

Performance of promising lines of generation in finger millet (*Eleusine coracana* Gaertn)

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Abstract

Twenty superior finger millet (*Eleusine coracana*) lines were evaluated along with four standard check varieties. The lines PR202 X GE1409-1-6 and PR202 X GE1409-2-5 where found significantly superior for grain weight per earhead, number of fingers per earhead and earhead weight and showed early maturing types, matured in 101 and 98 days respectively. The genotype MR-6-7-3 was found significantly superior for grain weight per earhead. Number of fingers per earhead, earhead weight and earhead length, matures in 113days. Where as the entry MR23-11-5 was found late maturing type and found significantly superior for earhead weight, number of fingers per earhead and grain weight, per ear, however thousand grain weight was almost similar for all the three maturity groups. The data showed that the duration of the genotypes increased, corresponding yield attributing parameters also increased and attributed for higher production.

Introduction

Finger millet (*Eleusine coracana*) has occupy relatively lesser position among food crops in Indian Agriculture, but it has very important from the point of food security for the poor and marginal farmer's. Therefore it has called poor man's food. It has known for better quality and nutrition and can contribute to effective nutritional security. It is one of the most nutrious cereals having high levels of useful components compared to other cereal crops. This crop will occupy 90% of the area in southern Karnataka and being cultivated in rainfed as well as irrigated situation the crop can be taken through out the year by using different maturity finger millet genotypes for different seasons the study was under taken to develop high yielding finger millet genotypes suitable for different maturity groups.

Materials and methods

The research was conducted at Zonal Agricultural Research Station (UAS,Bangalore) V.C.Farm, Mandya, Karnataka during 2001-02. Sixteen promising lines from F5 generation and four standard cheek verities were selected for study. The trial was planted at randomised complete block design with three replication and plot size of 3.0 mts X 2.25mts (6.75 Sq.mts) at a spacing of 22.5cms between the rows and 10.0cms between the plants all the recommend package of practices were followed to size the crop. The observation on days to 50% flowring, days to maturity, ear head length, ear head weight number of fingers per ear head grain weight per ear head and thousand grain weight were recorded.

Results and discussion

The data was statistically analyzed and the genotypes significantly difered for all the characters studied. Among sixteen newly developed genotypes compared with four different checks. The genotype PR202 X GE1409-2-5 and PR202 X GE1409-1-6 were found early ness and recording 63 and 64 days to 50 percent flowering respectively. These genotypes also showed significantly superior for earhead weight, number of fingers per earhead and grain weight per earhead (Sundaresan *et al. 1979*). The genotype MR 6-7-3 was found medium duration and matured in 113days. It was found significantly superior for ear length, earhead weight, number of fingers per earhead and grain weight per earhead. It willbe a medium duration genotype suitable for late khaif situation (Ravishankar, et al. 2003). While the long duration maturity genotype MR23-11-5 was found significantly superior for ear length, earhead weight and number of fingers per earhead but 1000grain weight showed that it has almost similar for irrespective of the maturity groups (Shankar. 1982).

The results revealed that based on the superiority of the genotypes for the different yield components under studied, early maturing genotypes PR202 X GE1409-2-5 and PR202 X GE1409-1-6, medium duration genotype of MR6-7-3 and long duration maturity genotypes of MR23-11-5 were found promising for higher yield.

References

Ravishankar, C.R., Ramappa, H.K., Prakash.P and Narayanaprasad, 2003. Performance of promising finger millet (Eleusine Coracona Gaertn) verities for yield and disease reaction. Symposium on Recent developments in the diagnosis and Management of plant diseases for meeting Global challenges. December 18-20,2003. P:19.

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Table : Yield components of F5 Finger Millet lines

SlNo	Genotypes	Daysto 50% Flowering	Daysto Maturity	Length(cm) Ear	EarHead No.	GrainWeight Per ear Wtgm	1000 grainwt.	Per ear (gm)
1	PR202 X GE1409-1-6	64	101	7.0	15.9	10.9	12.4	3.46
2	PR202 X GE1409-2-5	63	98	6.5	15.6	9.0	12.0	3.51
3	PR202 X GE1462-6	64	100	6.0	10.3	6.8	9.4	3.40
4	PR202 X GE1462-1-7	66	103	6.4	10.1	6.5	8.3	3.34
5	GPU26 X IE2954-1-9	63	101	6.8	11.0	6.4	9.0	3.39
6	GPU26 X IE2954-6-3	64	103	6.0	11.5	7.0	9.8	3.40
7	GPU26 X IE2954-7-4	67	105	6.5	11.9	6.9	10.0	3.40
8	MR6-7-1	77	114	8.9	15.5	8.0	11.6	3.42
9	MR6-7-3	76	113	8.9	16.0	9.3	12.9	3.45
10	MR6-7-4	77	115	9.0	17.0	8.0	12.0	3.42
11	MR6-7-9	79	119	9.8	17.8	7.3	12.6	3.41
12	MR23-6-3	73	116	9.0	17.3	7.1	12.4	3.42
13	MR23-6-5	74	115	8.8	17.0	7.0	12.0	3.44
14	MR23-8-1	80	121	8.0	17.0	8.0	12.3	3.40
15	MR23-11-5	79	120	8.5	17.6	9.5	13.3	3.42
16	MR23-11-7	83	123	8.0	16.9	7.0	12.1	3.44
17	GPU45 (ch)	68	103	6.0	14.3	7.0	10.0	3.41
18	GPU-28 (ch)	76	115	7.0	14.5	7.6	11.2	3.40
19	MR-1 (ch)	81	120	7.5	15.9	7.0	12.0	3.40
20	L-5 (ch)	80	120	6.0	15.3	8.0	11.1	3.41
Mean		72.7	111.2	7.4	14.8	7.6	11.3	3.41
CD@5%		5.4	5.0	0.7	0.6	1.3	1.1	NS
CV%		7.7	8.9	9.4	8.4	7.0	7.3	

Performance of stabilised finger millet (*Eleusine coracana* Gaertn) genotypes for grain and straw yield

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Abstract

Eleven stabilized finger millet (*Eleusine coracana*) genotypes of different maturity groups were evaluated along with standard check verities for grain and straw yield and as well as reactions to leaf blast, neck blast and finger blast diseases, the long duration genotype MR-33 and medium duration genotype of KMR-9 and KMR-3 were found significantly superior for higher grain and straw yield, and also showed highly resistant to leaf, neck and finger blast. While the early maturing genotype of KMR-7 and KMR-4 were also found significantly superior for grain and straw yield but they showed moderately tolerance to leaf, neck and finger blast.

Introduction

Finger millet (*Eleusine coracona*) is important food and fodder crop of vast rainfed situation of India. In Karnataka it occupies an area of 12 Lakh hectares out of which 90 percent of the area of finger millet cultivation confindes to southern Karnataka. Utilization of these crops is mainly as food for human consumption. The straw is often a precious fodder for bovines. The grain is mostly consumed in at the farm or village level. Though it has got very good nutritive value, their use is largely restricted to rural areas and very little finds its way to urban areas. The present investigation will be taken to develop more grain and straw yielding genotypes for different maturity groups and suits for varied seasons.

Materials and methods

The experiment was conducted at Zonal Agricultural Research Station (UAS, Bangalore) V.C.Farm, Mandya, Karnataka during 2001-02. Eleven stabilized finger millet genotypes and five standard check verities were selected for the study. The experiment was planted in a randomized complete block design with three replication and a plot size of 4.0m X 2.25m (9.00Sq. mts) at a spacing of 22.5 cms between the rows and 10.0cms between the plants. All the recommended package of practices were followed in ordered to get good crops growth. The observations were recorded on plant height, No of productive tillers per plant, main ear length, no of fingers per ear, days to 50 percent flowering and days to maturity, the grain and straw yield were recorded on plot yield basis and converted into grain yield Kg/ha and straw yield tons/ha and blast disease score were recorded as per blast disease score card.

Results and discussion

The data was statistically analyzed. The genotypes differed significantly from each other for all the characters studied. Among the long duration maturity groups, the genotypes MR33 was found significantly superior for main ear length, number of fingers per ear, grain yield, straw yield and it matured in 118 days. The genotypes KMR-9 and KMR3 were found medium duration groups, matured in 113 and 114 days respectively, and recorded significantly superior for number of productive tillers per plant, number of fingers per ear and grain yield while early maturing genotypes KMR7 and KMR4 were found superior for number of productive tillers per plant, main ear length, number of fingers per ear, grain and straw yield (Laxmaniah,1959 and Mochizuki, *et al* 1978).

The genotypes MR33, KMR-9, KMR-3,KMR-7 and KMR-4 were noticed highly tolerant to neck and finger blast diseases while all the genotypes were found tolerance to leaf blast (Rammappa, *et al*, 2003)

The results clearly indicates that the entries MR-33, KMR-9, KMR-3, KMR-7 and KMR-4 were found significantly superior for most of the yield attributing characters and also they were highly tolerant to neck and finger blast (Narasimha rao and Parathasarathy, 1968).

References

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Table 1. Performance of stabilized finger millet genotypes for grain yield, straw yield and reaction to blast disease.

Genotypes	Plant Height (Cm)	Productive Tillers Per plant	Main Ear length (cm)	No Fingers per ear	Day's To 50% flowering	Day's To maturity	Grain yield T/ha	Straw yield T/ha	Disease Reaction		
									LB	NB	FB
MR-29	105.6	6	6.5	8.3	79	119	5100	10.85	3	6	5
MR-33	109	7	8.8	11	78	118	5239	12.5	3	2	2
MR-34	103.3	6.5	7.1	9.8	78	119	5050	10.9	2	3	2
MR-35	106.9	6.8	7.4	8.5	80	120	5000	10.89	3	2	2
MR-36	110.5	6	7.7	8.9	79	119	5015	11.15	3	3	4
MR-15	98.6	6	5	6	79	120	3319	8.3	5	10	25
KMR-1	103	5	6	6	70	115	3000	7.6	3	25	22
KMR-9	105.7	5.8	7	8.9	71	113	4655	10.3	3	3	3
KMR-3	104.5	5.9	7.1	8.6	73	114	4560	9	2	3	2
KMR-4	110	6.9	6.8	8	63	104	4058	10.5	3	15	8
KMR-7	113.5	6.6	7	7.5	65	105	4070	10.35	2	6	6
GPU-45	95.6	5	6.5	7	68	105	3455	9.5	3	2	2
GPU-26	96.7	4.5	5.9	6.8	68	104	3015	8.35	3	8	10
Indaf-5	102	4	6	7.5	76	115	4050	8.75	3	18	20
GPU-28	110	5	6	7	75	115	4020	9	5	8	10
MR-1	118	5	7.7	8	81	121	4616	9.75	3	5	2
Mean	105.8	5.7	6.7	7.9	73	114	4532	9.73			
CD@5%	4.5	0.3	1.0	1.1	3.4	3.2	539	0.76			
CV%	9.7	7.4	8.3	8.0	9.6	8.6	7.9	8.10			

Phenotypic stability for grain yield and its important component traits in foxtail millet

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Abstract

Seventeen foxtail millet genotypes were assessed for stability under three different environments. Variance due to genotypes was significant for all the traits. The genotype x environment interaction (linear) was insignificant for grain yield per plot and pooled deviation was significant implying that the variation in the performance of genotypes is entirely unpredictable in nature. The genotypes HMT 100-1, SIA-2653, SR-16 and SIA-326 showed stable performance with respect to grain yield per plot with above mean performance.

Introduction

Foxtail millet (*Setaria italica*) is one of the important minor millet crop under dry land agriculture system because of its ability to yield under moisture stress conditions. This has attracted the attention of the breeders recently and good number of genotypes have been developed. However, information on stability of foxtail millet genotypes is lacking. Hence, the present investigation was carried out with seventeen promising genotypes over three years to test them for their stability for grain yield and its component traits.

Material and Methods

The experimental material comprising of 17 genotypes of foxtail millet was grown during *Kharif* 1999-2000, 2000-2001 and 2001-2002 at Agricultural Research Station, Hanumanamatti with three replications. Each genotype was planted in ten rows of 3.0 m length with a spacing of 22.5 cm between rows and 7.5 cm between two plants in a row. Observations were recorded on ten randomly selected plants with in each replication for days to 50 per cent flowering, days to maturity, plant height, fodder yield (kg/plot) and grain yield (kg/plot). The data were analysed for stability parameters following Eberhart and Russell (1966) model.

Results and Discussion

The genotypes differed significantly for grain yield and its component traits (table-1) thus justifying the material in the study. Environment (linear) component significant for all the traits except days to maturity. Both Genotype X Environment (linear)and pooled deviation were significant for days to 50 per cent flowering implying the importance of both predictable and non predictable causes for variation in the performance of genotypes. Whereas, for days to maturity, plant height, fodder yield and grain yield, non significant genotype x environment (linear) interaction was observed revealing the unpredictable performance of genotypes over environments.

In this study (Table-2), genotypes with regression coefficient (bi) hear to unity and non significant deviation from regression (S^2di) with high mean were classified as having average stability and the genotypes with bi > 1 as above average stability (suitable for favourable environments) and with bi < 1 as below average stability (suitable for unfavaourable environments). For days to 50 per cent flowering none of the genotypes were found to be stable. However, the genotype SIA 2669 showed above average stability. All the genotypes were unstable in their response to days to maturity. The genotype S 200 showed lower mean value (76 days) for days to maturity. The genotypes SIA 2642, SIA 2652 and Rs-118 exhibited uniformity in their expression for plant height across environments. Above average stability was showed by the genotype SIA 2653, and below average stability by the genotype HMT 100-1 for plant height. For fodder yield per plant, SIA 2653 exhibited stability with above mean performance (2.71 kg/plot). Higher fodder yield with suitability for favourable environments was showed by S4 16. SIA 2669 and ISC 247. Four genotypes SIA 2669, HMT 100-1, SR-16 and SIA 326 were found to be highly stable for grain yield per plot. Above average stability for grain yield was exhibited by SIA 2622 and SIA 2644, and below average stability by SIA 2642 and ISC 247.

Based on the stability parameters and overall mean, SIA 2669, HMT 100-1, SR-16 and SIA 326 were identified as better genotypes.

Reference

Eberhart S.A. and Russell W.A (1966). Stability parameters for comparing the varieties. Crop Sci. 6:36-40.

Table 1 : Analysis of variance for stability as per Eberhart and Russell (1966) for seed yield and its components in Finger Millet

Source of Variance	df	Days to 50% flowering	Days to maturity	Plant height (cm)	Fodder yield (kg/Phot)	Grain Yield (Kg/Plot)
Genotype (g)	16	73.81**	77.38**	356.15**	0.33*	0.11**
Environment + GE	34	15.31	14.76	367.62	1.38**	1.15**
Environment (Linear)	1	144.98**	23.86	10085.15**	41.26**	3.66**
GE (Linear)	16	19.05**	11.25	81.82	0.21	0.03
Pooled deviation	17	4.15**	17.52**	64.98	0.13	0.06*
Pooled error	96	0.08	0.01	54.1	0.22	0.03

** & ** Significant at 5% & 1% levels, respectively.*

Table 2 : Mean performance and stability parameters of selected genotype for different characters

Genotypes	Days to 50 flowering			Days to maturity			Plant height			Fodder yield (kg/plot)			Grain Yield		
	X	b_i	S^2di	X	b_i	S^2di	X	b_i	S^2di	X	b_i	S^2di	X	b_i	S^2di
S 200	46.33	1.98	19.29**	76	6.2	31.98**	88.33	1.58	27.25	2.08	0.81	0.1	0.78	0.53	0.03
SR 16	56.33	0.56	0.01	86.67	1.72	12.49**	107.23	0.64	48.07	3.1	1.19	0.22	1.16	1.01	0
GPUS 22	57.67	0.62	5.33**	87.67	-2.41	4.51**	104.04	0.92	2.6	2.51	1.16	0.07	1.02	0.52	-0.01
SIA 2622	55	5.01	2.11**	86.67	-4.48	112.52**	114.53	0.35	333.28**	2.6	0.89	-0.04	1.17	1.15	-0.01
SIA 2642	55	0.01	-0.03	84.33	2.41	0.49**	119.38	1.06	32.03	3.13	0.43	-0.07	1.36	0.43	-0.01
SIA 2644	52.67	-1	0.15	83.67	-0.3	12.50**	111.84	1.01	-15.82	2.72	1.14	-0.07	1.18	1.49	0.01
SIA 2652	63.33	2.23	0.39**	94	-1.03	12.50**	122.79	1.08	26.25	3	0.79	0.48	1.02	1.5	0.15**
SIA 2653	63.67	0.18	8.36**	95.33	0.35	24.50**	126.55	1.35	-18	2.71	0.98	-0.04	0.95	1.73	0.60**
SIA 2669	60.33	1.83	0	90	0.01	8.00**	117.24	0.65	141.74**	3.05	1.31	-0.06	1.15	1.07	0.02
SIA 326	52	2.95	-0.01	82.67	1.72	24.49**	105.17	0.8	46.51	2.47	1.16	0.06	1.25	1.02	-0.01
HMT 100-1	62.56	-0.06	14.46**	93.33	4.48	24.48**	125.71	0.74	-1.47	2.5	0.79	-0.02	1.07	0.91	0.01
HMT 100-2	65.33	1.05	3.30**	95.44	5.29	-0.03**	134.21	0.81	129.86*	2.91	0.59	0.32	1.06	1.52	0.02
RS 118	57	-0.05	1.95**	88.67	-2.41	12.51**	122.87	0.83	-12.43	2.24	1.28	-0.05	0.91	1.12	0.05*
ISC 247	55	0.74	9.33**	86.33	3.45	7.98**	109.9	1.83	24.37	3.23	1.25	0.3	1.32	0.24	0.01
GI 1	60	0.79	2.70**	90.33	0.35	0.50**	113.58	0.78	-13.16	2.48	1.3	-0.05	1.02	0.9	0.07**
GI 2	62	1.67	0.21**	91.33	0.35	0.50**	111.41	1.55	20.77	2.66	1.37	-0.05	0.73	0.9	0.09**
LOCAL	56.11	-0.01	2.71**	85.33	1.38	7.99**	104.33	0.5	26.33	2.33	0.56	-0.07	0.81	0.95	-0.01
Mean	57.67			88.16			114.06			2.69			1.05		

** & ** Significant at 5% & 1% levels, respectively.*

GPUP 21 - A new proso millet variety for cultivation in Karnataka and Tamil Nadu

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Proso millet which is familiarly known as Cheena (Hindi), Variga (Telgu), Baragu (Kannada) and Panivarigu (Tamil) is one of the oldest crops grown in several parts of Inida. It is recognized as one of the quickest growing food crops coming to harvest in 60-65 days. It is well adapted to high elevations as well as hot tropical situations in lower altitudes. The dehusked grain is nutritious with 10-13 per cent protein and cooked in form of rice.

The proso millet cultivation has gone down in many traditional areas in spite of having several favourable attributes like quick maturity and accompanied earliness, easy cultivation, assured harvest even in marginal soils, and superior grain quality . The lack of availability of diverse varieties has been one of the reasons for the declining cultivation and erosion of on farm diversity. The improved varieties developed in the past being state releases, the seed availability is scarce and besides being pure line selections from local germplasm, the genetic superiority was not much evident.

In order to improve the genetic base of the varieties, there was need up planned genetic enhancement work in proso millet through recombination breeding involving diverse germplasm. As part of this strategy, some of the exotic germplasm lines from Afghanistan and

Table 1 : Salient features of the variety GPUP 21 and K1

Descriptors	GPUP 21	K1
Parentage	GPUP 14 x K1	Selection from local
Pigmentation	Green	Green
Growth habit	Erect	Erect
Sheath pubescence	Present	Present
Blade pubescence	Present	Present
Degree of lodging	Medium	Medium
Flag leaf length	30 cm	27 cm
Flag leaf width	1.5 cm	1.5 cm
Days to flowering	43 days	40 days
Days to maturity	70 days	68 days
Plant height	86 cm	81 cm
Productive tillers	2-8	2-7
Panicle length	25 cm	20 cm
Panicle shape	Arched	Arched
Grain Colour	Grey	Light grey
Grain shape	Oval	Oval
1000 grain weight (g)	5.4	4.3
Grain yield q/ha	15-16	13-14
Fodder yield t/ha	4.2	3.7

erstwhile USSR were utilized in the hybridization work. The variety GPUP21 is the out come of this effort and released in 2003.

The GPUP21 in its pedigree has three lines namely S 7 a line from Afghanistan, L111 a local land race of Indian Origin and K1 a widely adapted variety. The initial cross, L 111 x S 7 made in 1990 resulted in transferring the large panicle size and bold lustered grains from Afghan parent to the local Agronomic base. From this cross several promising selections GPUP 10,11,12,13 and 14 were made. But, these selections were poor, especially for tillering ability and shootfly resistance.

In order to improve them further, GPUP 14 was hybridized with K1 during 1993-94. From the resulting F2 generation several single plant selections were made and further advanced following pedigree breeding. This cross gave several GPUP selections and entered in All India testing during the year 1999-2000. One of the selections GPUP21 performed well in the multilocation trials and finally selected for release and cultivation in Tamil Nadu and Karnataka. The GPUP21 was superior to the standard check K 1 in grain and fodder yield. The salient features of the variety are presented in Table1. GPUP 21 matures in 70 days with moderate tillering ability. The panicles are open and arched in shape, the grains are shiny gray, oval with smooth surface. Being highly pubescent both on culm and leaf surface, the variety shows field tolerance to shootfly which is a major pest on proso millet. On an average, the variety gives 15-16 q grain/ha under rainfed conditions. The variety is suitable for cultivation in Karnataka and Tamil Nadu and has entered the seed production and distribution chain.

Physiological approaches for yield improvement of Ragi

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Abstract

A study on physiological approaches for yield improvement of Ragi (CO 13) was conducted at Millet Breeding Station, Coimbatore in different dates of sowing (July 15th and August 25thduring the year 2002) with six treatments. The treatments consisting of foliar spray of cytokinin (10 ppm) on 40 and 50 DAS, urea (2%) on 40 and 50 DAS, three split application of recommended N, three split application of N combined with foliar spray of 2%urea, foliar spray of 2% DAP and control. The results revealed that significant yield reduction was observed in late sown (August 25th) ragi crop. The soluble protein, nitrate reductase activity, grain yield (2381 kg/ha) and total dry matter production (5725 kg/ha) were increased significantly due to 2 % foliar spray of urea. The economic analysis showed that spraying urea 2% brought out the cost benefit ratio to2.63 and was low (2.30) in control.

Introduction

Ragi (finger millet) a C_4 plant is an important grain crop in the Southern states of India. It has a high production potential yielding upto 40-50 quintals per hectare under optimum conditions. However, the yield levels achieved are a below the actual yield potential because of poor management and several biotic and abiotic stresses. In the late sown crop, there is generally a significant decrease of leaf area at flowering but days taken to flowering do not change. Physiological activity of the plant is regulated by variety of chemical substances and hormones. Enhancement of leaf area by hormonal (or) liquid fertilizer application 15-20 days before flowering would increase current photosynthesis during pre and post anthesis period. The development of crop canopy which intercept photosynthetically active radiation is determined by nitrogen nutrition. Split application of nitrogen at different stages resulted in a significant increase on grain yield. Physiological activity of the plant is regulated by the chemical substances and hormones. The wider stomatal opening induced by kinetin resulted in an increase in net photosynthesis. It stimulates many enzymatic activities, synthesis of protein and nucleic acid. In maize, foliar spray of kinetin (10 ppm at 10 DAF) improved the nutrient uptake, plant growth and yield of rice. In finger millet, kinetin promotes shoot development and tillering.

Kinetin increases the branching in scale cereals. Spraying of kinetin at post flowering stage was very effective in retarding the respiratory rate. Biomass production is predominantly depends on canopy photosynthesis and leaf area. Therefore a study on physiological approaches for enhancing leaf area and current photosynthesis during pre and post anthesis period of crop by chemical and hormonal application is very essential. Based on this back ground, the present study is carried out to develop the cost effective technology for increasing the yield of Ragi crop.

Materials and Methods

An experiment was laid out with ragi cultivar, CO13 at Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore. The normal sowing was taken on 15th July and late sowing was done on 25thAugust during the year 2002. The recommended dose of fertilizer was applied in all the treatments. The treatments consist of foliar spray of cytokinin 10 ppm($T-_1$) urea 2% on 40 and 50 DAS(T_2), three split application of recommended nitrogen(T_3), combined application of foliar spray of urea with three split application of nitrogen(T_4), foliar spray of DAP 2% (T5) and control (T_6) by adopting split plot design with three replications. Physiological and yield attributes such as Leaf area, Soluble protein Nitrate reductase activity, Total dry matter production and Grain yield were recorded at flowering and harvest stage respectively. LI 3100 area meter (USA) was used to measure leaf area and from this leaf area index was computed. Third leaf from the top was sampled for the estimation of soluble protein and nitrate reductase activity. Soluble protein was determined by adopting the procedure of Lowry *et al.* (1951) of and nitrate reductase activity was estimated as per (Nicholas *et al.*, (1976). Statistical analysis of the data was carried out as described by Panse and Sukhatme (1978).

Results and Discussion

Late sown ragi crop experienced water stress at early stages of the growth. As compared to normal planting, there was a reduction in LAI, soluble protein, nitrate reductase activity, total dry matter production and yield (Table 1). The difference in leaf area among the foliar spray treatments was significant. The foliar spraying of10ppm cytokinin (T_1) performed well than remaining treatments. The leaf area recorded by this treatment was 1328 cm^2. The unsprayed control (T_6) registered the leaf area of 872 cm^2. The foliar application of 10 ppm cytokinin arrested the chlorophyll degradation and protease activity and promoted the synthesis of photosynthetic enzymes and soluble protein content resulting in more assimilating surface area for longer period was described by Richmond and Lang (1957)

All the treatments performed well in recording increased soluble protein content compared to control. Urea 2% foliar spray showed its distinct effect in enhancing soluble protein by 17% over control. Soluble protein content being a measure of RUBP carboxylase activity is considered as an index for photosynthetic efficiency. RUBP carboxylase enzyme forms nearly 50 per cent of soluble protein in leaves of many plants were explained by Kung (1976). The higher soluble protein resulted due to the treatment imposed in this study could enhance the photosynthetic activity and the results are in agreement with the findings of Sivakumar (2000) in pearl millet.

The nitrate reductase activity was found to be maximum at flowering and there after it gradually decreased towards maturity. The higher nitrate reductase activity was related to the yield of grain and protein content in many crops (Mishra *et al.*, 1980). The higher (691 µg NO_2/g/hr) nitrate reductase activity was recorded by foliar spray of 2% urea (T_2). The increase in enzyme activity was also reported by Akhtar *et al.*, (1991).

The plant dry matter production was increased by foliar application of nutrients as well as growth regulators. Plants sprayed with 2% urea and 2% DAP was able to increase the dry matter production by 21 and 18% respectively over control. TDMP, the yield determinant in cereals, was lower at harvest stage in the control. The reduced TDMP appeared to be due to reduced photosynthetic activity during senescence period. This could have been brought about by the inability of plants to take up the nutrients from soil and due to the depletion of nutrients from leaves to seed. Foliar application of urea retarded leaf senescence and in turn produced higher TDMP and grain yield. Similar results were reported by Kannan (1986). Foliar application of nutrients and growth regulators are significantly and positively influenced the yield. Among the treatments urea (2%) and DAP (2%) increased the grain yield by 23 and 17% respectively, over control. The quantity of nutrients absorbed by roots at peak period of nutrient requirement may not be sufficient to meet the needs at flowering and grain filling stage. Hence supplementing nutrients through foliage might have resulted in better nutrient balance in the plants leading to increased yield components. Similar results were also reported by Kalarani *et al.* (2001).

The economic analysis showed that spraying urea 2% brought out the cost benefit ratio (2.63) and it was the lowest (2.30) for control.

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Table 1. Effect of foliar application of growth regulating chemicals on yield of ragi (CO-13)

Treatment	Leaf area (cm^2/plant)			Soluble protein content(mg/g)			NRase activity (µ g NO_2/g/hr)			Total dry matter production(kg/ha)			Grain Yield (kg/ha)			B/C ratio
	D_1	D_2	Mean	D_1	D_2	Mean	D_1	D_2	Mean	D_1	D_2	Mean	D_1	D_2	Mezn	
T_1	1379.7	1278.0	1328.8	10.41	9.36	9.75	422.3	377.7	400.0	5838.6	3632.0	4735.3	2685.7	1865.7	2275.7	2.50
T_2	1368.3	1249.7	1309.0	10.89	9.56	10.22	721.3	662.0	691.7	5753.6	4362.4	5058.0	2845.3	1917.3	2381.3	2.63
T_3	986.6	953.3	970.0	9.85	9.24	9.54	872.3	518.0	545.2	4963.0	3497.0	4230.0	2540.7	1480.0	2010.3	2.46
T_4	1211.7	1039.0	1125.3	9.33	8.84	9.09	591.3	535.0	563.2	5016.3	3598.0	4307.2	2437.0	1714.3	2075.7	2.30
T_5	1381.0	1257.7	1319.3	10.22	8.93	9.57	489.7	458.7	474.2	5314.0	4523.0	4917.0	2732.7	1813.7	2273.2	2.59
T_6	883.3	862.3	872.8	9.03	8.38	8.70	371.7	317.7	344.7	4194.8	4145.2	4150.0	2438.7	1418.3	1928.5	2.30
Mean	1201.8	1106.7		9.91	9.05		528.1	478.2		5540.5	3812.3		2546.7	1684.9	-	
•	CD			CD			CD			CD			CD			
T	17.20			0.256			11.414			22.33			15.10			
D	10.60			0.245			5.297			19.16			12.30			
TxD	25.16			NS			14.643			40.00			26.12			
DxT	25.98			NS			12.975			46.94			30.13			

T_1 ... Cytokinin (10 ppm) – Foliar spray at 40 & 50 DAS

T_2 ... Urea 2%

T_3 ... Three split application of recommended nitrogen

T_4 ... (T2 + T3)

T_5 ... Foliar application of DAP 2% at 40 & 50 DAS

T_6 ... Control

Date of Sowing : D_1 July 15th

D_2 August 25th

Adoptation of cropping sequence for sustainable production in rainfed hill farming of Uttaranchal

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Abstract

The aim of present study was increase the cropping intensity, LER as the monetary to return through introduction of suitable crops in Finger millet based cropping sequence to evaluate Ten (10) cropping sequence viz; Finger millet-wheat, Finger millet – barley, Finger Millet – Toria, Finger Millet – Oat alone as well as intercropping with soybean. Field experiment were conducted for 7 years during 1997 to 2003 at hill campus, Ranichauri at an elevation of 1900 M MSL in typical hill terraces under rainfed hill farming system. Pooled data over 7 years revealed that out of ten cropping sequence tested Finger Millet + Soybean- Oat recorded maximum grain yield (20.88 q/ha) plus soybean (2.91 q/ha) in Kharif and Oat is Rabi (14.49 q/ha) followed by Finger Millet (20.10 q/ha) in kharif and oat in rabi (1335 q/ha). The maximum monetary return (Rs. 17483/ha) was recorded in cropping sequence Finger Millet + Soybean-Oat followed by Finger Millet – Oat (Rs. 14536/ha). The performance of cropping sequence followed the order as:

u FM+S-OAT>FM-Oat>FM+S-Wheat>FM-
u Wheat>FM+S-Barley>FM-Barley>FM+S-
u Toria>FM-Toria>FM+S-Fallow>FM-Fallow.

Introduction

Finger millet (*Eleusine coracana* (L.) Gaertri) is one of the major important food and fodder crop of Uttaranchal hills in Kharif season. The most prevailing cropping sequence, three crops in two years rotation FM-Wheat-FM-Fallow have intensity of 150% are commonly practices.

Cropping intensity and net returns per unit area are not attractive in sequence. Soybean is an important crop of Himalayan region and is generally grown as mixed crop with Finger Millet. Productivity, net returns and cropping intensity from Finger Millet-Wheat-F.M.-Fallow crop sequence can be improved by including Finger Millet based cropping system. Hence an attempt was made to assess of suitability of Finger Millet based crop sequence under rainfed conditions.

Materials and Methods

The trials were conducted during Kharif & Rabi of 1997 to 2003 to study and assess the Finger Millet based cropping sequence for rainfed farming system at G.B. Pant University of Agril. & Technology, Hill Campus, Ranichauri, Tehri Garhwal, Uttaranchal. There were (10) Finger Millet based intensive crop sequence viz; Fingermillet-Fallow, Finger Millet-Wheat, Finger Millet- Barley, Finger Millet – Toria, Finger Millet – Oat alone as well as intercropped with soybean were evaluated in randomized block design with three replication. The experimental terraces were silty clay loam in texture, acidic in nature pH 5.6 and available N (205.0 kg N/ha), available P (12.6 kg P_2O_5/ha). The rainfall received was 1840.2, 1046.8 and 941.6 and 847.0 mm in 1998, 1999 & 2000 and average 1997 to 2003. The Kharif crops finger millet variety VL-149 and soybean Bragg were sown in June and Rabi crops, wheat (HS-240), Barley (VL-1), Toria (PT-503) and oat (kent) were sown in the month of November. Table 3.

Crop included in various sequences were raised with recommended agronomic practices. Economics of various crop sequences were calculated to work out the production potential of different crop sequences. Economic returns (gross and net returns Rs./ha) and cost of cultivation (Rs./ha) for individual crop in sequence were calculated on the basis of prevailing market price of produce and inputs. Land use efficiency was expressed as percentage of days actually used in a year and was worked out by summation of duration of each crop in individual crop sequence divided by 365. Production efficiency value in terms of a kg/ha/day was obtained by total production in a sequence divided by total duration of crop in that sequence. The data of 3 years were analysed and the comparison were made on the basis of pooled finger millet equivalent yield income equivalent ration and economics.

Results and discussion

The pooled data indicate that finger millet + soybean – oat cropping sequence recorded maximum grain yield (20.88 q/ha)+soybean (2.91 q/ha) oat (14.49 q/ha) followed by FM+S-wheat (19.94) and FM-wheat (19.17 q/ha). Similar trend was found in straw yield. Finger millet equivalent yield, finger millet + soybean-oat cropping sequence recorded maximum yield (42.42 q/ha) followed by finger millet + soybean – wheat (38.40 qt/ha) and finger millet – oat (36.40 qt/ha) was significantly superior over to other cropping sequence. Table 1. The highest land use efficiency was recorded in FM+S – oat and FM+S-Wheat crop sequence, because this sequence occupied the field for longest duration. It was the lowest FM-fallow sequence. Production efficiency in terms of kg/ha/day was also highest in FM-Fallow sequence followed by FM+S-oat and FM-oat. Table 2.

Economic analysis (Table 2) indicated that finger millet + soybean – oat sequence *gave* the highest monetary return (Rs.17,483/ha.) followed by finger millet – oat (Rs.14,536/ha), finger millet + soybean-wheat (Rs.13,858/ha) and finger millet – wheat (Rs.11,777/ha). The results also revealed that higher benefit cost ration was obtained from FM+S-oat and FM-oat and FM+S-oat cropping sequence. The highest net return in FM+S-oat cropping sequence was due to highest total production thus finger millet based cropping sequence viz; FM+S-Wheat proceed to be the next best crop sequences tested under rainfed hill farming system.

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Recommended cultural practices followed in different crops

Crop	Variety	Seed rate (Kg/ha)	Spacing Cm x cm	Fertilizer applied N P_2O_5 K_2O
Finger Millet	VL-149	10.0	25 x 10	40 20 20
Wheat	HS-240	100.0	20.0	80 90 90
Barley	VL-1	100.0	20.0	80 40 90
Toria	P.T.-303	5.0	30 x 15	60 20 20
Oat	Kent			
Soybean	VL-Soya-47	75.0	25 x 10	20 60 20

Table:1 Grain yield and Straw yield (q/ha) of finger millet, soybean and other rabi crops as influenced by different cropping sequences (7 years average)

Cropping Sequence	Grain yield kharf		Rabi	Straw yield kharf		abi
	FM	S		FM	S	
FM-Fallow	13.35	-	-	68.97	-	-
FM-Wheat	19.94	-	10.34	70.03	-	23.22
FM-Barley	17.55	-	7.33	68.02	-	17.12
FM-Toria	15.78	-	1.97	68.32	-	4.89
FM-Oat	20.82	-	13.35	75.60	-	28.25
FM+S-Fall0ow	12.33	303	-	71.09	15.28	-
FM+ S-Wheat	19.17	345	10.11	73.92	18.66	21.22
FM+ S-Barley	14.23	280	5.21	73.52	18.23	25.64
FM+S-Toria	15.18	330	2.76	69.54	15.95	6.4
FM+S-Oat	20.83	291	14.49	78.31	15.91	31.43

Table : 2 Finger millet equivalent yield (q/ha), monitoring returns (Rs./ha), productivity efficiency land use efficiency and benefit cost ratio under different cropping sequences

Cropping sequence	FM equivale yield (q/ha))	Mean duration of crop sequences	Production efficiency (kg/ha/day)	Land use efficiency (Rs/ha)	Monetory returns (Rs)	B:C ratio
FM-Fallow	13.35	138	16.5	38	3060	1.36
FM-Wheat	33.73	333	12.0	91	11777	2.17
FM-Barley	24.88	318	10.8	87	8509	2.13
FM-Toria	20.38	291	11.4	80	3221	2.12
FM-Oat	36.40	323	13.2	88	14536	2.61
FM+S-Fall0ow	17.28	140	18.6	38	6599	1.38
FM+ S-Wheat	38.40	335	14.5	92	13858	2.46
FM+ S-Barley	22.24	320	11.7	88	8810	2.17
FM+S-Toria	27.12	293	11.8	80	9557	2.15
FM+S-Oat	42.42	325	15.4	89	17483	2.92

Chemical weed control of transplanted finger millet under irrigated condition

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Abstract

To know the effectiveness of different herbicides (2,4-B ethyl ester, Butachlor, Isoproturon, Anilophos, oxyflurofen) for transplanted finger millet under irrigated condition. Among different herbicides and management practices were tested during kharif, 2002 oxyflurofen @ 0.1kg a.i/ha plus recomended cultural practices recorded significantly higher yield and also recorded higher net monitory returns compared to other herbicides and management practice tried either singly or in combination. The herbicide Isoproturon was applied as pre – emergency @ 0.5kg a.i/ha recorded lowest yield and lowest net monitory returns.

Introduction

Finger millet is one of the main food crop for Southern Karnataka. This will be grown both under rainfed and irrigated situation . Under irrigation production always more than the rainfed situation. Weed management will also played a role for higher production. Due to weeds about 25-30 percent of yield reduction was noticed in Ragi crop. Critical period for weed competition has been identified to be first 4-6 weeks from planting (Nanjappa, 1980) besides labour availability is scares and not timely. Therefore an attempt was made to evaluate the chemical suitable for controlling weeds effective in transplanted finger millet under irrigated condition.

Materials and methods

The experiment was initiated at Zonal Agricultural Research Station, (UAS,Bangalore), V.C.Farm, Mandya , Karnataka, during kharif 2001-2003. the trial was planted in randomized complete block design with three replication at a spacing of 30cms between the rows and 10cms between the plants with a gross plot size of 12 Sq.Mts (3mts X 4 mts). The crop was raised as per recommended package of practices and the followings treatments were imposed.

Treatments

TI	:	Unweeded check
T2	:	Recommended Practice
T3	:	2,4-Di ethyl ester @ 0.75Kg a.i/ha (post emergence)
T4	:	Butachlor @ 0.75Kg a.i/ha (pre-emergence)
T5	:	Iso Proturon @ 0.5Kg a.i/ha (pre-emergence)
T6	:	Anilophos @ 0.4Kg a.i/ha (pre-emergence)
T7	:	T4 + T3
T8	:	T5 + T3
T9	:	Oxyflurofen @ 0.1 Kg a.i/ha (pre-emergence)
T10	:	T4 + T2
T11	:	T5 + T2
T12	:	T9 + T2

The crops attained maturity the observations were recorded on grain yield (Kg/ha), Straw yield (Kg/ha) and worked out the economics by calculating gross monitory returns and net monitory returns.

Results and discussion

The data reveled that Oxyflurofen @ 0.1Kg a.i/ha as pre-emergence plus recomended packgage of practice gave significantly higher grain and straw yield which was followed by plots treated with Oxyflurofen @ 0.1Kg a.i./ha alone as pre-emergence (Mariraju, 1981). The lowest grain and straw yield was noticed in Iso proturon at 0.5Kg a.i/ha as pre-emergence as it caused phytotoxic effect of the chemical and the seedling motality (Subbiah, et al. 1974). The gross monitory return showed that Oxyflurofen @ 0.1Kg a.i/ha plus recommended practice was found superior followed by Oxyflurofen alone. The net returns, data revealed that though Oxyflurofen applied plots in combination with recommended practice recorded little higher net returns, where as Oxyflurofen alone applied plots will also on per with Oxyflurofen plus recommended practices. (Roopathi, et al, 1981) net returns data the Oxyflurofen @ 0.1Kg a.i/ha treated plot was found effective in controlling weeds under irrigated transplanted condition.

It can be conclude that Oxyflurofen @ 0.1Kg a.i/ha was noticed effective and economical in providing good weed control chemical in irrigated transplanted finger millet besides increasing grain and straw yield, there by gained highest net returns.

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Table : Grain and straw yield (Kg/ha) and economics as influenced by weed control measures in transplanted Finger Millet under Irrigated condition

Treatments	Grain Yield(Kg/ha)	Straw Yield(Kg/ha)	GMR(Rs/ha)	Net Returns(Rs/ha)
T1	2731	4600	15621	5908
T2	3210	5618	18619	7427
T3	2997	5244	17300	6738
T4	3011	5270	17464	7252
T5	2871	5023	16650	6564
T6	3050	5312	17603	7346
T7	3161	5565	18374	7247
T8	2880	5040	16704	5743
T9	3375	5906	19689	8909
T10	3030	5303	17575	6333
T11	2963	5184	17580	6462
T12	3475	6081	20156	8346
SEM	96	174		
CD@5%	283	511		

Intercropping of field bean in direct sown rainfed Finger millet

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Abstract

Field experiments were conducted at the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, India during *kharif* and *rabi* seasons of 2000-2003 under rainfed condition. In the same plots for three years with a view to study the impact of fieldbean then for productivity under rainfed conditions. The results indicated that higher grain yield of finger millet (CO 11) was obtained in intercropping system with indeterminate type of field bean with management practice of clipping tendrils. Sole finger millet CO 11 yielded more as compared to CO 13. In field bean, indeterminate type with clipping recorded higher seed yield than determinate type. The highest net return was recorded with finger millet (CO 11) intercropped with indeterminate field bean with clipping. B:C ratio

Introduction

Small millets play an important role in providing food to human and feed to animals living in harsh environments particularly in arid and semi arid areas. With rapid shift in agriculture, the house-holds food and nutritional security has been disturbed leading to chronic malnutrition, especially protein requirements. Intercropping is a potential system for maximizing crop production in drylands over space and time in subsistence farming situations (Hegde et al.,1980 and Maitra *et al.*, 2003). The major objectives of intercropping are to produce an additional crop, to optimize the use of natural resources and to stabilize the yield of crops (Willey, 1979). With the available rain water, it is possible to augment pulse production by adopting suitable inter, double, relay cropping systems and crop rotations. With this in view, the present study was proposed with an objective to find out the effect of field bean as a compani on crop along with finger millet and to study the impact of clipping of vegetative branches on especially tendrils on the productivity of intercrop and its economics as well as their effects on building up of soil fertility.

Materials and methods

Field experiments were conducted at dryland farm of Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu during *kharif* and *rabi* season of 2000-2003 in randomized block design with three replications under rainfed .

Conditions on the same field. The soil of the experimental site was clay loam in texture with P^H 8.0 and EC 0.85 dSm^{-1}. The soil had low available nitrogen (185 kg ha^{-1}), medium in available phosphorus (9 kg ha^{-1}) and high available potassium (538 kg ha^{-1}). The treatments included were intercropping of short and medium duration finger millet (CO 11 and CO 13) with indeterminate field bean (local) and determinate field bean (improved) with and without clipping with sole crop of finger millet and pure field bean crops with clipping for conformation. The treatment details are as follows.

T_1- Finger millet (CO 11) + Field bean Indeterminate type (local) with clipping.

T_2- Finger millet (CO 11) + Field bean Indeterminate type (local) without clipping.

T_3- Finger millet (CO 11) + Field bean Determinate type (Improved) with clipping.

T_4- Finger millet (CO 11) + Field bean Determinate type (Improved) without clipping.

T_5- Finger millet (CO 13) + Field bean Indeterminate type (local) with clipping.

T_6- Finger millet (CO 13) + Field bean Indeterminate type (local) without clipping.

T_7- Finger millet (CO 13) + Field bean Determinate type (Improved) with clipping

T_8- Finger millet (CO 13) + Field bean Determinate type (Improved) without clipping.

T_9- Pure finger millet (CO 11).

T_{10}- Pure finger millet (CO 13).

T_{11}- Pure field bean Indeterminate type with clipping.

T_{12}- Pure field bean Determinate type with clipping

The intercrops were raised at 6:1 row ratio as replacement series. The crops were given with a recommended fertilizer dose of 40:20:20 kg NPK ha^{-1} in all the years. A total rainfall of 504, 342 and 402 mm was received in 30, 25 and 27 rainy days during the respective years. Observations with regard to the yield of finger millet and field bean, grain equivalent yield and economics with soil fertility status of different systems were observed and worked out.

Results and Discussion

The results clearly indicated that short duration sole crop of CO 11 finger millet recorded significantly higher grain (2995 kg ha^{-1}) and straw yield (7588 kg ha^{-1}) than medium duration CO 13. (Table 1). Increased yield of field bean (indeterminate) might be due to reduction of excess vegetative growth by way of clipping which in turn put forth more flowering and produce more vegetable pods. Higher grain (2230 kg ha^{-1}) and straw yield (5708 kg ha^{-1}) was recorded in finger millet (CO 11) intercropped with field bean indeterminate type with clipping followed by finger millet (CO 13) intercropped with field bean indeterminate type with clipping.

With regard to field bean under pure stand, field bean (indeterminate type) with clipping recorded higher grain (682 kg ha^{-1}) and vegetable yield (3010 kg ha^{-1}) as compared to field bean (determinate type) with clipping.

Grain and straw yields of finger millet declined considerably when intercropped with legumes irrespective of the duration as compared with the sole stand of finger millet in all the years (Table 1). Yield reduction was mainly due to reduction in plant stand under replacement series as compared with that of pure cropping of finger millet. Singh and Arya (1999) and Siddeswaran *et al.* (1989) also observed similar reduction in finger millet under intercropping situation. However, the grain equivalent yield of finger millet was higher in intercropping system of finger millet (CO 11) and field bean (indeterminate type) with clipping (T_1) than other intercropping systems tested but it was on par with sole finger millet (CO 11) and (CO 13) + field bean (determinate type) with clipping (T_5) treatments .In general sole crop of finger millet varieties CO 11and CO 13 registered higher.GEY due to higher grain and straw yield.

With regard to the yield of field bean under intercropping situation, the highest grain yield (274 kg ha^{-1}) and vegetable yield (434 kg ha^{-1}) were recorded with the field bean indeterminate type with clipping when intercropped in finger millet (CO 11), followed by indeterminate field bean with clipping intercropped with CO 13 finger millet (247 and 415 kg ha^{-1} respectively) however, they are on par with each other. Irrespective of the finger millet varieties, indeterminate field bean with clipping recorded higher grain yield than without clipping under intercropping situations.

The highest grain equivalent yield (2481 kg ha^{-1}) was recorded with finger millet (CO 11) intercropped with field bean indeterminate type with clipping which increased net return (Rs.13361) and B:C ratio (4.14) (Table).With regard to the fertility status of the soil, increase in the N, P and K content was recorded in pure field bean indeterminate type with clipping followed by pure field bean determinate type with clipping (Table 3). This may be due to more production of vegetable growth and which in turn leads to higher leaf litter contribution and adds more organic matter to the soil. Hence, under rainfed condition ,short duration finger millet var. CO 11 with indeterminate field bean was found to be more remunerative and sustainable both in terms of maintaining higher productivity and soil health.

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Table 1. Effect of treatments on yield and GEY of finger millet (mean of 3 years)

Treatments	Grain yield (kg / ha)	Straw yield (kg / ha)	GEY (kg / ha)
T_1	2230	5708	2481
T_2	2000	5175	2195
T_3	2085	5306	2278
T_4	1816	5041	1993
T_5	2171	5537	2407
T_6	1756	5014	1949
T_7	1838	5407	2025
T_8	1793	5373	1973
T_9	2995	7588	2995
T_{10}	2706	6946	2706
T_{11}	-	-	-
T_{12}	-	-	-
SED	113	157	129
CD (P=0.05)	227	329	263

Table 2. Effect of treatments on yield of field bean and economics of intercropping systems (mean of 3 years)

Treatments	Vegetable yield (kg/ha)	Grain yield (kg/ha)	Net Return (Rs/ha)	B : C ratio
T_1	434	274	13361	4.14
T_2	341	224	11725	3.72
T_3	334	205	12221	3.86
T_4	317	191	10561	3.25
T_5	415	247	13013	4.04
T_6	344	213	10400	3.43
T_7	329	215	11691	3.51
T_8	324	204	11442	3.71
T_9	-	-	13762	4.57
T_{10}	-	-	12126	4.19
T_{11}	3010	682	6477	2.16
T_{12}	2174	663	9010	2.54
SEd	42	13	-	-
CD (P=0.05)	87	29	-	-

Cost of finger millet grain	:	*Rs.5/kg*
Cost of finger millet straw	:	*Rs.300/ton*
Cost of field bean grain	:	*Rs.15/kg*
Cost of field bean vegetable	:	*Rs.10/kg*

Table 3. Effect of treatments on soil fertility status (kg/ha) (Mean of 3 years)

Treatments	Available nitrogen	Available phosphorus	Available potassium
T_1	193	9.4	538
T_2	191	9.4	538
T_3	191	9.3	540
T_4	191	9.0	533
T_5	192	9.3	539
T_6	193	9.6	536
T_7	192	9.0	534
T_8	191	8.9	536
T_9	186	8.6	530
T_{10}	187	8.7	532
T_{11}	203	9.8	548
T_{12}	195	9.5	543
SED	3.1	1.3	5.6
CD(P=0.05)	6.7	NS	12.3

The effect of preceding grain and vegetable legumes on the succeeding finger millet under rainfed conditions

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Abstract

Field experiments were conducted at the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu during *kharif* and *rabi* seasons of 2000-2003 under rainfed condition to investigate the impact of early season pulse crops on the succeeding finger millet in a cropping systems approach. Results revealed that maximum yield was obtained in cowpea as compared to green gram. In succeeding finger millet crop, higher grain and straw yield with increased net returns were obtained where cowpea was incorporated during early season followed by transplanting of finger millet with P.

Introduction

Many legumes viz., cowpea, black gram, green gram and horse gram invariably find a vital place in finger millet under rainfed situations. These crops are taken either as a preceding crop or as an intercrop or as relay crop in the system depending on rainfall distribution and soil type. Many high yielding short duration varieties of these crops have been evolved in recent years for increasing cropping intensity. Hence, the feasibility of double cropping / inter cropping is possible wherever bimodal rainfall is a common feature. Seth and Balyan (1989) reported that inclusion of legumes in cropping system improves the nitrogen status of soil and increases the yield of succeeding cereal crops. Mehrotra and Ali (1970) stated that the legume after meeting their own nitrogen, can supply a part of the nitrogen that is fixed to another non-legume crop during the growth period and partly through the legume death through sloughing of nodules which gradually degenerate and release the N in to the soil. Hence the present study was mooted with an objective to find out the effect of preceeding early season legumes on growth and yield of finger millet and to study the buildup of soil fertility and economics.

Materials and methods

Field experiments were conducted at dry land farm of Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India during *kharif* and *rabi* seasons of 2000-2003. Cowpea and green gram were grown during *kharif* (I season) under randomized block design with five treatments and establishment of finger millet with and without P in the main plot (II season) with three replications. The experimental treatments are

I Season (Main plot)

M_1 Cowpea (CO 2) for fodder after harvest for vegetable purpose

M_2 Cowpea (CO 2) for incorporation after harvest for vegetable purpose

M_3 Green gram (pusa bold) for fodder after harvest for grain purpose

M_4 Green gram (pusa bold) for incorporation after harvest for grain purpose

M_5 Fallow

II Season (Sub plot)

S_1 Transplanting finger millet (CO 11) with P

S_2 Transplanting finger millet (CO 11) without P

S_3 Direct sown finger millet (CO 11) with P

S_4 Direct sown finger millet (CO 11) without P

The soil of the experimental site was clay loam in texture, with pH 8.0 and EC 0.85 dSm^{-1}. The soil had low available nitrogen (185 kg ha^{-1}) medium available phosphorus (9 kg ha^{-1}) and high potassium (538 kg ha^{-1}). N and K fertilizers were applied at 40 & 20 kg ha^{-1} respectively and P fertilizer @ 20 kg/ha was applied based on the treatment schedule as basal . A total rainfall of 504, 342 and 402 mm was received in 30, 25 and 27 rainy days during the respective years. Observations with regard to yield of legumes and finger millet and economics with soil fertility status were recorded.

Results and discussion

In the succeeding crop of finger millet, significantly higher yield were recorded when a preceeding crop of pulses either cowpea or green gram was grown (M_1 - M_4) compared to M_5, where there was no preceeding pulse crop and the field was left fallow. Among all the main plot treatments, cowpea incorporation after harvest for vegetable purpose (M_2) recorded significantly higher yield of the succeeding finger millet crop (2640 kg ha^{-1}). With respect to sub plot treatments in finger millet crop, transplanting finger millet (S_1 and S_2) recorded significantly higher yield compared to direct sown finger millet (S_3 and S_4) with and without P. Application of P significantly increased the finger millet yield compared to non application of P. Among all the treatments, transplanting finger millet with P (S_1) recorded highest finger millet grain and straw yield of 2390 and 5324 kg ha^{-1}, respectively. Increase in finger millet yield might be attributed to the effect of legume cowpea, which might have provided an additional N to succeeding finger millet through biological N fixation and minerlisation of root biomass. Similar results were reported by Balyan (1997).

In general, yield of finger millet were markedly higher when it was sown after incorporation of preceding cowpea in to the soil than it was removed from the field for fodder purpose which might be due to maximum contribution of nitrogen to the soil through this crop. These results are in close agreement with the findings of Seth and Balyan (1985).

The economics showed that cowpea incorporated early in the season followed by transplanting of finger millet with P and without P registered higher net returns and B:C ratio compared to other treatments.

With regard to soil fertility status, higher available nitrogen (196 kg ha^{-1}) available phosphorus (9.7 kg ha^{-1}) and available potassium (556 kg/ha) were registered where cowpea (CO 2) was grown for incorporation after the harvest for vegetable purpose. Similar results were already reported by Mehrotra and Ali (1970).

Further it could be concluded, that cowpea raised early in the season for incorporation after harvest for vegetable purpose followed by transplanting finger millet in the second season with basal application of P registered higher grain yield with increased net returns and B/c ratio under rainfed condition.

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Table 1. Effect of early season legumes on yield and soil fertility status (mean of 3 years)

Treatments	Vegetable yield (kg/ha)	Grain yield (kg/ha)	Available nitrogen (kg/ha)	Available (phosphorus kg/ha)	Available potassium kg/ha
M1	4019	-	194	9.6	554
M2	4047	-	196	9.7	556
M3	-	719	186	9.3	550
M4	-	740	187	9.4	553
M5	-	-	180	8.9	539
SEd	-	-	2.3	0.4	5.5
CD(P=0.05)	-	-	4.9	NS	11.9

Table 2. Effect of short duration legumes on yield and economics of succeeding finger millet (mean of 3 years)

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net Return (Rs ha^{-1})	B:C ratio
M_1	2315	3897	7386	2.54
M_2	2640	4268	8950	2.84
M_3	2270	3910	6820	2.39
M_4	2430	4051	7820	2.64
M_5	1680	3339	5807	2.30
SED	125	141	-	-
CD(P=0.05)	248	294	-	-
S_1	2390	5334	10864	2.75
S_2	2349	5297	10549	2.59
S_3	1580	4715	6465	1.87
S_4	1463	4231	6357	1.76
SED	97	137	-	-
CD(P=0.05)	189	269	-	-
M at S SED	130	158	-	-
CD(P=0.05)	246	291	-	-
S at M SED	124	138	-	-
CD(P=0.05)	248	275	-	-

Cost of ragi grain – Rs.5.00/kg ; Cost of straw – Rs.300/ t ; Cost of cowpea /green gram – Rs.20/kg

Intercropping of pigeonpea (*Cajnus cajan*) on yield and economics in kodomillet (*Paspalum scrobiculatum*) under Northern hill zone of Chhatishgarh

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Abstract

An experiment was conducted during *kharif* 2001 and 2002 at JNKVV, Research Farm, Dindori (M.P.) under rainfed condition on sandy- skeletal soils to evaluate the performance of pigeonpea with different duration on the yield of kodomillet. The results revealed that short duration kodomillet variety DPS-19 yielded (1416 kg/ha) higher than late maturing IPS-147-1(1400 kg/ha). In intercropping system, kodomillet (*DPS-19*) and pigeonpea (No.*148*) in 2:1 planting ratio was better than sole crop of kodomillet both in terms of kodomillet grain yield equivalent (2423 kg/ha) and net returns (Rs.7135/ha).

Kodomillet is a staple food grain crop of the poor people mostly of the tribal areas of Northern Hill Zone of Chhatishgarh and well adopted to poor and marginal uplands. However, realizing the nutrient composition it is considered as nutricereals (nutritious grains). In this Zone, kodomillet is commonly grown in low productive lands with either sole or mixed with pigeonpea, black gram or sesamum; but productivity is very low. Intercropping kodo millet and pulses is rated as a potential system for maximizing crop production in dry lands over space and time (Hegde, *et al.*, 1980 and Maitra *et al.*, 2003). The major objectives of intercropping are to produce an additional crop, to optimize the use of natural resources and to stabilize the yield of crops (Willey, 1979). Phenological characters and growth habits of pigeonpea make it ideal as a component crop with most of the dry land cereal/ millet crops because of its deep root system which helps to tap plant nutrients from deeper layers allowing the base food crop to feed at top layers of the soil. With this in view, the present investigation was taken up with the objectives to study the relative productivity and profitability of intercropping systems in kodomillet with different varieties of pigeonpea under rainfed condition.

Materials and methods

The field experiment was conduced during *Kharif* seasons of 2001 and 2002 at JNKVV, Regional Agricultural Research station, Dindori (M.P.) on sandy – skeletal soils having pH 7.2, low in available nitrogen (organic carbon 0.32%) available phosphorus (4.3 kg/ha), and available potassium (213 kg/ha). Kodomillet and pigeonpea were sown in 2:1 row ratio. The treatments consisted of two kodomillet varieties (long duration-IPS-147-1 and short duration-DPS-19) and four pigeonpea varieties (medium duration-No. 148 and JKN-7; short duration- ICPL-87 and UPAS-120). Both crops and their varieties were arranged with treatments as sole and intercrops in randomized block design with three replications during both the years. The crop was fertilized with recommended dose of 40:20:20 NPK kg/ha. A total rainfall of 1399.2 and 835.2 mm was received in 81 and 60 rainy days during the cropping seasons of respective years. Observations with regard to the yield of kodomillet and pigeonpea were recorded and later kodo millet grain yield equivalent (KMGYE) and economics of various systems were worked out.

Results and discussion

Sole and inter crops

The yield of kodomillet and pigeonpea in general varied in two seasons. In 2002, the yield of both the crops was low because of very poor and late rainfall as well as low intensity during the initial stages of crop establishment, which resulted in initial setback to kodomillet and Pigeonpea with respect to growth. Probably which lead to significantly lower yields of kodomillet and pigeonpea in 2002 under steep slope & skeletal soil conditions. The highest seed yield of KM was obtained with sole crop of kodomillet during both the years (Table 1). On the basis of two years mean, it is clear that short duration KM variety (DPS-19) produced higher seed yield (1416 kg/ha) than long duration KM variety (1400 kg/ha). Among different sole pigeonpea varieties, short duration ICPL-87 gave higher grain yield (1753 kg/ha), net return (Rs. 4565/ha) and B:C ratio (1:2.08) than others.

Grain yield equivalent

Among different intercropping combinations (2:1) short duration KM variety (DPS-19) with medium duration pigeonpea (No.148) produced highest kodomillet grain yield equivalent (2423 kg/ha), which was significantly superior over other treatments. This was mainly due to the fact that pigeonpea (No.148) put forth less growth during early stages of crop growth because of the compact and short stature. The results corroborate with the findings of Hegde *et al.*, (1980) and advantages of raising pulses in replacement series by Subba Reddy (1985) and, Singh and Reddy (1986) on fingermillet.

Economics

Highest net return (Rs. 7135/ha) and B:C ratio (2.43) were recorded with kodomillet (DPS-19) intercropped with pigeonpea (No.148). In conclusion, raising medium duration PP (No.148) as intercrop in base crop of short duration KM (DPS-19) in a system approach is more remunerative under rainfed condition as compared to the sole crop of KM on skeletal – sandy soils of Northern Hill Zone of Chhatishgarh.

Table 1: Grain yield of Kodo millet & pigeonpea and economics as affected by various inter cropping (IC) system

Treatments	Grain Yield (kg/ha.)									NMR	B:C
	Kudomillet			PP			KMGYE			(Rs./ha.)	Ratio
	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean		
KM Short Duration (SD)-DPS-19	1819	1014	1416	-	-	-	1819	1014	1416	3480	1:1.96
KM Long Duration (LD) –IPS-147-1	1750	1050	1400	-	-	-	1750	1050	1400	3400	1:1.94
PP SD-ICPL-87	-	-	-	639	530	584	1917	1590	1753	4565	1:2.08
PP SD–UPAS-120	-	-	-	629	510	569	1887	1530	1708	4340	1:2.03
PP MD-JKN-7	-	-	-	669	385	527	2007	1155	1581	3705	1:1.88
PP MD- No.-148	-	-	-	701	410	555	2103	1230	1666	4130	1:1.98
KMSD- DPS-19 + PPSD-ICPL-87	991	691	841	512	410	461	2527	1921	2224	6140	1:2.23
KMSD- DPS-19 + PPSD-UPAS-120	894	664	779	548	448	498	2538	2008	2273	6385	1:2.28
KMSD-DPS-19 + PPMD-JKN-7	963	663	813	642	342	492	2889	1689	2289	6715	1:2:34
KMSD-DPS-19 + PPMD- No.-148	977	666	821	684	384	534	3029	1818	2423	7135	1:2.43
KMLD-IPS-147-1+PPSD-(ICPL-87)	831	681	756	503	403	453	2340	1890	2125	5595	1:2.12
KMLD-IPS-147-1 +PPSD-UPAS-120	827	627	727	478	428	453	2261	1911	2086	5450	1:2.09
KMLD-IPS-147-1 +PPMD-(JKN-7)	813	613	713	589	388	488	2580	1777	2178	5910	1:2.18
KMLD-IPS-147-1+PPMD-No.-148	855	632	743	608	384	496	2679	1784	2231	6175	1:2.23
SEm ±	26	25	19								
CD 5%	76	74	56								

Selling rate of KM = Rs. 5/kg , Pigeonpea = Rs. 15/kg

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Productivity and profitabilty of little millet (*Panicum sumatrense*) based intercropping system under rainfed conditions

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Abstract

A rainfed field experiment was conducted during the rainy season of 2001 & 2002 at JNKVV Research farm, Dindori (M.P.) under rainfed condition on sandy-skeletal soils where intercropping of little millet (LM) and pigeonpea (PP) was conducted involving late, and early duration varieties of LM as base crop and PP as companion crop were included with a row proportion of 2:1 of LM and PP. Short duration LM (JK-8) + medium duration PP(No.148) intercropping system in 2:1 planting ratio gave highest little millet grain yield equivalent (1903kg/ha). The net profit (Rs. 4335/ha) and B:C ratio (1.91) were also higher in this combination.

Introduction

Among rainfed crops, millets as a group figure prominently and often referred to coarse cereal. Little millet *(Panicum sumatrense)* is a staple food grain crop of the poor people, mostly of the tribal areas of Madhya Pradesh. In Dindori District of Madhya Pradesh, the productivity of crops are low and unstable, due to erratic rainfall and prolonged dry spells. Inter cropping is a potential system for maximizing crop production in dry lands over space and time in subsistence farming situations (Hegde *et. al.* ; 1980 and *Moitra et. al, 2003).* It provides insurance against crop failure in extremely dry years and fairly high yield is achieved in good rainfall years (Singh and Singh, 1995). The present study was therefore, conducted to study the relative productivity and profitability of inter cropping systems in little millet with different varieties of pigeonpea under rainfed conditions.

Materials and methods

The field experiment was conduced during *Kharif* seasons of 2001 and 2002 at JNKVV, Regional Agricultural Research station, Dindori (M.P.) on sandy–skeletal soils having pH 7.2, low in available nitrogen (organic carbon 0.32%) available phosphorus (4.3 kg/ha), and available potassium (213 kg/ha). Littlemillet and pigeonpea were sown in 2:1 row ratio. The treatments consisted of two LM varieties (long duration-DLM-155 and short duration-JK-8) and four pigeonpea varieties (medium duration-No. 148 and JKN-7; short duration- ICPL-87 and UPAS-120). Both crops and their varieties were arranged with treatments as sole and intercrops in randomized block design with three replications during both the years. The crop was fertilized with recommended dose of 40:20:20 NPK kg/ha. A total rainfall of 1399.2 and 835.2 mm was received in 81 and 60 rainy days during the cropping seasons of respective years. Observations with regard to the yield of LM and pigeonpea were recorded along with littlemillet grain yield equivalent (LMGYE) and economics of various systems.

Results and discussion

Seed yield of little millet and intercrops

Owing to optimum rainy showers, seed yield of little millet and other intercrops was higher in 2001 than 2002 due to erratic and low rainfall. sole little millet gave the higher seed yield than of intercropped one during both the years (Table 1). On the basis of two years mean, it was noted that short duration LM variety JK-8 produced higher little millet grain yield (914kg/ha) than long duration LM variety-DLM-155 (761kg/ha). Among different sole pigeonpea varieties; short duration variety ICPL-87 (1461kg/ha) and UPAS-120 (1419kg/ha) gave better yield than medium duration varieties of No. 148 (1362kg/ha) and JKN-7 (1284 kg/ha).

Little millet equivalent yield

- The highest little millet grain yield equivalent was recorded in short duration little millet (JK-8) + medium duration pigeonpea (No. 148) in 2:1 planting ratio (1903 kg/ha) which was significantly superior over other treatments. This is due to the reason that pigeonpea (No. 148) put forthless growth during early stages because of the compact and short stature. The results corroborate the findings of Hegde *et. al.*, (1980) on finger millet and; Dubey and Shrivas (1997) on kodomillet crop.

Economics

The highest net monetary returns (Rs. 4335/ha) and B.:C ratio (1.91) were recorded under little millet (JK-8) intercropped with pigeonpea (No. 148) followed by little millet (JK-8) intercropped with PP (ICPL-87) in 2:1 planting ratio (Rs. 4155/ha of NMR and 1.83 B:C ratio). The return from intercropping were higher and more dependable than these from the relevant sole crop (Rao *et. al.*, 1979).

Thus, intercropping of short duration little millet (JK-8) + medium duration pigeonpea (No. 148) in 2:1 planting ratio may be recommended o.1 sandy-skeletal soils of Northern Hill Zone of Chhatisngarh unaer rainfed conditions.

Table 1: Grain yield of little millet & pigeonpea and economics as affected by various inter cropping (IC) system.

Treatments				Grain Yield (kg/ha.)						NMR(Rs./ha.)	
	LM			PP			LMGYE			B:CRatio	
	2001	002	Mean	2001	2002	Mean	2001	2002	Mean		
LM Short Duration (SD)-JK-8	974	854	914	-	-	-	974	854	914	970	1:1.26
LM Long Duration(LD) -DLM-155	813	710	761	-	-	-	813	710	761	205	1:1.05
PP SD-ICPL-87	-	-	-	442	532	487	1326	1596	1461	3105	1:1.73
PP SD–UPAS-120	-	-	-	431	515	473	1293	1545	1419	2898	1:1.68
PP MD-JKN-7	-	-	-	466	390	428	1398	1170	1284	2220	1:1.52
PP MD- No.-148	-	-	-	506	402	454	1518	1206	1362	2610	1:1.62
LMSD- JK-8 + PPSD-ICPL-87	801	510	655	396	385	390	1989	1665	1827	4155	1:1.83
LMSD -JK-8+ PPSD-UPAS-120	717	570	643	309	452	380	1644	1926	1785	3945	1:1.79
LMSD-JK-8+ PPMD-JKN-7	741	590	715	347	330	338	1882	1580	1731	3675	1:1.73
LMSD- JK-8+ PPMD- No.-148	890	615	752	397	370	383	2081	1725	1903	4335	1:1.91
LMLD-DLM-155+PPSD-(ICPL-87)	756	500	628	366	390	378	1854	1670	1762	3630	1:1.72
LMLD-DLM-155+PPSD-UPAS-120	707	510	608	299	390	344	1604	1680	1642	3230	1:1.64
LMLD- DLM-155+PPMD-(JKN-7)	736	530	633	380	950	365	1876	1580	1728	3660	1:1.73
LMLD- DLM-155+PPMD-No.-148	739	525	632	369	375	372	1840	1650	1745	3745	1:1.75
SEm ±	19	34	23	-				-			
CD 5%	56	102	68	-				-			

Selling rate of LM = Rs. 5/kg , Pigeonpea = Rs. 15/kg

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Performance of kodo millet varieties (*Paspalum scrobiculatum*) to different nitrogen levels

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Abstract

In order to find out appropriate dose of nitrogen level to improved varieties of kodo millet, eight varieties (RK-13, RK-106, RK-40, ICK-7112, RK-87, RK-390, IGK-20 and GPUK-3) were tested with three nitrogen levels (0, 20 and 40 kg N/ha) in Factorial Randomized Block Design with three replications in two consecutive years i.e. 2002 and 2003 under rainfed conditions at S.G. College of Agriculture and Research Station, IGAU, Jagdalpur (C.G). Increasing the level of nitrogen from 0 to 40 kg/ha significantly increased the yield and grain yield attributing characters during both the years. Application of 40 kg N/ha recorded significantly higher grain yield. However, large variation for yield and yield attributing characters was noticed among kodo millet varieties. Maximum grain yield was recorded by RK-40 (1264 kg/ha) during the year 2002, while RK-106 (5717 kg/ha) gave more yield in year 2003 respectively.

Introduction

Kodo millet is an important food grain crop in the tribal areas of Baster region. In Bastar agro climatic region, kodo millet is very popular among the tribal farmers with their food habit and sometimes as a medicinal purpose. But the yield levels at farmers field is very low. The yield can be increased by using proper fertilizer management practices. Among the various nutrients Nitrogen play vital role in enhanced production that's why there is need for identifying optimum dose of nitrogen. Improved varieties, with a view to obtain higher productivity per unit area. Therefore, the present experiment was carried out to know the appropriate dose of nitrogen for these improved high yielding varieties.

Material and Methods

Eight varieties (RK-13, RK-106, RK-40, ICK-7112, RK-87, RK-390, IGK-20 and GPUK-3) were tested with three nitrogen levels (0, 20 and 40 kg N/ha) in Factorial Randomized Block Design with three replications in two consecutive years i.e. 2002 and 2003 under rainfed conditions at S.G. College of Agriculture and Research Station, IGAU, Jagdalpur (C.G). The soil of the experimental site were medium fertile having 238 kg N/ha, 9.38 P_2O_5 kg/ha and 248 K_2O/ha. The crop was sown at spacing 25cm x 10 cm with the onset of monsoon. The recommended agronomical practices were adopted to rise a successful crop. Randomly 5 plants were selected to take observations *in each plot for the yield attributing characters under study.*

Results and discussion

Effect of Nitrogen levels on yield and yield attributes

Increasing the nitrogen levels from 0 to 40 kg/ha significantly increased the number of panicles per plant, panicle length, straw yield and grain yield in both the years. The above result also confirms with the finding of Balasubramanian et al. (1995). Application of 40 kg N/ha gave significantly higher grain yield of 1303 and 4817 kg/ha, respectively during the year 2002 and 2003 (Table 1). The highest grain yield obtained with 40 kg N/ha which might be due to efficient utilization of N by plants which helps in increase of more photosynthesis accumulating more dry matter in seed.

Effect of varieties on yield and yield attributes

Among kodo millet varieties higher variation were observed for yield and yield attributing characters. Maximum grain and straw yield were recorded by RK-40 variety (1264 kg/ha) in the year 2002, while variety RK-106 (5717 kg/ha) gave more yield in year 2003 as compared to other varieties. Higher grain yield was obtained may be due to more number of panicle per plant and panicle length. The lowest yield was recorded for RK-13 (967 kg/ha) and ICK – 7112 (1859 kg/ha) in 2002 and 2003, respectively.

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Table 1. Yield and yield attributing characters of different varieties of kodo millet as influenced by nitrogen levels

Treatment	Grain yield (kg/ha)		Straw yield (kg/ha)		Panicles/ plant		Panicle length(cm)	
	2002	**2003**	**2002**	**2003**	**2002**	**2003**	**2002**	**2003**
Variety								
RK-13	967	-	1316	-	9.5	-	6.0	-
RK-106	-	1906	-	2511	-	2.44	-	6.08
RK-40	1264	-	1557	-	9.4	-	6.2	-
ICK-7112	-	620	-	888	-	2.38	-	6.47
RK-87	1019	-	1390	-	10.0	-	6.1	-
RK-390	1076	-	1498	-	10.1	-	5.6	-
IGK-20	-	978	-	1233	-	2.41	-	5.60
GPUK-3	1124	1703	1533	2235	10.0	3.04	6.0	6.47
CD (P=0.05)	NS	236	NS	312	NS	0.32	NS	NS
Nitrogen (kg/ha)								
0	827	992	1085	1409	7.5	2.05	5.7	5.51
20	1141	1307	1548	1794	10.4	2.64	6.0	6.45
40	1303	1606	1742	2083	11.5	3.02	6.2	6.51
CD (P=0.05)	193	205	184	276	2.25	0.28	0.31	0.61

Current status of small millets:Shootfly future research and development requirements

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Abstract

The predominant small millet crops comprise Foxtail millet (*Setaria italica*), Kodo millet *Paspalum scrobiculatum*, Proso millet *Panicum miliaceum*, Little millet *Panicum sumatrense* and Barnyard millet *Echinochloa frumentaceae*. The only serious limiting factor in the cultivation of these crops is shootfly. The impact of diseases is limited. The studies conducted at AICSMIP, Bangalore has brought to light shootfly species composition, on these crops. A detailed study in the evaluation of germplasm of little millet shootfly *Atherigona pulla* has resulted in marking GPMR 236 and GPMR 243 as highly tolerant, GPMR 584 and GPMR 98 as tolerant and GPMR 210 and GPMR 20 and GPMR 20 as moderately tolerant. Intensive evaluation of physical and chemical constituents of susceptible and tolerant plant types has proved various factors like wax content of leaf trichome density silica content, total sugars, protein content and major elements like N,P,K, have played a key role in determining the susceptibility to shoot fly. The population dynamics studies have documented peak population of shootfly during August to September. This lead to adjustment in planting date to escape infestation. The insecticide control measure includes application of carbofuran at sowing as the only effective treatment in reducing shootfly infestation. The biology, ecology and management of little millet shootfly is well understood. There are lot of gaps in our knowledge on shootfly of other small millet crops which have so far not received the attention of entomologists is presented in this paper.

Small millets cultivated in India are finger millet or ragi (*Eleusina coracana)*; Foxtail millet (*Setaria italica*); Kodo millet (*Paspalum scrobiculatum*); Prosomillet (*Panicum miliaceum*); Little millet (*Panicum miliare*); Barnyard millet (*Echinochloa frumentacea*). These crops occupy an area of around 4.0 million hectares, producing about 3.6 to3.8 million tones of grain. Small millets being crops of rain fed areas are often cultivated by tribals in hills under marginal management. Many millets are of short duration and are able to provide green fodder and grain even in a short period of 60-65 days. Besides, many are nutritionally rich and serve as food security. These crops suffer severely by infestation of shoot fly and some times the level of infestation reaches up to 60% resulting in 90% crop loss (Anon.1986, 87, 88). Shooflies were known to earliest workers of economic entomology in India like Fletcher (1914), Ballard and Ramachandra Rao (1924) who in their pioneering work furnished first accounts of biology of shootfly. Jotwani *et al* (1969); Singh and Dias (1972); Nageshchandra and Mustak Ali (1983) have reported a number of shootfly species on small millets. It was only in recent years that our lacunae of knowledge on shootfly has been identified. Jagadish (1997) reported various insect pests that ravage small millets and documented the importance of shoot flies on little millet, besides reporting tolerant germplasms based on trichome density and silica content in little millet. The above reviews conclusively indicate lack of our understanding on many facets of shootfly. However, the work done at AICSMSP has focused on some issues on little millet shoot fly. Findings of this coupled with important lacunae that needs to be bridged are presented in this paper under different headings *viz.,*

1. Species constitution
2. Nature of damage
3. Population dynamics
4. Evaluation of germplasm
5. Role of physical, bio-chemical constituents
6. Integrated management and future thrust areas for research

Species constitution

Four species of shoot fly occur on these crops.

Host		Species of shoot fly
Proso millet	:	Atherigona simplex
Little millet	:	Atherigona pulla
Kodo millet	:	Atherigona simplex
Foxtail millet	:	Atherigona atripalpis
Barnyard millet	:	Atherigona falcata

Nature of Damage:

The species of shootfly infesting little millet preferred to deposit its eggs on lower surface of the leaf when the crop is between 8-10 days after germination. At this stage one or two leaves are found. The eggs are similar to jowar shootfly, white in colour, cigar shaped and glued firmly to the leaf. The eggs hatch within 2-3 days, the maggots on hatching crawled through the leaf midrib and reached meristamatic tissue and started feeding. This leads to dead hearts and excessive tillering of the crop, which are also affected. The pupation took place in the soil.

Population Dynamics:

The population of small millet shootfly monitored by fishmeal trap had two peaks during 4th week of August and September. During October the population was low. It further picked up during first fortnight of November and December (Anon, 1995; Kadiregowda *et al* 1995) similar trend was reported with respect to sorghum shootfly (Kulkarni *et al.*,1978; Davis and Seshu Reddy, 1977). The literature documents that continuous rains with high relative humidity reduced trap catch. Similarly sunshine hours, wind speed and temperature were important in determining trap catches (Singh and Verma 1988). It is evident that efforts in this line has to be stepped up to accumulate information on population levels of shootflies of various small millet crops in different regions of the country, which will help to develop a forecasting model for use in an integrated management programme.

Evaluation of germplasm:

The following germplasm of little millet were screened considering the number of dead hearts and number of eggs laid at 30 days after sowing. Germplasm numbers: 20, 66, 80, 84, 94, 95, 96, 98, 110, 117, 161, 163, 164, 189, 190, 191, 192, 193, 195, 210, 213, 217, 218, 219, 236, 238, 241, 242, 243, 264, 270, 274, 324, 337, 356, 565, 569, 581, 583, 584, 596, 598, 666, 670, 681, 682, 689, 690, 720 (Annon 1995; Kadiregowda *et al.*, 1996) Further these germplasm were grouped as **Highly tolerant:** GPMR 164, 274, 236, 243, 110 and 213.

Tolerant: GPMR 584, 66, 683, 569, 189, 241, 98, 163, 324, 670, 598, 192, 96, 583, 161, 596, 95, 190.

Moderately tolerant: GPMR 94, 720, 856, 210, 581, 117, 238, 681, 689, 565, 84, 242, 337, 80, 690, 20, 191.

Susceptible: GPMR 666, 195, 219, 193, 217, 218.

Highly susceptible: GPMR 264 and GPMR 270.

Role of physical and biological constituents

Physical characters like morphology of the plant and bio-chemical constituents like moisture content, crude protein, reducing sugars, total sugars, chlorophyll content, and NPK contents are known to play a key role in determining the susceptibility of the host plant to insect damage (Norris and Kogan, 1980; Beck, 1965; Schoonhoven, 1968; Jotwani, 1981; Khurana and Verma, 1983) as they affect the growth, survival and reproduction of insects in various ways.

The studies conducted at co-ordinating unit Bangalore has documented the morphological character trichome density, and biochemical constituents such as chlorophyll, nitrogen, phosphorus, moisture and crude protein content determine the susceptibility or tolerance to shootfly in little millet. It is inferred from above studies that tolerant germplasm had higher content of above factors. (Arun, 1995, Beck 1965; Dubois, M., *et al*, 1990; Khurana and Verma, 1983; Nwanze *et al*, 1990; Schoonhooven, 1960; Singh and Jotwani, 1980 abc).

Integrated management and future thrust areas:

The available knowledge on shootfly of small millets is restricted to only little millet, however the following low cost management practices can be adopted for effective management of shootfly.

1. Early sowing of crop i.e. second fortnight of July or with the onset of mansoon.

2. Adopt higher seed rate (1.5 times the recommended seed rate) to make up for seedling mortality (Jagadish et al., 1997)

3. Need based application of insecticides.

The major lacunae of our knowledge of shootfly in small millets are as follows:

1. Taxonomy, biology and ecology

At present there is no person working in India on taxonomy of this group of insects. Therefore immediate attention should be paid to develop a centre to work exclusively on taxonomy of these groups, in order to save the valuable foreign exchange for identification services.

+ Studies on population ecology of shootfly:

Species constitution in different zoogeographic regions together with identifying alternate host plants. Population ecology of the pest to understand pest behaviour and utilization in the management programme.

+ Investigation on biological control of pest.

There are no efforts to identify the natural enemies, which require attention.

II. Host plant resistance :

1. The nature of resistance for little millet shootfly is well understood and resistant sources are identified. However, for other small millet crop studies in this line has to be focused.
2. Identified resistant line should be crossed with existing resistant line in an effort to enhance the level of resistance.
3. Molecular studies should be initiated to identify the resistant gene and its further utilization for crop improvement.
4. A national nursery should be maintained at different centres, which will be concentrating on resistance breeding programme.

III. Insecticidal control :

Use of insecticides for the control of shootfly on small millets is limited owing to low value of the crop. However they find a place in the integrated management by way of using resistant lines, good agronomic practices, coupled with seed treatment with insecticides. Therefore it is of value to continue studies on insecticidal control of shootfly in order to evolve cheaper and cost effective control measures.

IV. Other alternative methods of control

The research on small millets shootfly should also focus on alternative means of control viz.,

1. Attractants (including sex attractants) and repellents.
2. Ecological studies on special characteristics of the environments in the areas where shootfly is endemic.
3. Physiological bio-types and strains and their vulnerable points.
4. Natural enemies of shootfly and their ecology.
5. Agronomic practices like manipulating sowing dates, seed rate, rogueing and mixed cropping etc.

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Potential of finger millet as feed additive for enhancing mulberry silk yield

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Introduction

The mulberry silkworm, (*Bombyx mori* L.) is commercially exploited for silk cocoon production. Karnataka is the leading state producing mulberry silk in India with a production of 9828 Metric Tons. *B.mori* is monophagous, feeding only on mulberry (*Morus indica*). Knowledge of silkworm nutrition is of great applied value, which involves chemical and physiological activities transforming food into body structures. Insect nutrition primarily possesses biochemical substances that are necessary to activate various metabolic process resulting in growth and development. Legay (1958) stated that silkworm nutrition is a major thrust area of research in sericulture, while Pant (1978) envisaged great scope of utilizing data for proper dietary exploitation of beneficial insects like silkworm and stressed that qualitative and quantitative yield can be directly increased through proper dietary management. In India, possibility of giving an ideal artificial diet to silkworm at mass level is is still remote. Therefore, one of the possible cost effective methods is to enrich the leaves with fortification agents. Cereal flours are readily available with sericulturists and are a good source of nutrition. In this paper, the response of *B.mori* to cereal flour supplemented mulberry is assessed.

Table 1 : Effect of cereal flour supplemented leaf feeding on productivity parameters of silkworm hybrids

Treatments	Productivity parameters (single)			
	Mature level Weight (g)	Cocoon weight(g)	Pupal weight (g)	Silk filament length(m)
Hybrid : PM X CSR2				
Ragi	2.78	1.73	1.24	748
Rice	2.54	1.65	1.23	732
Wheat	2.49	1.55	1.17	721
Jowar	2.38	1.45	1.10	704
Control	2.35	1.39	1.05	625
F Test	*	*	*	*
S.Em±	0.05	0.01	0.01	16
CD@5%	0.42	0.21	0.03	1.38
Hybrid CSR 2 X CSR4				
Ragi	3.79	2.17	1.62	1235
Rice	3.67	1.97	1.56	1203
Wheat	3.54	1.86	1.51	1174
Jowar	3.48	1.73	1.42	1080
Control	3.41	1.42	1.38	926
F Test	*	*	*	*
S.Em±	0.04	0.02	0.01	18
CD@5%	0.31	0.22	0.01	1.47

Material and methods

Four cereal flours (150 i mesh) viz., ragi, rice, wheat and jowar were assessed for acceptability by dusting with sieve on mulberry leaves (variety M5) at 1:10 (Flour : Leaf, w/w=796g: 7.96 kg/dfl) and fed to silkworm hybrids viz., PM X CSR2 (multivoltine x biovoltine) and CSR2 X CSR4 (bivoltine x bivoltine). The flour supplemented feed was provided for one feed/day, while the remaining three feeds given were un supplemented. One disease free laying (dfl) was reared per treatment and replicated thrice. The control was represented by dfls reared on un supplemented (normal) leaves. The treatments were imposed from the first feed of the third instar upto spinning. The quantity of leaf provided per dfl was calculated as per Jolly (1987). During the rearing period observations on the productivity parameters like larval weight, pupal weight, cocoon weight and silk filament length were recorded. The data was analyzed statistically (one way CRD) as outlined by Sundar Raj et al., 1972).

Results and discussion

The results (Average of the two rearing) are presented in Table 1.

The mature larval weight was significantly maximum for both hybrids reared on leaves supplemented with ragi flour. Higher mature larval weights of PM X CSR 2 (2.78 g) and CSR 2 X CSR4(3.79 g) was observed as against the unsupplemented control (2.35 g, 3.41 g, respectively). Rathinam et al (1994) reported similar trend in silkworm fed with soybean protein supplementation and Ganga and Gowri (1990) on other flours. Increase in larval weight is attributed to increased accumulation of storage protein / carbohydrates.

Significantly maximum pupal weight was recorded for both hybrids of silkworm reared on ragi flour supplemented mulberry leaf as against the control.

Significantly maximum cocoon weight was recorded for PM X CSR2 (1.73 g) and CSR2 (2.17 g) with ragi flour supplemented feed as compared to the other cereal flours and control (1.39 g, 1.42 g respectively).

Hybrids fed on mulberry leaf supplemented with all cereals flour recorded shorter duration to ripen as compared to hybrids reared on normal (control) leaves. Sundar Raj et al reported similar trend with soybean flour supplementation.

The silk filament length of cocoons spun by silkworm provided with various cereal flours differed significantly. Longest filament length was recorded for cocoons for both hybrids reared on ragi supplemented leaf. Filament length of PM X CSR2 was 748 m whereas for CSR2 X CSR4 it was 1235 m as compared to control (625 m, 926 m, respectively). Such enhancement in filament length has been reported with other supplements by Sreedhar and Radha (1987) and Sundar Raj (2000).

It is inferred that PM X CSR2 and CSR2 X CSR4 hybrids reared on mulberry leaf supplemented with ragi flour from third instar onwards upto spinning showed superiority in productivity parameters over control. Mulberry leaf can be fortified with ragi flour (finger millet) @ 1:10 w/w (flour : leaf) which is locally available with the sericulturists of Karnataka and is a cost effective means of enhancing silk yield.

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Current status of biotic stresses of kodo millet production in Madhya Pradesh

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Abstract

Incidence of head smut and *Striga* spp. was recorded in the survey programme conducted in kodo millet growing villages of Rewa, Satna, Sidhi and Shahdol districts of Madhya Pradesh during 1999 to 2003. Though average incidence of head smut and *Striga* spp. was 1.7 to 2.8% and 1.6 to 2.0%, respectively but frequency of incidence was high both for head smut (45.4 to 100.0%) and *Striga* spp (66.7 to 100.0%). About 9.4% farmers told problem of Matona in kodo millet during survey. Hence, further studies pertaining to actual cause, their biological effects and effective management are essential. The study clearly indicates that extensive field survey is a need to know the status of biotic stresses in farmers field and to plan strategies for their remedial measures.

Small millets are very important group of crops in semiarid and hill regions of the country. Kodo millet (*Paspalum scrobiculatum* L.) rank first in area and production among small millets excluding finger millet. Madhya Pradesh and Chattisgarh shares about 72% of total area of Kodo millet followed by Uttar Pradesh, Tamil Nadu, Gujarat, Maharashtra and Karnataka (Yadava, 1997). Kodo millet is nutritionally comparable or even superior to major cereals especially with respect to protective nutrients. Several biotic stresses are known to affect the grain yield of Kodo millet qualitatively and quantitatively. Among them, head smut caused by *Sorosporium paspali-thunbergii* (Mishra *et al*, 1976 and Jain and Khare, 1999) and *Striga* spp., a phanerogamic semi root parasite (Jain and Tripathi, 2002) are predominant. Kodo millet grains were also found infected with fungal pathogens in humid environment or if crop moistened before harvesting and threshing. Fungal growth in grains and fodder causes a decrease in nutritional value and also results in health hazards locally known as *Matona* (Pall *et al*, 1980, Ansari and Shrivastava, 1991). It produces unconsciousness, vomiting, giddiness, difficulty in swallowing and sometimes death of human being and cattle after their use as food and feed. Hence, attempts have been made to study the status of these biotic stresses in the farmer's field at four districts of Madhya Pradesh.

Materials and Methods

A roving field survey was conducted in the months of October to January at Kodo millet growing areas of Rewa, Satna, Sidhi and Shahdol districts of Madhya Pradesh to record the incidence of head smut and *Striga* spp. during 1999-2003. A total of 117, 58, 169 and 98 fields of Kodo millet were surveyed in the districts of Rewa, Satna, Sidhi and Shahdol, respectively for head smut.

During 2001 and 2003, fifty nine kodo millet fields in Rewa, 17 in Satna and 53 fields in Shahdol districts were systematically surveyed for *Striga* infestation. Seventy four kodo millet growers were contacted during 1999 for *Matona* problem in the crop. Incidence of head smut and *Striga* spp. was recorded from 8 to 10 places randomly selected in each field and percent incidence was calculated.

Results and Discussion

A perusal of results presented in Table 1 reveals that head smut is the most frequently occurring disease in all four surveyed districts of Madhya Pradesh. Head smut incidence varied 0.0 to 8.0%, 0.0 to 4.5%, 0.0 to 8.0% and 0.0 to 8.5% in the districts of Rewa, Satna, Sidhi and Shahdol, respectively. Average head smut incidence was 2.7% at Rewa, 1.7% at Satna, 2.2% at Sidhi and 2.8% at Shahdol districts.

Striga incidence ranging from 0.0 to 4.5% and 0.0 to 3.5% was recorded during 2001 and 2003, respectively in the three surveyed districts of Madhya Pradesh (Table 2). Frequency of incidence was 76.9 to 100.0% in Rewa, 66.7 to 80.0% in Satna and 81.5 to 83.3% in Sidhi districts but average incidence was rather low i.e. 2.0, 1.7 and 1.6%, respectively

Among 74 kodo millet growes, seven accepted the problem of *Matona* if they consume the newly harvested grains of kodo millet as Bhat and Chapati.

It is inferred from the present study that head smut and *Striga* are important biotic stresses in kodo millet cultivation in all four districts of Madhya Pradesh. About 9.4% farmers told the problem of Matona in Kodo millet. Therefore, detailed studies on causal agent and metabolites produced by them are necessary for effective management of *Matona* in kodo millet.

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Table 1. Field survey for head smut of Kodo millet.

District	Year	Frequency of incidence	Village surveyed	Head smut (%)	
				Range	Mean
REWA	1999	78.6	14(11)	0.0 to 7.4	1.8
	2000	87.5	08(07)	0.0 to 7.0	4.2
	2001	100	13(13)	1.0 to 8.0	3.7
	2002	83.3	06(05)	0.0 to 3.2	1,2
	2003	87.5	08(07)	0.0 to 5.0	2.8
SATNA	1999	66.7	03 (03)	0.0 to 2.7	1.1
	2000	100	03 (03)	1.0 to 2.5	1.8
	2001	100	03 (03)	1.5 to 2.5	1.5
	2002	75	08 (06)	0.0 to 4.5	1.8
	2003	100	05 (05)	0.5 to 3.8	2.5
SIDHI	1999	66.7	12(08)	0.0 to 4.5	1.6
	2000	45.4	11(05)	0.0 to 8.0	1.6
	2001	100	17(17)	1.0 to 7.5	2.8
	2002	81.2	16(13)	0.0 to 3.7	1.8
	2003	100	12(12)	2.0 to 4.8	3.4
SHAHDOL	1999	84.6	13(11)	0.0 to 6.5	2.3
	2000	90	10(09)	0.0 to 8.5	3.6
	2002	88.9	09(08)	0.0 to 5.5	2.5

Fig.1. Average and frequency of incidence of Striga spp. in Rewa, Satna and Sidhi districts of M. P. during 2001 and 2003

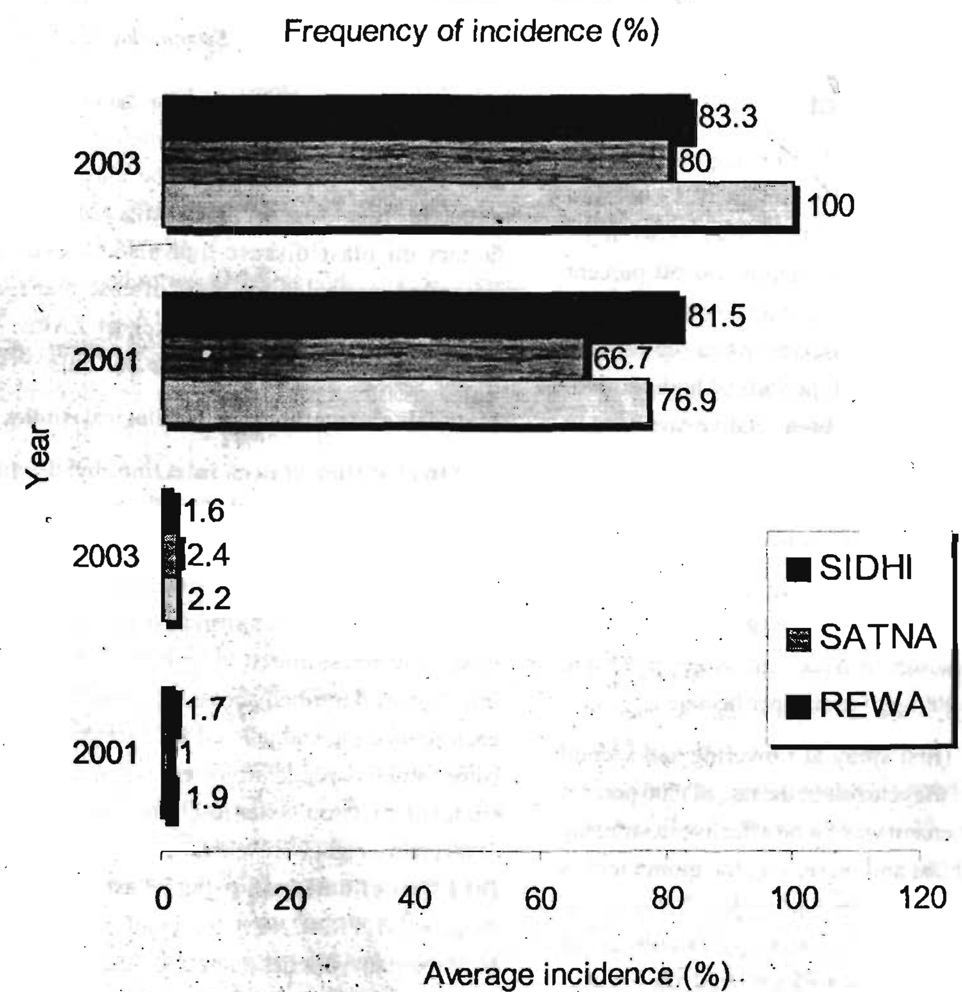

Table 2. Field survey for incidence of *Striga* spp. in Kodo millet.

District	Year	Village surveyed	Frequency of incidence	Incidence of *Striga* spp. (%)	
				Range	Mean
REWA	2001	13 (10)	76.9	0.0 to 4.5	1.9
	2003	08 (08)	100	1.0 to 3.5	2.2
SATNA	2001	03 (02)	66.7	0.0 to 2.0	1
	2003	05 (04)	80	1.7 to 3.5	2.4
SIDHI	2001	17 (13)	81.5	0.0 to 3.5	1.7
	2003	12 (10)	83.3	0.0 to 3.0	1.6

Epidemiology and integrated approach for the management of blast disease of Finger millet (*Eleusine corocona*) in Southern Karnataka

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Abstract

As high as 76 percent reduction in grain yield and 70percent reduction in1000 grain weight was observed when infection occurred immediately after flowering / earhead formation. While the reduction was 50 percent when the disease occurred at milky stage, maximum neck and finger blast (>90%) was observed when the earhead formation period coincides with periods of high rainfall, more number of rainy days and high relative humidity in the month of October. Application of Nitrogen at the rate of 120kg N / hectare was recorded 35 percent more of neck and finger blast as compared to no nitrogen application.

Of the several finger millet verities tested GPU28 , GPU45, GPU48, GPU52, GPU53, MR1 and MR6 were showed resistant reaction to neck and finger blast and also recorded over 5000kg of grains per hectare.

Two sprays (first spray at flowering and second at 10 days interval) of tricyclozole at the rate of 0.06 percent and Sarf 0.1 and 0.2 percent was found effective in reducing the neck and finger blast and increasing the grain yield as compared to check fungicide, edifenphos 0.1 percent. Further bacterial bio agent *Pseudomonas fluorescens* at the rate of 0.3 percent was also showed the rate of suppressiveness of neck and finger blast increased the grain yield as compared to check.

Introduction

Finger millet (*Eleusine corocona*) is affected by many disease, but blast disease caused by *Pyricularia grisea* is the most important disease, which adversely affected the yield of ragi in Karnataka. In India disease occurs every year in almost all the finger millet growing area McRae (1922) reported that blast may occurs in epidemic proportions and loss of grain yield may exceed 50%. Ramappa, et al (2003) recorded 50 and 70 percent neck and finger blast respectively during *kharif* 2001 in Mandya and Mysore District of Karnataka. The extent of yield loss depends on the severity and the time of on set of disease. Further environmental factors, varieties under cultivation, fertilizers used and other cultural practices are also influencing the on set of the blast disease in finger millet. In order to determine the effect of each of the above factors on blast disease and also to evolve suitable integrated strategies for blast disease management, the present studies were under taken at ZARS. V.C.Farm, Mandya during kharif 2001, 2002 and 2003.

Materials and methodsEpidomilogical studies

(a) Effect of time of neck infection. Indaf-9 finger millet variety was selected with four levels of infection (time) namely, 1. No Infection (healthy), 2. Infection immediately after earhead formation. 3. Infection during milky stage and 4. Infection after milky stage. Immediately after observing neck infection at different levels (time) of infection as described above, 10 earhead were selected in each replication and labeled for each neck infection level (time) and five replication were maintained in each levels (time) of infection. After reaching maturity grain yield and 1000 grain weight were recorded in all the levels of infection. **(b) Effect of dates of sowing .**Blast susceptible varieties namely K-7, PR202, KM252, Indaf-5, Indaf-9, HR911 and blast resistant varieties namely GPU28, GPU45, MR-1 and MR-6. Were sown 10 times between July to November of an interval of 10-15 days in all the three years (2001,2002 and 2003) in a plot size 1.35 X 3 mts by employing RCBD design with four replication. Meteriological observation namely temperature, relative humidity, rainy days and rain fall were recorded during the crop growth period. Neck blast, finger blast and grain yields were recorded in all the years.**(c) Effect of Nitrogen on the incidence of neck and finger blast.**Five long duration varieties viz,. GPU57, GPU58, VR22, PR202 and MR-1 with five levels of Nitrogen Viz,. N_0,N_{30}, N_{60}, N_{90} and N_{120} were studied. Twenty days old seedlings of all the varieties were planted in a plot size of 2.25 X 3 mts with a spacing of 30 X 10 cms, in a RCBD design and there replications were maintained. recomended P & K along with 50% N were applied at the time of planting.

remaining 50% N in all the levels were applied in equal split dose at tillering and panical initiation stage. Crop was raised as per the package of practices. After milky stage incidence of neck and finger blast were recorded. **Effect of fungicides, biopesticides and bio agent on blast disease.** Three fungicides viz,. Saaf (combination of carbandazim + mancozeb) at 1g/L and 2g/L, Hinosan 1m/L and Tricyclozole 0.5g/L, two biopesticides namely Vijayaneem 2m/L, Econeem 2m/l and bacterial bioagent *Psendomonas fluorescens* 3g/L were tested against neck and finger blast of variety PR202 during *kharif* 2001, 2002 and 2003. In all the treatment two sprays were given, 1st spray at 50% flowering and second spray at 10 days later. The experiment was conducted using RCBD design with three replication. The individual plot size was 2.25 X 3mts. Twenty days old seedlings were planted at spacing of 22.5 X 10cms using 2-3seedlings per hill. All the recomended package of practices were followed in raising the crop. Incidence of neck blast, finger blast and yields Kg/ha were recorded.

Results and discussion

The loss of grain yield goes up to 70% when neck infection occurs immediately after earhead formation. While 50% reduction was observed at milky stage infection whereas only 5% reduction of grain occurred after milky stage infection. Similar treated was observed with respect to 1000 grain weight reduction (Table-1). Venkatanarayan (1947) reported about severe outbreak of the blast in Karnataka and estimated the loss to be around 80-90%. The ultimate loss in grain yield due to the cumulative effect of reduction in grain number and weight as well as enhanced spikelet sterility (Rath and Mishra, 1975) Pall (1977) observed a loss in panicle length, grain number and grain weight in the blast affected plants.

Maximum incidence of neck blast (>95%) and finger blast (90%) and also lowest grain yield was recorded on blast susceptible variety KM252, flowered in the month of October due to highest rainfall (200mm) more rainy days (16) and high RH(90%) as compared to August or November flowering (Table-2). Similar trend was observed on other varieties Viz,. K-7, PR202, Indaf-5, Indaf-9 and HR911. Viswanth and Channamma (1987) raised the crop year round at fortnightly intervals recorded the maximum incidence in August sown crop under Bangalore condition. The climatic condition, minimum temperature of 20°C and maximum 30°C and relative humidity of more than 80% are favorable for blast disease development (Bisht, et al., 1984).

Application of Nitrogen at higher level (120Kg N/ha.) recorded 35% more incidence of neck and finger blast on blast susceptible PR202. As compared to 0 N. Similar trend was also observed on GPU57, GPU58, VR822 as compared 0 Nirtogen/ha. (Table-3). An increase in nitrogen level significantly increased the disease intensity was observed in Tamil Nadu. under rainfed condition (Muthuswamy, et al. 1985). This phenomenon was true for susceptible verities but not with blast resistant varieties.

Two sprays of Saaf at 0.1 and 0.2 percent and tricyclazole at 0.05 percent was found very effective in reducing the neck blast, finger blast and also increase in the grain yield as compared to check fungicide ediphenphos and untreated check in all the three years further bacterial bioagent *pseudonomos fluorescens* also observed suppressiveness of neck blast and increases the grain yield as compared to check.

For almost 50 years of the first report of this disease in India, no chemical control measure was tried. The first anthentic report regarding the chemical control of blast of ragi was of Raju and Rao (1961) who found Bordeaux mixture and copper oxychloride were found effective. Hinosan give best control of blast and increased the yield by 40% (Mohanty and Mohapatra, 1978). Adipala and Mukiibi (1991) found three sprays with either benomyl or mancozes (1Kg ai/ha.) at 42, 70 and 91 DAS was necessary for economic returns. Pall et al., (1985) found carbendazim to be highly effective against blast. Vishwanth et al., (1997) suggest a application of one spray of tricyclozole or two sprays of carbendazim for the effective control of neck blast. In Tamilnadu six strains of flureoscent pseudomonas which belongs to *pseudomonas fluorecense* and Pseudomonas Puteda were tested and found inhibitory to blast finger in the laboratory and also under field condition (Sitther and Gnana manickam 1998),

The present study indicated that the epidemiological factors like early infection results in higher percentage of grain loss, flowering or ear head formation coincide with periods of more number rainy days, high rainfall, and higher relative humidity in the month of October recorded highest neck and finger blast. Higher the application of Nitrogen results in greater the incidence of blast was observed. However the blast disease can be managed by timely sowing /planting and judicious use of fungicide at 50 percent flowering and at 10 days interval. The present study also indicated the efficacy of Bio agent *pseudomonas fluorescence* in controlling the neck and finger blast and provide an opportunity to utilize this as component in integrated management strategies.

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Table – 1. Effect of stage or time of neck infection of *pyricularia grisca* on finger millet variety – Indaf – 9.

Stage or time Of infection	Weight of grains Per 10 earhead	Percent reduction Over healthy	1000 grain weight	Percent reduction Over healthy
Immediately After earhead formation	19	76.82	1.06	70.14
During milky stage	39	52.43	1.75	50.7
Late or after milky stage	73.5	10.36	3.38	4.78
Healthy	82	-	3.55	-

Table – 2. Effect of different levels of nitrogen on the incidence of neck and finger blast in finger millet varieties.

Varieties	Nitrogen levels and incidence of neck and finger blast.									
	N0		N30		N60		N90		N120	
	NB	FB	NB	FB	NB	FB	NB	FB	NB	FB
GPU 57	2.5	3.5	3.4	8.5	6.5	10.2	9	11.25	10.5	16.5
GPU 58	1	2.5	1.5	3.5	2.5	4.5	3.5	4.5	6.5	10.5
VR 822	1.5	5.5	2.5	12.5	5	15.5	5.5	18	6	20
PR 202	15	20	30	44	42.5	54	46	50	50	50
MR 1	0	1.5	0	1.5	1.25	2	1	2.5	1.5	2.65
MR 6	0	0.5	0	0.75	0.75	1.25	0.75	1.5	1	1.5

Table : 3. Effect of fungicides, bioagent and biopesticides on finger millet blast disease

Treatment	2001			2002			2003		
	NB	FB	Yield kg/ha	NB	FB	Yield kg/ha	NB	FB	Yield kg/ha
Saaf (0.1%)	15.5	31.1	4318.7	3	6.5	4790.2	8.17	11.78	5259.25
Saaf (0.2%)	10.9	27.1	5111.11	3	5	5037.2	5.17	10.28	5530.8
Pseudomonas (0.3) fluorescens	13.2	40.5	4518.5	9.3	12.5	4469.1	15.71	29	4666.66
Vijay Neem	0.3	20.6	44.9	4148.1	13.7	19	4641.9	19.78	22.14716
Neem gold/ ecomene	20.1	31.7	4015.8	12.5	20	4646.8	16.5	22.16	4770.07
Hinosen (0.1%)	17.1	27.6	4305.5	5.9	7.6	4745.6	10.27	13.95	5002.37
Tricyclozole 0.06%	1.8	-	-	2.8	5.5	5.1	5.5	10	555000
Control	24.5	42.3	4009.85	14.1	18.9	4139.4	26.84	40.84	4049.33
CD at 5%	4.78	5.4	352	1.76	2.87	386.2	2.27	12.58	306

NB = Neck blast.   FB = Finger blast. (average of three replications)

Effect of blight disease on grain yield in finger millet varieties (*Eleusine coracana*) and its fungicidal management

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ZARS (UAS,Bangalore) V.C.Farm, Mandya, Karnataka – 571405.

Abstract

Blight disease of finger millet caused by *Helminthosporium nodulosum* is next only to blast in severity, distribution and also cause appreciated yield loss in susceptible finger millet verities. The pathogen attacks earhead, finger, spikelets and grains resulting in poor grain formation. 70 and 77 percent grain reduction per spikelet and per finger respectively over healthy was observed in GPU28 followed by 40 and 50 percent grain reduction per spikelet and per finger respectively over healthy was observed on PR202 while minimum percent grain reduction (5%)per finger and per spikelet was observed on Indaf -7 and showed resistant reaction to blight.

Among seven fungicide and`bacterial bio agent *Pseudomonas fluorescens* tested two sprays of saaf @ of 0.2percent was found to b^e effective in reducing the blight severity (16.66%) and increasing the grain yield (3447kg/ha)as compared to untreated check, recorded 52.66 percent blight severity and recorded the grain yield of 2592.18kg/ha. Mancozeb at 0.2% was next best in reducing the blight severity (20.00)and increasing the yield (3313kg/ha). Further the bio agent *Pseudomonas fluorescens* was also found effective in reducing the blight and increasing the grain yield.

Introduction

Blight disease of finger millet caused by *Helminthosporium nodulosum* is next, only to blast both in severity and distribution. The pathogen infect almost all parts of the plants like, roots, stem, nodes, leaf, leafsheath, seedlings and mature plants. Heavy infection results in premature death of the leaf. The pathogen also attacks earhead, fingers, spikelets and grains resulting in poor grain formation yield shivelled grains. Higher incidence of disease was observed on late sown crops compared to early *kharif* crops or summer crops.

During past several years, Indaf and other popular varieties were showed tolerant reaction to blight disease, however off late, the GPU varieties observing blight susceptible reaction under late sown irrigated condition resulting in considerable yield loss. Presently the disease is managed by seed treatment, fungicidal spray varietal adaptation etc. there is a lack of information's on yield loss contributory factor under irrigated eco system late sown/planting condition. Therefore the present study was conducted to know the effect of blight diseases on grain set in different finger millet varieties and also to know the efficacy of different fungicides and bioagent on blight disease.

Materials and methods

Effect of blight disease on grain yield.

Experiment was conducted in late khaif 2003 at zonal agriculture research station VC Farm Mandya, Karnataka, to know the effect of blight disease on grain yield per finger and per spikelet. Eight finger millet verities namely Indaf5, Indaf7, Indaf9, Indaf15, GPU28, GPU45, PR202 and MR6 were planted on 16-10-2003 in a plot size of 3x2.25 mts with spacing of 22.5x10 cms. RCBD design was employed and three replications were maintained on each varieties. The crop was raised as per the package of practice. After earhead formation, 50earheads of each blight infected and healthy earheads were labeled in each variety and replication after attaining maturity, the labeled earhead harvested separately for observation. The average number of spikelet per finger, number of grains per finger,number of grain per spikelet was recorded, further the percent grain reduction per finger and per spikelet were calculated by using following formula.

Management of blight disease

Field experiment was conducted during late *Kharif* 2003 at Zonal Agriculture Research Station, V.C.Farm, Mandya, Karnataka under natural field condition. The experiment was conducted by using RBD design with three replication and the individual plot size was 3X2.25 mts. Twenty days old seedling of GPU d8 was planted at spacing of 2.25X10cms using 2-3 seedlings per hill in the month of October (15th 2003.) Fertilizers were applied at 100:50:50, N,

(a) Percent grain reduction per spike let

$$= \frac{\text{Number of grains per spiklet in healthy} - \text{number of grains per spikelet in diseased.}}{\text{Number of grains per spikelet in healthy.}} \times 100$$

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P_2O_5, K_2O per hectare. Nitrogen was applied in three equal split doses at planting, tillering and panical initiation stage of crop growth.

Seven fungicides (Table 2) namely mancozeb 2g/l (dithane M45); carbendazim + mancozeb 2ml (EC formulation); Saff (carbondazim + mancozeb) 2g/l (wp formation); kitazin 1ml/l (IBP); trichlorozole 0.5g/l (beam); bitertanol 1ml (Baycor); hexaconazole 1ml (contaf); and bacterial bio-agent *pseudomonas fluorescens* 2g/l were sprayed just after initiation of disease and repeated 10 days later. Plots without fungicidal spray served as check. Observations were reduced on blight severity (%), blighted plants and grain yield.

Results and Discussion

The pooled data presented in the table 1 clearly showed that, maximum reduction of spikelet per finger (32%), grains per finger (77%) and grains per spikelet (70) was observed on GPU28 followed by PR202 recorded 15, 53 and 44.11 percent reduction of spikelet per finger, grains per finger and grains per spikelet respectively. Where as minimum reduction in spikelet per finger (5%), grains per finger (8.8%) and grains per spike let (4%) over healthy was observed on Indaf-7 followed by Indaf-5, GPU45 and MR-6 (table-1). The data presented in the table 2 indicated that two sprays of saff @ 2 g/l was found to be effective in reducing the blight severity (16.66%) blighted plants (6.66%) and increasing the yield (3447 kg/ha). Followed by mancozeb and bitertanol. A Bacterial bio-agent *pseudomonas fluorescens* also showed effectiveness in reducing the blight severity (23.33%) blighted plants (17.33%) and increasing the yield (3096kg/ha) whereas untreated check recorded 52.66 and 29 percent blight severity and blighted plants respevtively and also recorded low grain yield (2592kg/ha). Further kitazin at 1ml/l was found to be enhanced blight severity (table-2).

According to Coleman (1920)considerable differences were observed in the reaction of different varieties in Karnataka. The varieties with green glumes exhibited grater infection than those with purple glumes. The present study also indicate differences in the reaction of GPU and Indaf series. Venkataraman (1954) also observed all the cultivated varieties to be susceptible to the blight. Unlike blast disease of Ragi, leaf blight of ragi do not cause appreciable damage to the crop cultivated under normal condition. However under late sown situation demands management practices, especially under irrigated ecosystem. Venkataramaiah(1935) was the first person to suggest the use of chemicals. Hegde and Shivandappa (1968) evaluated several fungicides and antibiotics for their efficiency *invitro* condition and Captan was the best followed by brestan and duter. The out come of the present study indicated that Indaf-7 variety can be recomended for late kharif under irrigated ecosystem. The blight disease also managed by seed treatment with mancozeb 2g/L and fungicidal spray of saaf at 0.2% and also using bio-agent *pseudomonas fluorescens* as a component in disease management along with other methods.

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Table-01: Effect of blight disease on number spikelet/finger and number of grains per spikelets in finger millet varieties

Sl. no	Varieties	Number of spikelets Per finger			Number of grains Per finger			Number of grains Per spikelets		
		Apparently healthy	Diseased	% reduction over healthy	Apparently healthy	Diseased	% reduction over healthy	Apparently healthy	Diseased	% reduction over healthy
1	GPU-28	70	58	32	510	115	77	6.62	1.98	70.01
2	GPU-45	50	49	2	225	170.6	24	4.5	3.5	22.22
3	Indaf-5	70.75	67.5	4.5	442	332	23	6.25	5	20
4	Indaf-7	76	72.2	5	475	433	8.8	6.25	6	4
5	Indaf-9	80	70.2	12	340	225	34	4.25	3.25	23.5
6	Indaf-15	66	57	13.6	409	257	37	6.25	4.5	28
7	PR-202	64	54	15	288	135	53.1	4.5	2.5	44.4
8	MR-6	75	80	6.25	580	432	25.37	7.25	5.75	20.6

Table-02: Effect of different fungicides on blight disease and finger millet

Sl. No	Treatments Dosage	Blight Per lit.	Blight Plant per plot Severity	Yield No. of Plants	%	Kg/ha
1	Mancozeb	2g	20	19.33	9.66	3313
2	Seed treatment (Mancozeb)	2g	38.33	31.33	15.66	2773
3	Carbendazim + Mancozeb EC	2ml	23.33	16.33	18.16	3043
4	Saaf (Carbendazim + Mancozeb) WP	2g	16.66	13.33	6.66	3447
5	Kitazin	1ml	60	58.33	29.16	2693
6	Tricycozole	0.5	30	47.33	23.66	2875
7	Bitertanol	2g	31.66	19.66	9.83	3096
8	Pseudomonas flourescens	3g	23.33	17.33	8.66	3096
9	Hoxconazol	1g	38.33	39.66	19.83	2750
10	Check (Water spray)	-	52.66	57.4	28.5	2592
CD@5%						208.8

Resistance source and influence of time of sowing on blast disease of foxtail millet

H.K. Ramappa, C.R. Ravishankar, and P. Prakash.

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Abstract

Blast disease of foxtail millet caused by *Pyricularia sataria* is one of the important disease and caused considerable damage to the crop under congineal condition during late kharif. Sixteen varieties of foxtail millet evaluated against blast

b. Effect of dates of sowing on the blast severity.

The study was conducted at the experimental field of zonal Agriculture Research Station VC Farm, Mandya under natural condition during kharif 2003. The trial was laid out in randomized block design with four replication. Four foxtail millet varieties namely PS4, SIA326, TNAU190 and CO6 were sown on eight different sowing dates (August 8, 18, 28, September 7, 17, October 8, 28 and November 9,2003 at 10-15 days interval). The plot size was 3x1.20mts and spacing was 30x10cms between row to row and plant to plant respectively. The care was taken raising the crop as per package of practices.

Observation as blast severity and weather data like temperature relative humidity, rainfall and rainy days were recorded

Result and Discussion

The data presented in the table 1 showed that, the leaf blast severity was ranged from 0-50 during kharif 2001-2002. TNAU-186 was completely from leaf blast severity during2001, but showed 15 percent severity during 2002 and recorded the grain yield of 152 kg/ha. The popular variety SIA 326 recorded maximum grain yield of 2814 kg/ ha and 20 percent blast severity and showed tolerant reaction under field condition leaf blast severity of 3 percent and yield of 1894 was recorded by VFMC 308 and observed resistant to leaf blast followed by CO 6 (4% 1037 kg/ha.), TNAU 193 (4.5% : 1033 kg/ha.) and TNAU 196 (8.5% and 2222 kg/ha.) Rest of the varieties were showed high leaf blast severity (Table. 1). The leaf blast disease severity was observed more an seedlings than on matured plants. Palaniswamy (1930) reported that young plants up to 40 days old seedlings were affected more than matured plants. Singh, et al., (1976) found the varieties SR 118, SR 102, ISC 701, 703, 709, 710, 201, JMSC 33, 56, RS179 and ST 5307 were resistant.

Effect of time of sowing on the blast severity experiments results revealed that, maximum leaf blast severity of 65, 55, 45, 48 percent recorded on PS4, SIA 326, CO 6 and TNAU190 respectively on October last week sowing followed by second week of October and November (Table. 2) where as minimum leaf blast severity in all the varieties was observed on August sown crops.

The probable reason for the higher severity during October could be higher rainfall, more rainy days and higher relative humidity (Table. 3). Vishwanath and Seetharam (1989) reported that, rainfall, temperature and humidity are the most important factors affecting the severity of blast disease in Foxtail millet.

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Table. 1. Reaction of Foxtail millet cultivation / lines to blast disease during 2001-2003

Cultivars/lines	Blast disease severity (%)			Yield
	2001	2003	Average of (2001-2003)	Kg/ha.
PS 4	20	20	20	1629
SIA 326	20	20	20	2814
SIA 2867	25	5	15	1926
SIA 2870	15	20	22.5	1926
SIA 2871	15	50	32.5	1778
SIA 2876	15	15	15	1592
SIA 2881	30	50	40	1778
SIA 2882	30	25	27.5	2222
SR 17	5	25	15	2222
SR 51	5	35	20	2222
TNAU 186	0	15	7.5	1529
TNAU 193	2	5	4.5	1037
TNAU 196	2	15	8.5	2222
CO6 5	3	4	1037	
VFMC 308	1	5	3	1894

Table: 2 Effect of dates of sowing on the incidence and severity of blast disease in Foxtail millet varieties

Dates of Sowing	Varieties and leaf blast disease severity (%)			
	PS 4	SIA 326	CO 6	TNAU 190
8/8/03	1	1.5	0.5	1.5
18-8-03	5.5	2.5	3.5	5
28-8-03	7.19	4.85	6.25	7.5
7/9/03	25	16.25	10.2	13.75
17-9-03	32.5	36.25	25	21.25
8/10/03	50	48.75	35	45
28-10-03	65	55	45	48
9/11/03	50	48.5	35	40.25

Reaction of kodo millet and barn yard millet entries to smut disease

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Zonal Agricultural Research Station,(UAS-Bangalore) V.C.Farm, Mandya, Karnataka 571405

Abstract

Over thirty varieties of Kodo millet screened against head smut caused by *Sorosporium paspali thunbergione* during 2001-03. Twelve varieties namely RK31,RK65-18, RK87-9, RK 162, RK106, DPS486, DPS516, DPS542, DPS672, DPS700, DPS727 and ICK769 were observed free from smut incidence and showed resistance reaction to smut. Further RK65-18 was also recorded higher grains (2237kg/ha).

Twenty four barnyard millet advanced varieties evaluated against smut during Kharif 2003. Only three varieties viz, TNAU25, TNAU63 and VL198 were observed completely free from grain smut disease and recorded grain yield of 2667, 1926 and 2222kg/ha respectively. Where as VL197 recorded smut incidence of 60 percent. Seven varieties namely TNAU3, TNAU72, KE44, IK64, JSC307 and JSC310-6 recorded less than 5 percent smut incidence.

Introduction

Kodomillet (*Paspalum scrobiculatum*) and barn yard millet (*Echinochloa frumentacea*) are two important small millet crops being cultivated in several states in our country for both grain as well as fodder. There is a very big differences between the yield obtained in front line demonstration and in the farmer field. Several reasons are responsible for low yield in farmer field one such problems could be smut disease in both kodo and barn yard millet. According to Butler (1918) head smut of kodomillet causes heavy losses in some years. Three smut namely head smut (*Ustilago crus-galli*) kernel Smut (*Ustilago paradoxa*) and (*Ustilago panici-frumentacei*) causes heavy losses under favorable conditions in barn yard millet. Since they are seed born and infect inflorescence and symptoms appear after earhead emergence there by making the control measure ineffective. However the head smut born both in kodomillet and barn yard millet can be effectively managed by using resistant varieties and seed treatment. Therefore present study was under taken at Zonal Agriculture Research Station, V.C.Farm, Mandya, Karnataka during kharif 2002 and 2003 to identity the resistance source against smut of kodo and barn yard millet.

Materials and methods

The field experiment was conducted at the experimental plots of Zonal Agriculture Research Station, V.C.Farm, Mandya during 2002-2003. Fifteen kodomillet entries and twentyfour entries of barn yard millet (table 1&2) seeds were sown directly in two rows each of 3.0 meter long at a spacing of 22.5cms between rows and 10cms between plants in case of kodomillet and 25cms between the rows and 10cms between plants in barn yard millet. Fertilizers applied at the rate of 20kg each of NPK / ha. For Kodomillet and 40:20:20 kg $N:P_2O_5:K_{20}$ /ha for barn yard millet. In both the nitrogen was applied in two equal split doses. After inflorescence emergence (kodomillet) and at dough stage in barn yard millet, the smut incidence was recorded and percent disease incidence (PDI) was calculated as followed.

$$PDI = \frac{\text{Number of smut infected plants}}{\text{Total number of plants observed}} \times 100$$

Results and discussion

Five varieties of kodo millet namely DPS, 486, DPS 516, DPS 542, DPS700 and RBK486 were almost free from seed smut during both years (Table: 1) and showed resistant reaction to head smut. Where as maximum smut incidence of 50.65 and 40.50 percent recorded during 2002 and 2003 respectively on RK106 and observed highly susceptible reaction. Butler (1918) observed that smut disease causes heavy losses in some years. The data presented in the table 2 indicated that three barnyard millet varieties namely TNAU63, TNAU25 and VL10 were observed completely free from smut incidence and recorded the grain yield of 2667, 1926 and 2222 kg/ha respectively. JSC 307 also recorded very low incidence of smut (1.50%) and showed resistant reactions. Rest of the varieties were observed the smut incidence of 5-60 percent (table:2). Good source of resistance were observed with good yielding ability. Such material may be useful in smut disease management without using the chemicals.

Reference

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Table : 1. Reaction of kodomillet varieties to head smut disease.

Varieties	Smut incidence		Sl. no	Varieties	Smut incidence	
	2002	2003			2002	2003
RK13	5.7	2.65	10	PSC1	5.44	5.44
RK40	2.5	2.75	11	ICK769	10.5	11.5
RK87	5.5	0	12	DPS331	5.78	8.5
RK390	10.55	0	13	DPS365	10.5	15.5
RK106	0.75	2.5	14	DPS693	5.5	5
RBK112	50.65	40.5	15	DPS486	0	0
RBK486	2.5	5.5	16	DPS516	0	0
ICK	0.5	0.5	17	DPS542	0	0
GPUK	2.5	2.5	18	DPS700	0.8	0

Table: 2. Reaction of barn yard millet varieties to smut disease during 2003

Varieties	Smut incidence (%)	Yield Kg/ha	Sl No.	Varieties	Smut incidence (%)	Yield Kg/ha.
TNAU63	0	2667	13	VL29	30	1778
TNAU72	5	1926	14	K1	10	1629
TNAU80	10	1185	15	VL198	0	2222
VL183	25	2222	16	VL199	35	889
VL184	10	1481	17	DBM	15	740
VL200	25	1037	18	KE44	5	1118
VL201	15	2074	19	ER64	5	1925
VL190	25	740	20	JSC144-6	5.5	1037
TNAU25	0	1926	21	JSC307	1	1185
TNAU43	5	2580	22	JSC310-4	10	592
VL196	30	888	23	JSC310-6	5	1037
VL197	60	1037	24	EK72	35	1038

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