VOL. 24 NO. 2 JULY 2000

ISSN 0378-813 X

PKV RESEARCH JOURNAL

DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH,
(AGRICULTURAL UNIVERSITY)
AKOLA (MAHARASHTRA) INDIA

Dr. PANJABRAO DESHMUKH KRISHI VIDYAPEETH, AKOLA

RESEARCH JOURNAL

1. PKV Research Journal is published twice a year in January and July by Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.
2. The contribution of paper is open only to active members and subscribers.
3. Annual membership of Journal subscription (with effect from 1-1-1999)

i) Active Member	Rs. 100/- per annum
ii) Students	Rs. 50/- per annum
iii) Libraries/Institutes	Rs. 150/- per annum
iv) Other subscribers	Rs. 400/- per annum
v) Life members/Donors	Rs. 1000/- (Rs. 3000/- for overseas)
vi) Patrons	Rs. 5000/-
vii) Sustaining Associates	Rs. 10,000/-

4. Printing charges @ Rs. 50/- per printed page will be charged to the first author of the article/notes and Rs. 75/- per printing pages for special issue.
5. A limited space will be provided for the advertisement pertaining to various branches of Agriculture and Veterinary Science.
6. Correspondence : All correspondence regarding subscription and business matter may please be address to the Secretary, PKV Research Journal, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Krishi Nagar, Akola - 444 104, Maharashtra State (India)

This publication is included in the abstracting and indexing coverage of Biosciences information Service of Biological Abstracts and Field Crop Abstracts.

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

RESEARCH JOURNAL

CONTENT

Vol. 24 No. 2 July, 2000

PKV Res. J. Vol. 24 (2) : 2000

Organic Recycling Through Different Intercrops in the Base Crop of Cotton

N.D. Parlawar[1], R.M. Adpawar[2], P.V. Yadgirwar[3] and S.B. Bhoyte[4]

ABSTRACT

An experiment was conducted during *kharif* season of 1994-95, 95-96 and 96-97 to sutdy the performance of cotton and organic recycling through legume under rainfed conditions. Pooled results of three years revealed that among intercropping burried treatments, cotton with full recommended fertilizer dose + green gram burried at 10 per cent flowering (T_6) treatment recorded highest seed cotton yield (8.11 q ha^{-1}) among all treatments. In other intercropping mulching treatments, cotton with full recommended fertilizers dose + green gram (T_8) mulched after first pod plucking recorded highest GMR (Rs. 18,456 ha^{-1}).

Cotton (*Gossypium hirsutum* L.) is an important cash crop in India in general and in Maharashtra particularly in Vidarbha region. Farmers growing cotton in the central Vidarbha zone of Maharashtra intercrop it with mung. Experiment conducted at Yavatmal, Maharashtra cotton with mung (1:1) can fetch the farmers an addtional GMR Rs. 5968/- ha^{-1} without affecting the yield of cotton. In central Vidarbha zone cultivation of hybrid cotton become very popular. This has resulted in reducing the cropping intensity because of long duration of cotton crop. Growth habit of cotton indicates availability of enough time and space for growing short duration intercrops, which would help in increase the production and lead to better utilization of resources and inputs. Intercropping has recently been recognised as potentially beneficial and economic system of crop production under rainfed conditions. American cotton (*Gossypium hirsutum* L.) being long duration and a widely spaced crop, offers great scope for intercropping of short duration pulses. Singh, (1975) and Deshmukh *et al.* (1987) reported that monetary returns were increased when cotton was planted with optimum plant population and blackgram and soybean were taken as intercrops. Intercropping of suitable legumes in cotton is more remunerative, (Giri and Upadhyay, 1979). In India at various other locations mung as an intercrop increased the economic returns over sole cotton, (Kairon and Singh 1972 and Devotta and Chowdappan, 1976). The present study was therefore, undertaken to evaluate the performance of American cotton in relation to different intercropping of legumes.

MATERIAL AND METHODS

An experiment was conducted at National Agriculture Research Project, Yavatmal during *kharif* seasons of 1994-95, 1995-96 and 1996-97. The experimental soil was shallow, low in N (240 kg ha^{-1}), moderate in available P_2O_5 (39.77 kg ha^{-1}) and high in potash (412 kg ha^{-1}) with soil pH 7.5 to 8.0 CAHH-468 (PKV-Hy-2), American cotton was main base crop and green gram (Kopergaon) and cowpea (RC-19) were taken as intercrops i.e. one row of intercrop sown at 45 cm in between the rows of cotton planted with 90 cm x 60 cm spacing. Thus, 18518 hills of main crop of cotton were maintained with two plants $hill^{-1}$. Thus, nine treatment consisted of

- T_1 - Cotton (sole) with no fertilizer (control)
- T_2 - Cotton (sole) with 0.5 RF (25N + 12.5 P_2O_5 + 12.5 K_2O Kg ha^{-1})
- T_3 - Cotton (sole) with RF (50 N + 25 P_2O_5 + 25 K_2O kg ha^{-1})
- T_4 - Cotton with 0.5 RF + green gram burried at 10 per cent flowering of whole plant
- T_5 - Cotton with 0.5 RF + cowpea burried at 10 per cent flowering of whole plant
- T_6 - Cotton with RF + green gram burried at 10 per cent flowering of whole plant
- T_7 - Cotton with RF + Cowpea burried at 10 per cent flowering of whole plant
- T_8 - Cotton with RF + green gram mulched after first pod plucking
- T_9 - Cotton with RF + Cowpea mulched after first pod plucking

The experiment was conducted in randomized block design (RBD) with four replications. The sowing of all the crops was done 23rd, 28th June in the 94-95 and 95-96 respectively and 7th July in the year 1996-97 with the commencement of regular monsoon. N, P and K were applied to cotton as per treatments. Nitrogen was applied in two equal splits at 0, 30 days after sowing whereas P and K as a based dose.

Physical-chemical properties of soil before start of the experiment

pH	E.C. (d Sm^{-1})	O.C (g kg^{-1})	Available N kg ha^{-1}	Available P_2O_5 kg ha^{-1}	Available K_2O kg ha^{-1}
7.53	0.182	2.98	274	39.77	412

1. Asstt. Prof. (Agronomy), NARP, CVZ, Yavatmal, 2. Sr. Res. Fellow, Dept. of Horticulture, Dr. PDKV, Akola 3. Asstt. Prof. (Entomology), NARP, CVZ, Yavatmal, 4. Sr. Res. Asstt. NARP, CVZ, Yavatmal.

RESULTS AND DISCUSSION

Yield : It is revealed from Table 1 that the seed cotton yield was reduced significantly in the year 1996-97 due to intercropping of green gram and cowpea mulching after first pod plucking in 1:1 row ratio as compared to sole cotton with recommended dose of fertilizer by 6.87 and 14.83 per cent. Reduction in cotton yield up to 56.5 per cent with groundnut was reported at Dharwad Anonymous, (1977).

Table 1. Seed cotton yield q ha^{-1} as influenced by various treatments during 1994-95, 1995-96, 1996-97 and in pooled

Treatments	Seed cotton yield (q ha^{-1})			Total	Pooled average
	1994-95	1995-96	1996-97		
T_1	2.11	3.40	5.27	10.78	3.59
T_2	2.75	6.18	8.68	17.61	5.87
T_3	3.11	6.58	9.17	18.86	6.29
T_4	3.50	8.26	9.63	21.39	7.13
T_5	3.52	7.58	8.87	19.97	6.66
T_6	4.32	9.68	10.33	24.33	8.11
T_7	4.08	9.63	9.43	23.14	7.71
T_8	4.03	6.98	8.54	19.55	6.51
	2.57	6.10	4.24	12.91	4.30
T_9	3.69	7.02	7.81	18.52	6.17
	2.28	2.52	2.07	6.87	2.29
SE±	0.33	0.38	0.20		0.30
CD at 5%	0.95	1.12	0.58		0.88

Sole crop of cotton recorded maximum yield may be attributed due to competition free environment and considerably higher yield components on sole cotton. Cotton with recommended dose of fertilizer and intercropped with greengram burried at 10 per cent flowering increase cotton yield by 22.44, 27.62 and 55.57 per cent as compared to sole cotton with full RDF, half RDF and control respectively. This treatment (T_6) also recorded 4.93, 19.72 and 23.92 per cent more yield than T_7, T_8 and T_9 treatments respectively.

Cotton with half RDF with green gram intercropping burried at 10 per cent flowering (T_4) recorded cotton yield 6.89 per cent more than treatment (T_5). In case of mulching treatment (T_8) recorded cotton yield 5.22 per cent more than treatment (T_9). Cotton intercropping with green gram system recorded significant more cotton yield than cotton intercropping with cowpea system this is clearly indicates that due to profused growth of cowpea crop as compared to green gram showed higher degree of competition with cotton for the natural resouces i.e. space, light, nutrient and moisture causing reduction in cotton yield. These results are similar with the results reported by Koraddi *et al.* (1990) and Tomar *et al.* (1994).

Economics : From Table 2, it is revealed that all the intercropping treatments recorded higher GMR ha^{-1} than sole crop of cotton. Treatment (T_8) recorded highest GMR (Rs. 18453 ha^{-1}). Similar GMR were higher in all intercropping system that sole cotton. Treatment (T_8) recorded 32.34 and 18.54 per cent more yield than treatment (T_3) and (T_9) and it also recorded significantly more GMR than treatment T_1, T_2, T_3 and T_5. In case of burried treatments T_5 and T_6 also recorded 17.54 and 16.91 per cent less GMR than T_8. Treatment (T_3) also recorded 32.34 per cent less GMR than T_8.

From pooled results it is revealed that treatment (T_6)

Table 2. Gross monetary returns (Rs. ha^{-1}) as influenced by various treatments during 1994-95, 1995-96, 1996-97 and in pooled

Treatments	Gross monetary returns (Rs ha^{-1})			Pooled mean
	1994-95	1995-96	1996-97	
T_1	4188	6797	10419	7134
T_2	5471	12363	17143	11659
T_3	6181	13159	18115	12485
T_4	6958	16530	19015	14171
T_5	6990	15160	17510	13220
T_6	5878	19368	20402	15216
T_7	8107	19267	18621	15331
T_8	8003	13970	16873	12948
	+(2894)	+(7331)	+(6290)	+(5505)
T_9	7328	14493	15427	12416
	+(2287)	+(2769)	+(2769)	+(2608)
SE m ±	664	1307	767	1559
CD at 5%	1939	3812	2241	4674

Parenthesis figure indicates GMR of intercrop

Grain and seed cotton price (Rs. q^{-1})

Seed Cotton	1985	2000	1975
Green gram	1126	1200	1485
Cowpea	1000	1100	1335

Table 3. Effect on physico-chemical properties of soil after 3rd year of experiment due to organic recycling through different intercrops in the base crop of cotton at NARP, Yavatmal

Treatments	pH	E.C. (dSm^{-1})	Organic carbon ($g\ kg^{-1}$)	Available NPK ($kg\ ha^{-1}$)			Bulk density ($Mg\ m^3$)
				N	P_2O_5	K_2O	
T_1	7.65	0.23	6.1	270	46.81	397	1.42
T_2	7.64	0.24	7.6	364	49.37	418	1.43
T_3	7.59	0.24	8.4	363	51.94	447	1.48
T_4	7.47	0.18	8.2	365	70.53	521	1.36
T_5	7.63	0.21	8.9	375	58.35	506	1.41
T_6	7.48	0.19	8.5	365	71.17	547	1.41
T_7	7.56	0.22	8.5	364	65.40	541	1.32
T_8	7.51	0.23	8.5	373	76.94	552	1.33
T_9	7.50	0.24	8.6	338	56.42	484	1.31
SE±	0.05	0.01	0.3	12.26	3.59	18.65	0.05
CD at 5%	–	0.03	1.0	35.80	10.48	54.45	–

recorded highest cotton yield (8.11 q ha^{-1}) than all the treatments. Treatment (T_8) recorded highest GMR (Rs. 18453 ha^{-1}) among all treatments. The results obtained in present investigation with regards to green gram intercropping are in agreement with the results reported by Kairon and Singh (1972) and Singh *et al.* (1973). It was concluded from above results that the intercropping in cotton with green gram and cow pea (1:1) ratio with RFD was found to be more remunerative than sole cotton under rainfed situation in Central Vidarbha Zone of Maharashtra. This results is corroborated with the work of Mathur *et al.* (1972).

Organic recycling : From Table 3, it is revealed that treatment T_4 and T_5 significantly reduced the conductivity of soil over control (T_1) organic carbon of soil was significantly increased due to all treatments over control. It was highest due to T_5 i.e. (8.9 k kg^{-1}). All treatments increased available N level in the soil significantly over T_1 (control). They were at par among themselves. Available P_2O_5 status of soil was significantly increased due to burrying or mulching of green gram over T_1, T_2 and T_3 treatments. Significant increase in available K_2O status of soil was noticed due to T_4, T_5, T_6 and T_8 treatments over T_1, T_2 and T_3 treatments. These results are coincide with the results reported by Giri and Upadhyay (1979).

From above experimental results, it is concluded that available nutrients, nitrogen (373 kg ha^{-1}), Phosphorus (76.94 kg ha^{-1}), Potash (552 kg ha^{-1}) and GMR (Rs. 18453/- ha^{-1}) were highest recorded by T_8 treaments. Hence, for improving available nutrients status of soil and obtaining high GMR hectare^{-1} intercropping of green gram in cotton and mulching the same after first pod plucking should be done.

LITERATURE CITED

Anonymous, 1977. Annual report of all India cordinated cotton improvement project in Karnataka for the year 1976-77. Presented at the South Zone Panel Meeting, at Coimbatore on 7-8 June, 1977.

Deshmukh, S.C., R.I. Sisodia and K.C. Mandloi, 1987. Studies on planting pattern and intercropping in cotton. J. Cotton Res. & Develop. 2(1) : 24-30.

Devotta, A.D. and S.R. Chowdappan, 1976. Mixed cropping of cotton with legume and non-legumes in black cotton soils of Tamilnadu. Madras Agric. J. 63 : 249-250.

Giri, A.N. and U.C. Upadhyay, 1979. Studies on planting pattern, intercropping and nitrogen economy of H-4 cotton under rainfed conditions. Indian J. Agron. 25(1) : 71.76.

Kairon, M.S. and A. Singh, 1972. Intercropping of cotton with legumes and its residual effect on wheat. Cotton Dev. 2 : 1-5.

Koraddi, V.R., S.K. Channal, A.K. Guggari and K.S. Kamath, 1991. Studies on planting pattern and fertilizer requirements for intercropping of cotton and groundnut under assured rainfall conditions. Karnataka J. Agric. Sci. 4 (2 & 4) : 126-128.

Mathur, B.N., V.S. Singh and N.K. Agrawal, 1972. Mixed cropping of cotton and groundnut in irrigated areas of Rajasthan. Indian Agric. 16 (1) : 27-31.

PKV Res. J. Vol. 24 (2) : 2000

Response of *Rabi* Sorghum Genotypes (*Sorghum bicolor*) to Different Fertilizer Levels Grown After Greengram (*Vigna radiata*) Under Rainfed Condition

M.R. Kale[1], S.S. Wanjari[2], J.P. Deshmukh[3] and S.B. Atale[4]

ABSTRACT

A field experiment was conducted at NARP, Washim, during 1997-98 to 1999-2000 to know the performance and economical feasibility of *rabi* sorghum varieties in greengram - *rabi* - sorghum cropping system. The gross and net monetary returns of sorghum were significantly superior in greengram *rabi* sorghum. The gross and net monetary returns were significantly higher under greengram - *rabi* sorghum (cv. SPV-504) as compared to other genotypes. Similarly, under the fertlity levels, application of 40:20:20 NPK kg ha^{-1} recorded significantly more gross and net monetary returns under rainfed conditions.

Rabi sorghum is predominantly grown in the state of Maharashtra, Karnataka and Andhra Pradesh. The area under *rabi* sorghum in Maharashtra is 35 lakh ha. The average productivity of *rabi* sorghum in Maharashtra is 600 kg ha^{-1}. In Vidarbha area of Maharashtra state the *kharif* sorghum area is reduced due to grain mold problem. Therefore, to escape from the grain mold and with limited irrigation facility farmers are growing *rabi* sorghum for getting good quality grain and fodder and ultimate price. Several workers reported the beneficial effects of *kharif* legumes on *rabi* sorghum (Nagre and Chandrashekhar, 1988 and Kumar Rao *et al.*, 1983). Therefore, it was felt imperative to conduct systematic study in *rabi* sorghum genotypes with fertilizer levels under rainfed condition.

MATERIAL AND METHODS

A field experiment was conducted at NARP Washim during *kharif-rabi* 1997 to 2000. The experiment was laid out in split plot design with three replications consisting three sorghum genotypes (V_1 : SPV-504, V_2 : M35-1 and V_3 :Ringni) in main plot and five fertilizer levels (F_0 i.e. Control, F_1 20:10:00, F_2 20:10:20, F_3 40:20:00, F_4 40:20:20, NPK kg ha^{-1}) in sub plot treatment. Plot size was 1.8 x 3.6 m. *Rabi* sorghum crop was sown on 4.10.97, 10.10.98 and 1.10.99. Sowing of *kharif* green gram was done on the same plot.

The site of experimental plot was low in nitrogen (139.75 kg ha^{-1}), moderate in available P_2O_5 (23.00 kg ha^{-1}) and sufficient in avaialble K_2O (311.11 kg ha^{-1}), slightly alkaline in reaction (pH 7.62) and good water holding capacity. *Rabi* sorghum was sown on residual moisture. Observations on grain and fodder yield are recorded and presented in Table 1. Similarly, gross monetary returns and net monetary returns Rs. ha^{-1} calculated from the prevailing market rates and are presented in Table 2 and 3.

RESULTS AND DISCUSSION

Gross monetary returns (GMR) and net monetary returns (NMR) for *rabi* sorghum

Effect of Genotypes

Significantly higher GMR and NMR was recorded by cv. Ringni during 1997-98 season followed by cv. SPV-504 and M-35-1. Whereas, during 98-99 season cv. SPV-504 registered significantly higher GMR and NMR followed by M-35-1 and Ringni. During 1999-2000 sorghum genotype M-35-1 registered significantly higher GMR and NMR (Table 2), followed by SPV-504 and Ringni.

In Pooled results cv. SPV-504 recorded significantly higher GMR and NMR than M-35-1 and Ringni.

Effect of Fertilizer levels :

Fertility level of 40:20:20 results significantly higher GMR and NMR however, it was at par with 40:20:00. The lowest GMR and NMR was registered in control in the year 97-98, similar trend was observed during 98-99 and 99-2000.

When data was pooled, fertility level of 40:20:20 (NPK kg ha^{-1}) registered significantly higher GMR than 40:20:00. Whereas, the fertility levels of 40:20:20 and 40:20:00 were at par and recorded significantly higher monetary returns than other fertility levels.

Gross monetary returns (GMR) and net monetary returns (NMR) from greengram - *rabi* sorghum cropping system

Effect of sorghum genotypes :

Significantly higher GMR and NMR was recorded with greengram-sorghum cv. Ringni during 1997-98 season (Table 3). Green gram-SPV-504 and green gram-sorghum cv. M-35-1 sequence was at par with each other. 1998-99 season was exceptionally good and recorded higher GMR and NMR than the other two years of study. Greengram *rabi* sorghum cv. SPV-504 sequence recorded higher GMR and NMR as compared to M-35-1 and Ringni. During 1999-2000 season, crop sequence, greengram M-35-1 recorded significantly higher GMR and NMR followed by greengram SPV-504 and greengram-Ringni.

Pooled results of three years indicated that sequence of greengram - sorghum cv. SPV-504 has recorded significantly higher GMR and NMR (Table 3).

1. Assoc. Prof. of Agronomy, 2. Sorghum Agronomist 3. Senior Res. Asstt., 4. Senior Res. Sci. (Sorghum), Dr. PDKV, Akola

Table 1. Grain and fodder yield (q ha^{-1}) as influenced by sorghum genotypes and fertility levels

Treatments	1997-98	1998-99	1999-2000	Pooled mean
Greengram	10.03	13.99	13.58	12.53
	(6.17)	(6.19)	(5.20)	(5.85)
A) Sorghum genotypes (3)				
G_1 SPV-504	12.55	40.74	18.91	24.06
	(48.25)	(70.37)	(39.50)	(52.65)
G_2 M-35-1	11.72	32.92	19.75	21.46
	(45.01)	(67.07)	(58.42)	(56.81)
G_3 Ringni	15.08	32.71	15.21	20.99
	(57.71)	(62.03)	(28.39)	(49.40)
CD P=0.05	1.35	1.59	0.60	1.14
	(4.17)	(4.95)	(1.47)	(2.19)
B) Fertility levels (kg N, P_2O_5 and K_2O ha^{-1})				
F_0 Control	9.94	27.94	15.08	17.60
	(37.20)	(58.98)	(35.15)	(43.69)
F_1 (20:10:00)	11.31	32.92	16.29	19.91
	(42.86)	(63.10)	(38.40)	(48.01)
F_2 (20:10:20)	13.11	35.66	17.66	22.07
	(50.58)	(66.52)	(42.00)	(52.95)
F_3 (40:20:00)	14.74	38.58	19.54	24.24
	(57.78)	(70.30)	(46.46)	(58.20)
F_4 (40:20:20)	16.46	42.18	21.26	26.55
	(63.27)	(73.56)	(48.42)	(61.76)
CD P=0.05	2.06	5.42	1.95	2.22
	(7.89)	(7.10)	(4.34)	(3.69)

Figure in parenthesis indicates fodder yield

Table 2. GMR and NMR (Rs. ha^{-1}) for *rabi* sorghum as influenced by sorghum genotypes and fertility levels

Treatments	1997-98	1998-99	1999-2000	Pooled mean
A) Sorghum genotypes (3)				
G_1 SPV-504	18229	46350	22727	29336
	(13695)	(41039	(16273)	(23499)
G_2 M-35-1	17385	39248	26634	27761
	(12104)	(33427	(20072)	(21863)
G_3 Ringni	22696	38183	17678	26186
	(17246)	(32377	(11224)	(20288)
CD P=0.05	2138	972	736	1096
	(1821)	(742	(568)	(1204)
B) Fertility levels (kg N, P_2O_5 and K_2O ha^{-1})				
F_0 Control	14745	33674	22727	22388
	(9897)	(28270	(12784)	(16984)
F_1 (20:10:00)	16520	38538	20180	25090
	(10946)	(32825	(13818)	(19191)
F_2 (20:10:20)	19809	41440	22110	27776
	(14606)	(35666	(15501)	(21924)
F_3 (40:20:00)	22434	44528	24456	30478
	(16984)	(38476	(17725)	(24395)
F4 (40:20:20)	24827	48111	26248	33057
	(19315)	(41996	(19454)	(25927)
CD P=0.05	3010	48.01	2408	2146
	(3072)	(4678	(2331)	(2223)
Interaction Effect G x F				
Interaction	NS	NS	NS	NS
	(NS)	(NS)	(NS)	(NS)

Figure in parenthesis indicates fodder yield

Table 3. GMR and NMR (Rs. ha^{-1}) from greengram *rabi* sorghum cropping system

Treatments	1997-98	1998-99	1999-2000	Pooled mean
Greengram (G + F)	16899	23467	22571	20979
	(12619)	(18791)	(17375)	(16262)
A) Sorghum genotypes (3)				
G_1 SPV-504	35820	69819	45300	50318
	(26309)	(59351)	(33679)	(39773)
G_2 M-35-1	34276	62701	49207	48728
	(24765)	(52526)	(37550)	(38275)
G_3 Ringni	39588	61651	40252	47169
	(30007)	(51168)	(28610)	(36608)
CD P = 0.05	2138	975	745	1100
	(1621)	(1039)	(538)	(1065)
B) Fertility levels (kg N, P_2O_5 and K_2O ha^{-1})				
F_0 Control	31636	57143	41317	43370
	(22511)	(47601)	(30138)	(33412)
F_1 (20:10:00)	33427	62007	42753	46057
	(23978)	(51615)	(31204)	(35604)
F_2 (20:10:20)	36700	64909	44667	48759
	(27220)	(54441)	(33057)	(38244)
F_3 (40:20:00)	39325	67997	47030	51446
	(29598)	(57313)	(35110)	(40668)
F_4 (40:20:20)	41718	71579	48821	54040
	(31929)	(60771)	(36870)	(43185)
CD P = 0.05	3010	4832	2411	2153
	(2918)	(4710)	(2331)	(2130)
Interaction Effect G x F				
Interaction	NS	NS	NS	NS
	(NS)	(NS)	(NS)	(NS)

Figure in parenthesis indicates fodder yield

Effect of fertility levels :

Fertility level of 40:20:20 NPK kg ha^{-1} has recorded significantly higher GMR and NMR (Table 3) than the other levels but at par with the level of 40:20:00 during all the three years of investigation. Pooled results indicated that, fertility level of 40:20:20 was found superior than the other fertility levels tried.

The pooled gross and net monetary returns were significantly more with the each additional level of fertility level because of increase in grain and fodder yield these results are in agreement with those of Nagre and Chandrashekar 1988.

The beneficial effect of *kharif* legumes on *rabi* sorghum has also reported by Pawar *et al.* 1995 and Nagre and Chandrashekar 1998.

Productivity of Sorghum :

The three years experimentation (Table 1) clearly showed that greengram - *rabi* sorghum crop sequence variety SPV-504 produced highest grain yield followed by M-35-1 and Ringni and highest fodder yield was recorded by M-35-1 followed by SPV-504 and Ringni under rainfed conditions. Application of fertilizer level @ 40:20:20 NPK k g ha^{-1} and 40:20 NP kg ha^{-1} was found at par for getting highest yield. GMR and NMR (Table 3) was found to be highest with Green gram followed by *rabi* sorghum (SPV-504) crop sequence and also with fertilizer level 40:20:20 NPK kg ha^{-1}.

LITERATURE CITED

Kumar Rao, J.V.D.K., P.J. Dart and P.V.S.S. Sastry, 1983. Residual effect of pigeon pea (*Cajanas cajan*) on yield and nitrogen response of maize. Experimental Agriculture 19 : 131-141.

Nagre, K.T. and A. Chandrasekher, 1988. Effect of summer legumes on nitrogen economy and yield of succeeding sorghum. PKV Res. J. 12 (2) 102-106.

Pawar, K.P., A.S. Jadhao and A.A. Shaikh, 1995. Effect of *kharif* legumes on yield, nitrogen economy of *rabi* sorghum and economics of cropping system. J. Mah. Agril. Univ. 20 (2) : 242-245.

PKV Res. J. Vol. 24 (2) : 2000

Combining Ability Studies in Colour Linted Upland Cotton (*Gossypium hirsutum* L.)

Swati G. Bharad[1], L.D. Meshram[2] and P.W. Khorgade[3]

ABSTRACT

Combining ability of 7 x 7 diallel crosses without reciprocals in colour linted cotton of *G. hirsutum* L. revealed that both gca and sca means squares were highly significant for all the characters studied, except days to 50 per cent flowering and days to 50 per cent boll bursting for which gca mean squares were not significant. The parent AKHC-7 was observed to be the best general combiner for seed cotton yield, bolls plant $^{-1}$ while AKHC-4 was the best general combiner for plant height and boll weight. The cross AKHC-39 x AKHC-4 and AKHC-46 x AKHC-7 were identified for hybrid development while cross AKHC-7 x AKHC-4 was found to be good for development of new pureline varieties in naturally colour cotton.

Cotton occupies a place of pride in Indian agriculture and textile industry. Recently the commercial cultivation of naturally coloured cotton has reassumed new importance in USA as well as in India. Selection of parents is an important step in crop improvement programmes. Different biometrical tools have been adopted for identifying desirable parents, for which diallel analysis is unique and reliable. This information on combining ability through diallel mating in cotton is very meagre, and hence the present investigation was, undertaken.

MATERIAL AND METHODS

Seven promising genotypes of naturally upland cotton *G. hirsutum* L. viz. AKHC-3, AKHC-39, AKHC-46, AKHC-89, AKHC-14 ,AKHC-7 and AKHC-4 were crossed in 7 x 7 diallel fashion excluding reciprocals. Seven parents and 21 hybrids were grown during, *kharif*, 1997-98 in randomized complete block design with three replications at Cotton Research Unit, Dr. PDKV, Akola. Each progeny consisted of two rows of 6 m length with inter and intra row spacing of 60 cm. The observations were recorded on five randomly selected plants replication $^{-1}$ for eight characters as listed in Table 1. Combining ability analysis was carried out according to method 2, model - I of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Table 1) indicated that the mean squares due to general and specific combining ability were significant for all the characters studied except days to 50 per cent flowring and days to 50 per cent boll bursting for which the general combining ability mean squares were not significant. This revealed that both additive and non-additive gene effects were important in the expression of these characters. However, the general predictability ratio (Baker, 1987) indicated the predominance of additive component of genetic variance for plant height, number of bolls plant $^{-1}$, ginning outturn and days to 50 per cent boll bursting. The results of similar nature in cotton were also raported by Sharma (1979) for plant height and Amalraj (1989) in white linted and Amudha and Reaveendran (1997) in coloured cottons for number of bolls and ginning outturn.

The predictability ratio for seed cotton yield plant^{-1}, number of sympodia plant $^{-1}$, boll weight and days to 50 per cent flowering was close to 0.5 which indicated that the additive as well as non-additive components are equally responsible for inheritance of these characters. These results are in conformity with those reported by Jagtap and Kolhe (1987) for boll weight, Amudha and Raveendran (1997) for number of sympodia in colour cotton, Jain (1997) for seed cotton yield in white linted cotton.

Estimates of general combining ability of parents presented in Table 2 revealed that AKHC-7 was the best general combiner for seed cotton yield plant^{-1}, bolls plant^{-1}, and sympodia plant^{-1}. AKHC-4 was found to be the best general combiner for plant height and boll weight, while AKHC-39 was the best general cobiner for ginning outturn. The parents which exhibited good general combining ability may possess the favourable genes for seed cotton yield and its component attributes.

The selected promising crosses alongwith their mean performance, heterosis, gca effects of parents involved and sca effects for some important characters are presented in Table 3. On the basis of high mean performance, high heterotic response, poor/high gca effects but significant sca effect for seed cotton yield plant^{-1}, the cross AKHC-39 x AKHC-4 was found to be the best combination followed by AKHC-46 x AKHC-7. Such colour linted hybrids may be evaluated in multilocation trials for identifying the best hybrids suited to specific locations or wide regions.

The cross showing high mean performance, high heterosis, involving parents with high/average gca effects,

1. P.G. Student 2. Senior Research Scientist (Cotton), Dr. PDKV, Akola 3. Associate Professor of Botany, College of Agriculture, Akola

Table 1. Analysis of variance for combining ability for eight characters in coloured cotton

Sources	d.f.	Mean squares							
		Days to 50% flowering	Days to 50% boll bursting	Plant height (cm)	No. of sympoida plant^{-1}	No. of bolls plant^{-1}	Boll weight (g)	Ginning outtern (g)	Seed cotton yield plant^{-1}
General combining ability	6	1.154	7.282	95.763**	1.919*	6.214**	0.055**	3.487**	40.763**
Specific combining ability	21	2.003**	8.019	51.709**	2.390**	4.816**	0.082**	2.988**	50.199**
Error	54	0.732	4.144	13.601	0.715	1.500	0.011	1.049	12.144
General predictability ratio		0.535	0.645	0.787	0.616	0.721	0.574	0.700	0.619

2 MS gca
- MS gca + Sca.

*, ** Significant at 5 per cent and 1per cent level, respectively.

Table 2. Estimates of general combining ability for parents

Parents	Days to 50 % flowering	Days to 50% boll bursting	Plant height (cm)	No. of sympodia plant^{-1}	No. of bolls plant^{-1}	Boll weight (g)	Ginning outtern	Seed cottons yield plant^{-1} (g)
AKHC-3	0.14	1.57*	-1.31	-0.79**	-1.60**	0.01	0.64*	-3.37**
AKHC-39	0.59*	-0.03	-0.90	-0.01	0.26	-0.05	0.75*	0.43
AKHC-46	-0.12	-0.84	-3.38**	0.00	0.46	-0.07*	-0.90**	0.61
AKHC-89	-0.45	0.08	3.27**	0.27	-0.41	0.06	0.40	-0.81
AKHC-14	-0.34	0.71	-3.47**	-0.27	-0.04	-0.24	3.12**	-11.69**
AKHC-7	0.25	-0.92	0.61	0.71**	1.01**	-0.08	1.94	-11.69**
AKHC-4	-0.08	-0.58	5.18**	-0.10	0.32	0.11**	-0.08	1.94
SE (gi)	0.264	0.628	1.138	0.261	0.378	0.033	0.316	1.075
SE (gi - gi)	0.403	0.960	1.739	0.399	0.577	0.050	0.483	1.643

*, ** Significant at 5 per cent and 1 per cent level, respectively.

Table 3. Selected crosses and their performance for important characters

Characters/Crosses	Mean	Heterosis	GCA Effect of parents		SCA effect
			P_1	P_2	
No. of sympodia plant^{-1}					
AKHC-46 x AKHC-7	17.40	42.62**	P	H	3.04**
AKHC-39 x AKHC-4	16.13	31.17**	P	A	2.39**
AKHC-89 X AKHC-7	16.13	30.11**	A	H	1.50
No. of bolls plant^{-1}					
AKHC - 39 x AKHC-4	19.07	56.28**	A	A	3.47**
AKHC-7 x AKHC-4	18.67	51.35**	H	A	2.32**
AKHC-46 x AKHC-7	18.20	30.94**	A	H	1.71
Ginning percentage					
AKHC-39 x AKHC-89	41.09	7.72*	H	A	2.65**
AKHC-14 x AKHC-7	39.39	14.58**	P	P	2.90**
AKHC-3 x AKHC-39	38.93	0.53	H	H	0.24
Seed cotton yield plant^{-1}					
AKHC-39 x AKHC-4	51.56	119.84**	P	H	16.29**
AKHC-46 x AKHC-7	44.55	40.67**	A	H	7.06*
AKHC-7 x AKHC-4	42.98	61.38**	H	A	4.17

*, ** Significant at 5 per cent and 1 per cent level, respectively.
A, H and P indicate average,high and poor general combiners, respectively

but comparatively low sca effect for some economic traits may be helpful to develop base populations for selection of better segregates. The hybrid AKHC-7 x AKHC-4 may provide such good segregating population for further breeding programme in naturally colour cotton.

LITERATURE CITED

Amalraj, S.F.A., 1989. Combining ability studies on *Gossypium hirsutum* x *Gossypium barbadense* hybrids. Indian J. Agric. Res. 23(2) : 65-69.

Amudha, K. and T.S. Ravendran, 1987. Combining ability for yield components and fibre characters in coloured linted cotton (*Gossypium hirsutum* L.) J. Indian Soc. Cotton Improve 22(2) : 101-104.

Baker, R.J., 1987. Issues in diallel analysis Crop Sci. 18(4) : 533-536.

Griffing, B., 1956. Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci. 9 : 463-493.

Jagtap. D.R. and A.K. Kolhe, 1987. Genetic analysis of yield and its components in upland cotton (*Gossypium hirsutum* L.) J. Indian Soc. Cotton improv. 12 (1) : 5-10

Jain, S., 1997. Studies on combining ability in intra and interspecific crosses of cotton. Crop Res. 14 (1) : 91-95.

Sharma D.R., 1979. Heterosis and combining ability in cotton Mysore J. Agric. Sci 13 (1) : 4-9.

PKV Res. J. Vol. 24 (2) : 2000

Effect of Organics and Inorganics on Yield and Nutrient Availability Under Soybean Wheat Sequence in Vertisols

H.N. Ravankar[1], D.M. Patil[2], N.B. Mohod[3] and P.W. Deshmukh[4]

ABSTRACT

Effect of organics and inorganics on yield and nutrient availability under soybean-wheat sequence in Vertisols were studies by conducting a field experiment with the treatment consisting combinations of inorganics and organics alongwith S and Zn. The results revealed that with the application of 150 per cent recommended NPK + S + Zn to both the crops recorded highest yield and uptake of nutrients. Application of inorganics in combination with organics S and Zn also reported higher yield over the treatments where only inorganics were applied. The results further indicated that application of inorganics in combination with organics increased the availability of nutrients in soil. Inclusion of S and Zn in the treatments increased their availability in soil.

Soybean has became the miracle crop of the Twentieth Century and ranks eighth in world crop production. Besides being an important source of protein, it contains fairly appreciable percentage of oil also. Though soybean is cultivated largely, it's average productivity is very low. It is therefore obvious to boost up per hectare production by balanced use of manures and fertilizers. Wheat is an important cereal being consumed next to paddy and contribute to the extent of 25 per cent of total food grains.

Balance fertilizer application is a must for increasing production on farms. Use of organic manures with optimum rate of fertilizers under intensive farming system increased the turn over of nutrients in the soil plant system (Nambiar and Abrol, 1989). Longterm experiments have indicated the favourable effects of FYM on soil properties and availability of nutrients which are released on mineralization and become available to growing crops, while applied fertilizer can supply essential nutrients needed for the crops in adequate amounts. Judicious combination of organic manures and fertilizers can maintain the soil fertility and productivity at higher levels. Use of organic materials and manures in cropping system may result in better utilization of P and K alongwith secondary and micronutrients. The present investigation was undertaken with these observations in view.

MATERIAL AND METHODS

A field experiment with soybean (PKV-1)-wheat (AKW-1071) sequence was conducted on fine montmorillonitic, slightly calcareous, hyperthermic family of Typic Haplustert. The experiment was laid out in a Randomized Block Design with twelve treatments (Table 1) replicated four times during the year 1998-99. This is the third year of this experiment on same site.

Grain and straw yields were recorded, plant samples were analysed for total N, P, K, S content, (Jackson, 1958) and for Zn content (Lindsay and Norvell, 1969). Surface soil samples (0-30 cm) from each plot before sowing and after harvest of each crop were analysed for organic carbon, total N (Jackson, 1958), available N (Subbiah and Asija, 1956), available P, K, S (Jackson, 1958) and available Zn (Lindsay and Norvell, 1969).

RESULTS AND DISCUSSION

Various treatments significantly influenced both yield and uptake of nutrients by soybean and wheat (Table 2 and 3). Significantly highest yield of soybean as well as wheat and uptake of nutrients were recorded on applying 150 per cent recommended dose of NPK + S + Zn (T_{10}). The treatments where organics, S and Zn were applied alongwith inorganics favourably influenced yield and nutrient uptake by soybean and wheat than the inorganic applied alone. Application of P through S containing fertilizer appeared significantly superior over S free fertilizer. The results are in confirmity with the findings of Naphade *et al.* (1993) and Jat and Nepalia (1995).

More or less similar results were observed in respect of fertility status of soil after harvest of soybean as well as wheat (Table 5 and 6). Highest content of organic carbon, total nitrogen, available N,P,K and Zn in soil were observed in the plot where 150 per cent recommended dose of NPK was applied alongwith S and Zn (T_{10}). Highest content of available S was observed in the treatment T_{11} where S containing P fertilizer was applied.

Thus, on the basis of 3 years results it can be concluded (Table 6) that the treatments where the nutrients were supplied through organics improved the soil fertility status particularly in respect to organic carbon and total nitrogen. Application of P through S containing fertilizers improved the fertility status than S free fertilizer and inclusion of S and Zn in the treatment increased their availability as

1. Associate Prof., 2 & 3 P.G. Students, 4. Sr. Research Assitt., Dept. of Agril. Chemistry and Soil Science, Dr. PDKV, Akola

Table 1. Treatment details

S.N.	Treatments	*Kharif*	*Rabi*
T_1	Control (No manure no fertilizer)	-	-
T_2	Recommended dose of NPK (S free Urea, DAP, MOP)	30:75:0	120:60:60
T_3	Recommended dose of NPK + S (Through gypsum) + Zinc sulphate	30:75:0:20:10	120:60:60:0:10
T_4	Recommended dose of NPK + Zinc Sulphate	30:75:0:0:10	120:60:60:10:0
T_5	Recommended dose of NPK + S (Through gypsum)	30:75:0:20:0	120:60:60:10:0
T_6	Recommended dose of NPK + S + Zinc sulphate (50% N through fertilizer, 50% N through *Leucaena* loppings)	30:75:0:20:10	120:60:60:10:10
T_7	Recommended dose of NPK + S + Zinc sulphate (50% N through FYM, 50% N through fertilizer)	30:75:0:20:10	120:60:60:10:10
T_8	Recommended dose of NPK + S + Zinc sulphate (N to be added through wheat straw produced in plot + Rest of N through fertilizer)	30:75:0:20:10	120:60:60:10:10
T_9	Recommended dose of NPK + S + Zinc sulphate (50% N through *Leucaena* loppings + 25% N through FYM + 25% N through wheat straw)	30:75:0:20:10	120:60:60:10:10
T_{10}	150% Recommended dose of NPK + S + Zinc sulphate	45:112.5:0:20:10	180:90:90:10:10
T_{11}	Recommended dose of NPK through urea, SSP and MOP	30:75:0:0:0	120:60:60:0:0
T_{12}	Recommended dose of NPK (S free)	30:75:0:0:0	120:60:60:0:0

Table 2. Effect of organics and inorganics on yield and nutrient uptake by soybean

	Treatments	Yield (q ha^{-1})		Uptake of nutrients (kg ha^{-1})				Zn
		Grain	Straw	N	P	K	S	(g ha^{-1})
T_1	Control	4.51	6.67	29.49	2.42	10.74	1.59	15.00
T_2	RD NPK (S free)	15.15	22.57	105.55	9.86	42.55	6.70	59.89
T_3	RD NPK + S + Zn	17.62	26.48	125.41	11.83	47.88	8.80	80.73
T_4	RD NPK + Zn	16.15	24.02	113.49	10.92	46.01	7.02	82.16
T_5	RD NPK + S	17.18	25.83	120.65	11.86	47.95	9.32	71.40
T_6	RD NPK + S + Zn (N 50:50 *Leucaena* + Fertilizer)	18.68	27.56	132.13	13.03	52.32	10.22	93.12
T_7	RD NPK + S + Zn (N 50:50 FYM + Fertilizer)	16.06	23.93	113.73	12.03	47.01	8.94	81.10
T_8	RD NPK + S +Zn (N WS in pot + Fertilizer)	15.03	22.43	106.56	11.29	43.70	8.43	76.15
T_9	RD NPK + S + Zn (N 50:25:25 *Leucaena* + FYM + WS)	16.08	24.71	114.01	11.51	46.64	9.05	80.47
T_{10}	150% RD NPK + S + Zn	23.23	30.20	169.28	18.13	70.26	13.10	117.18
T_{11}	RD NPK (with S)	17.96	26.21	125.74	12.28	52.42	9.73	76.24
T_{12}	RD NPK (S free)	15.20	22.51	101.08	10.33	41.77	6.80	62.79
	SE $\pm$ (m)	0.28	1.25	2.66	0.25	0.98	0.27	1.73
	CD at 5%	0.80	3.64	7.65	0.71	2.81	0.77	4.97

Table 3. Effect of organic and inorganics on yield and nutrient uptake by wheat

	Treatments	Yield (q ha^{-1})		Uptake of nutrient (kg ha^{-1})				Zn
		Grain	Straw	N	P	K	S	(g ha^{-1})
T_1	Control	5.18	9.70	13.51	2.81	12.73	1.79	39.79
T_2	RD NPK (S free)	25.28	48.20	79.16	18.36	78.34	10.74	241.16
T_3	RD NPK + S + Zn	26.09	50.50	81.03	19.11	84.83	12.93	333.54
T_4	RD NPK + Zn	25.26	49.25	80.20	17.44	80.60	10.60	346.10
T_5	RD NPK + S	24.32	47.35	77.98	18.26	85.78	12.21	280.82
T_6	RD NPK + S + Zn (N 50:50 *Leucaena* + Fertilizer)	26.66	52.12	88.19	21.04	94.35	13.46	356.77
T_7	RD NPK + S + Zn (N 50:50 :FYM + Fertilizer)	27.22	52.84	90.74	21.67	97.97	13.47	365.03
T_8	RD NPK + S + Zn (N WS in pot + Fertilizer)	25.69	49.23	83.14	21.21	87.95	12.17	335.66
T_9	RD NPK + S + Zn (N 50:25:25 *Leucaena* + FYM + WS)	28.03	53.47	93.47	22.10	100.84	14.04	379.62
T_{10}	150% RD NPK + S + Zn	35.30	68.90	126.44	32.55	135.50	19.93	520.70
T_{11}	RD NPK (with S)	26.75	52.75	84.07	19.61	85.47	13.05	287.50
T_{12}	RD NPK (S free)	24.76	47.32	76.03	18.45	80.05	9.51	262.00
	SE $\pm$ (m)	0.94	1.72	3.13	0.82	3.17	0.50	11.50
	CD at 5%	2.65	4.85	8.98	2.36	9.11	1.42	33.03

Table 4. Soil fertility status before sowing of soybean crop

Treatments		Organic carbon (%)	Total N (%)	Available nutrients (Kg ha^{-1})			S (ppm)	Zn (ppm)
				N	P	K		
T_1	Control	0.300	0.0347	164	13.17	284	13.35	0.49
T_2	RD NPK (S free)	0.518	0.0515	273	27.57	372	18.14	0.54
T_3	RD NPK + S +Zn	0.506	0.0519	271	27.83	380	24.86	0.72
T_4	RD NPK + Zn	0.544	0.0521	275	28.09	383	18.47	0.74
T_5	RD NPK + S	0.536	0.0516	274	26.36	380	25.19	0.61
T_6	RD NPK + S + Zn (N 50:50 *Leucaena* + Fertilizer)	0.578	0.0513	277	29.05	375	25.03	0.77
T_7	RD NPK + S + Zn (N 50:50 FYM + Fertilizer)	0.626	0.0521	283	30.28	383	24.94	0.81
T_8	RD NPK + S + Zn (N WS in pot + Fertilizer)	0.540	0.0518	266	30.04	387	25.11	0.80
T_9	RD NPK + S + Zn (N50:25:25 *Leucaena* + FYM + WS)	0.551	0.0522	263	31.12	377	24.77	0.78
T_{10}	150 % RD NPK + S + Zn	0.643	0.0580	324	33.87	430	26.12	0.79
T_{11}	RD NPK (with S)	0.578	0.0526	251	27.09	386	32.10	0.60
T_{12}	RD NPK (S free)	0.548	0.0500	268	27.84	386	18.05	0.61
	SE $\pm$ (m)	0.018	0.0006	4.98	1.07	12.7	0.319	0.024
	CD at 5%	0.054	0.0018	14.4	3.14	36.8	0.924	0.070

Table 1. Treatment details

S.N.	Treatments	*Kharif*	*Rabi*
T_1	Control (No manure no fertilizer)	-	-
T_2	Recommended dose of NPK (S free Urea, DAP, MOP)	30:75:0	120:60:60
T_3	Recommended dose of NPK + S (Through gypsum) + Zinc sulphate	30:75:0:20:10	120:60:60:0:10
T_4	Recommended dose of NPK + Zinc Sulphate	30:75:0:0:10	120:60:60:10:0
T_5	Recommended dose of NPK + S (Through gypsum)	30:75:0:20:0	120:60:60:10:0
T_6	Recommended dose of NPK + S + Zinc sulphate (50% N through fertilizer, 50% N through *Leucaena* loppings)	30:75:0:20:10	120:60:60:10:10
T_7	Recommended dose of NPK + S + Zinc sulphate (50% N through FYM, 50% N through fertilizer)	30:75:0:20:10	120:60:60:10:10
T_8	Recommended dose of NPK + S + Zinc sulphate (N to be added through wheat straw produced in plot + Rest of N through fertilizer)	30:75:0:20:10	120:60:60:10:10
T_9	Recommended dose of NPK + S + Zinc sulphate (50% N through *Leucaena* loppings + 25% N through FYM + 25% N through wheat straw)	30:75:0:20:10	120:60:60:10:10
T_{10}	150% Recommended dose of NPK + S + Zinc sulphate	45:112.5:0:20:10	180:90:90:10:10
T_{11}	Recommended dose of NPK through urea, SSP and MOP	30:75:0:0:0	120:60:60:0:0
T_{12}	Recommended dose of NPK (S free)	30:75:0:0:0	120:60:60:0:0

Table 2. Effect of organics and inorganics on yield and nutrient uptake by soybean

	Treatments	Yield (q ha^{-1})		Uptake of nutrients (kg ha^{-1})				Zn
		Grain	Straw	N	P	K	S	(g ha^{-1})
T_1	Control	4.51	6.67	29.49	2.42	10.74	1.59	15.00
T_2	RD NPK (S free)	15.15	22.57	105.55	9.86	42.55	6.70	59.89
T_3	RD NPK + S + Zn	17.62	26.48	125.41	11.83	47.88	8.80	80.73
T_4	RD NPK + Zn	16.15	24.02	113.49	10.92	46.01	7.02	82.16
T_5	RD NPK + S	17.18	25.83	120.65	11.86	47.95	9.32	71.40
T_6	RD NPK + S + Zn (N 50:50 *Leucaena* + Fertilizer)	18.68	27.56	132.13	13.03	52.32	10.22	93.12
T_7	RD NPK + S + Zn (N 50:50 FYM + Fertilizer)	16.06	23.93	113.73	12.03	47.01	8.94	81.10
T_8	RD NPK + S +Zn (N WS in pot + Fertilizer)	15.03	22.43	106.56	11.29	43.70	8.43	76.15
T_9	RD NPK + S + Zn (N 50:25:25 *Leucaena* + FYM + WS)	16.08	24.71	114.01	11.51	46.64	9.05	80.47
T_{10}	150% RD NPK + S + Zn	23.23	30.20	169.28	18.13	70.26	13.10	117.18
T_{11}	RD NPK (with S)	17.96	26.21	125.74	12.28	52.42	9.73	76.24
T_{12}	RD NPK (S free)	15.20	22.51	101.08	10.33	41.77	6.80	62.79
	SE $\pm$ (m)	0.28	1.25	2.66	0.25	0.98	0.27	1.73
	CD at 5%	0.80	3.64	7.65	0.71	2.81	0.77	4.97

Table 3. Effect of organic and inorganics on yield and nutrient uptake by wheat

	Treatments	Yield (q ha^{-1})		Uptake of nutrient (kg ha^{-1})				Zn
		Grain	Straw	N	P	K	S	(g ha^{-1})
T_1	Control	5.18	9.70	13.51	2.81	12.73	1.79	39.79
T_2	RD NPK (S free)	25.28	48.20	79.16	18.36	78.34	10.74	241.16
T_3	RD NPK + S + Zn	26.09	50.50	81.03	19.11	84.83	12.93	333.54
T_4	RD NPK + Zn	25.26	49.25	80.20	17.44	80.60	10.60	346.10
T_5	RD NPK + S	24.32	47.35	77.98	18.26	85.78	12.21	280.82
T_6	RD NPK + S + Zn (N 50:50 *Leucaena* + Fertilizer)	26.66	52.12	88.19	21.04	94.35	13.46	356.77
T_7	RD NPK + S + Zn (N 50:50 :FYM + Fertilizer)	27.22	52.84	90.74	21.67	97.97	13.47	365.03
T_8	RD NPK + S + Zn (N WS in pot + Fertilizer)	25.69	49.23	83.14	21.21	87.95	12.17	335.66
T_9	RD NPK + S + Zn (N 50:25:25 *Leucaena* + FYM + WS)	28.03	53.47	93.47	22.10	100.84	14.04	379.62
T_{10}	150% RD NPK + S + Zn	35.30	68.90	126.44	32.55	135.50	19.93	520.70
T_{11}	RD NPK (with S)	26.75	52.75	84.07	19.61	85.47	13.05	287.50
T_{12}	RD NPK (S free)	24.76	47.32	76.03	18.45	80.05	9.51	262.00
	SE $\pm$ (m)	0.94	1.72	3.13	0.82	3.17	0.50	11.50
	CD at 5%	2.65	4.85	8.98	2.36	9.11	1.42	33.03

Table 4. Soil fertility status before sowing of soybean crop

Treatments		Organic carbon (%)	Total N (%)	Available nutrients (Kg ha^{-1})			S (ppm)	Zn (ppm)
				N	P	K		
T_1	Control	0.300	0.0347	164	13.17	284	13.35	0.49
T_2	RD NPK (S free)	0.518	0.0515	273	27.57	372	18.14	0.54
T_3	RD NPK + S +Zn	0.506	0.0519	271	27.83	380	24.86	0.72
T_4	RD NPK + Zn	0.544	0.0521	275	28.09	383	18.47	0.74
T_5	RD NPK + S	0.536	0.0516	274	26.36	380	25.19	0.61
T_6	RD NPK + S + Zn (N 50:50 *Leucaena* + Fertilizer)	0.578	0.0513	277	29.05	375	25.03	0.77
T_7	RD NPK + S + Zn (N 50:50 FYM + Fertilizer)	0.626	0.0521	283	30.28	383	24.94	0.81
T_8	RD NPK + S + Zn (N WS in pot + Fertilizer)	0.540	0.0518	266	30.04	387	25.11	0.80
T_9	RD NPK + S + Zn (N50:25:25 *Leucaena* + FYM + WS)	0.551	0.0522	263	31.12	377	24.77	0.78
T_{10}	150 % RD NPK + S + Zn	0.643	0.0580	324	33.87	430	26.12	0.79
T_{11}	RD NPK (with S)	0.578	0.0526	251	27.09	386	32.10	0.60
T_{12}	RD NPK (S free)	0.548	0.0500	268	27.84	386	18.05	0.61
	SE $\pm$ (m)	0.018	0.0006	4.98	1.07	12.7	0.319	0.024
	CD at 5%	0.054	0.0018	14.4	3.14	36.8	0.924	0.070

Table 5. Soil fertility status after harvest of soybean crop

	Treatments	Organic carbon (%)	Total N (%)	Available nutrients (Kg ha^{-1}) N	P	K	S (ppm)	Zn (ppm)
T_1	Control	0.274	0.034	184	8.39	263	11.13	0.49
T_2	RD NPK (S free)	0.450	0.036	269	12.88	324	14.69	0.56
T_3	RD NPK + S +Zn	0.510	0.051	272	20.72	374	21.06	0.90
T_4	RD NPK + Zn	0.465	0.046	272	18.19	349	18.58	0.90
T_5	RD NPK + S	0.521	0.050	270	17.86	363	24.88	0.62
T_6	RD NPK + S + Zn (N 50:50 *Leucaena* + Fertilizer)	0.574	0.051	271	18.48	397	24.57	0.90
T_7	RD NPK + S + Zn (N 50:50 FYM + Fertilizer)	0.570	0.051	273	18.76	386	24.48	0.90
T_8	RD NPK + S + Zn (N WS in pot + Fertilizer)	0.574	0.053	274	19.04	386	24.78	0.93
T_9	RD NPK + S + Zn (N50:25:25 *Leucaena* + FYM + WS)	0.585	0.053	273	18.76	400	24.57	0.90
T_{10}	150 % RD NPK + S + Zn	0.589	0.055	305	24.08	436	25.09	0.92
T_{11}	RD NPK (with S)	0.555	0.051	264	19.60	422	31.96	0.62
T_{12}	RD NPK (S free)	0.462	0.042	266	17.92	333	17.11	0.61
	SE $\pm$ (m)	0.0102	0.014	11.20	0.86	8.38	0.305	0.029
	CD at 5%	0.0295	0.04	32.40	2.49	24.48	0.902	0.086
	Initial Values	0.420	0.043	156.80	10.50	336	10.80	0.66

Table 6. Soil fertility status after harvest of soybean crop

Treatments		Organic carbon (%)	Total N (%)	Available nutrients (Kg ha^{-1}) N	P	K	S (ppm)	Zn (ppm)
T_1	Control	0.272	0.0364	176.22	7.37	258.70	10.46	0.48
T_2	RD NPK (S free)	0.417	0.0392	230.50	13.87	355.60	13.38	0.52
T_3	RD NPK + S +Zn	0.495	0.0517	271.33	20.25	352.70	17.55	0.55
T_4	RD NPK + Zn	0.449	0.0483	253.95	18.37	355.50	16.65	0.69
T_5	RD NPK + S	0.454	0.0524	248.43	18.37	361.20	22.83	0.49
T_6	RD NPK + S + Zn (N 50:50 Leucaena + Fertilizer)	0.497	0.0531	278.11	18.75	392.00	22.62	0.85
T_7	RD NPK + S + Zn (N 50:50 FYM + fertilizer)	0.502	0.0538	275.34	19.87	380.80	21.96	0.83
T_8	RD NPK + S + Zn (N WS in pot + fertilizer)	0.470	0.0554	272.88	19.50	372.45	20.96	0.84
T_9	RD NPK + S + Zn (N50:25:25 Leucaena + FYM + WS)	0.505	0.0569	275.29	20.62	378.00	20.96	0.86
T_{10}	150 % RD NPK + S + Zn	0.585	0.0618	298.10	24.37	405.75	23.51	0.90
T_{11}	RD NPK (with S)	0.482	0.051	256.36	21.37	380.80	31.50	0.62
T_{12}	RD NPK (S free)	0.432	0.455	243.57	14.12	352.67	14.08	0.61
	SE $\pm$ (m)	0.0143	0.0015	5.45	1.56	12.23	0.759	0.017
	CD at 5%	0.0412	0.004	15.79	4.54	35.43	2.19	0.05
	Initial Values	0.420	0.043	156.80	10.50	336.00	10.80	0.66

well. The results supports the findings of Rao and Dakhore (1993) and Bellaki *et al.* (1998). There was a depletion in available nutrient status of soil in control plot. Similar results were also reported by Bhandari *et al.* (1992).

LITERATURE CITED

Bellakki, M.A., V.A. Badanur, R.A. Setty, 1998. Effect of long term integrated nutrient management on some important properties of a Vertisol, J. Ind. Soc. Soil Sci. 46 (2) : 176-180.

Bhandari, A.L., Anil Sood, K.N. Sharma and D.S. Rana, 1992. Integrated nutrient management in rice wheat system. J. Ind. Soc. Soil Sci. 40 (4) : 742.

Jackson, M.L., 1958. Soil chemical analysis, Prentice Hall, Inc. Englewood Eliffs, N.J. (U.S.A.).

Jat, B.L. and V. Nepalia, 1995. Effect of N and P application on productivity of soybean. Madras Agric. J. 82 (5) : 329-330.

Lindsay, W. and W.A. Norvell, 1969. Equilibrium relation of Zn, Fe, Ca and H with EDTA and DTPA in soils Proc. Soil Sci. Am. 33 : 62-68.

Nambiar, K.K.M., and I.P. Abrol, 1989. Longterm fertilizer experiments in India. Fert. News 34 (4) : 11-20.

Naphade, K.T., V.N. Deshmukh, S.S. Rewatkar and B.U. Solanke, 1993. Grain yield and nutrient uptake by irrigated wheat grown on vertisol under various nutirent levels. J. Ind. Soc. Soil Sci. 41(2) : 370-371.

Rao, K. Jeevan and R.C. Dakhore, 1993. Effect of long term application of PK and FYM on micronutrient status of Vertisol of Akola. J. Soil and Crops 3(1) : 52-55.

Subbiah, B.V. and G.L. Asija, 1956. A rapid procedure for determination of available nitrogen in soil. Current Sci. 25 : 256-260.

❖ ❖ ❖

PKV Res. J. Vol. 24 (2) : 2000

Effect of Organic Farming on Yield and Soil Fertility Under Cotton-Sorghum-Soybean Rotation

H.N. Ravankar[1], R.H. Patil[2], N.B. Mohod[3] and P.W. Deshmukh[4]

ABSTRACT

Field experiments on cotton-sorghum-soybean rotation were carried out from 1996 to 98 at the Department of Agronomy, Dr. PDKV, Akola. The soil at the experimental site was clayey, montmorillonitic hyperthermic family of Typic Ustochrepts. The field experiment was laid out in RBD with eight treatment combinations of organics, inorganics and tillage methods, replicated four times. Highest yield of cotton, sorghum and soybean were obtained (1st cycle) with full recommended dose through fertilizer but was at par with the treatment where 50 per cent N is supplied through organics. The soil fertility was improved with the application of nutrients through organics. Hence, it could be concluded that for sustainable yields and maintenance of soil fertility the inclusion of organics appears to be essential.

The causes of low yield are many but chiefts amongst them are low soil fertility level and imbalance manuring (Ramamurthy and Bajaj, 1969). The data from long term experiments have clearly indicated higher yield levels with supplementation of chemical fertilizers with organic manures. It is therefore, necessary to use judiciously both organic manure and inorganic fertilizers for increasing productivity. In many cases chemical fertilizers deteriorates the soil condition and lowers its productivity (Dhua, 1975). On the other hand organic manures have a high absorption and adsorption capacity of nutrients.

FYM, the most widely used organic manure, is of great significance in organic farming, it exercises a critical role in the upkeep of soil productivity, fertility and health.

In Vidarbha region cotton-sorghum-legume is commonly followed rotation and soybean can be a legume component. In general the productivity of rotational crop is very low. It is, therefore, necessary to increase per hectare production of crops grown in rotation by proper and balance use of organics and inorganic fertilizers.

Considering the significance of above rotation and organic manures in maintaining fertility and soil health, field experiments were conducted during 1996-98 to study the effect of organic farming on yield and soil fertility under cotton-sorghum-soybean rotation.

MATERIAL AND METHODS

The field experiment was laid out in a Randomised Block Design with eight treatments combining organics, inorganics and tillage methods replicated four times at the farm of Department of Agronomy,Dr. PDKV, Akola during *kharif* 1996 to 1998 (cotton 1996, sorghum 1997 and soybean 1998). The recommended doses of N, P and K for cotton, sorghum and soyben were 50:25:30, 80:40:30 and 30:70:0, respectively. Minimum tillage means one harrowing, no hoeing, weeds cut and left in the plot. Normal tillage 3 harrowing, 3 hoeing and 2 weedings as and when required. In T_2 and T_3 RD N and in T_4 and T_5 half N through organics as basal only. In T_6 half N through organic as basal and remaining half topdressed. Full PK at sowing through fertilizer in all treatments (except T_7 and T_8). The soil at the experimental site was clayey, montmorillonitic, hyperthermic, family of typic Ustochrepts. Grain and straw yields were recorded separately. Surface soil sample (0-30 cm) from each plot before sowing of cotton in *kharif* 1996 and after harvest of soybean crop during 1998 were analysed for organic carbon, total N (Jackson, 1958), available N (Subbiah and Asija, 1956) and available P_2O_5 and K_2O (Jackson, 1958).

RESULTS AND DISCUSSION

Yield :

The yields of seed cotton, sorghum as well as soybean grains were significantly influenced with the various treatments and the lowest yields were obtained in control with minimum tillage, which was at par with normal tillage.

The highest yield of cotton, sorghum and soybean was obtained with the application of full-recommended dose through fertilizers. In case cotton and sorghum the yields were at par with full dose of N through organics or 50 per cent through organics and 50 per cent through fertilizers. In all the crops the next best treatment as regards the yield was T_6 where 50 per cent N was supplied through organics and the yields were statistically at par with a full dose through fertlizers, except in soybean where the differences could reach to the level of significance. The results are in conformity with the findings of Rajput *et al.* (1995) who reported that under mixed organic farming soybean production was 58 per cent higher than under conventioal farming. The results reported by Rajeshkumar and Singh (1996), also appeared to support present findings.

1. Associate Professor, 2 & 3 P.G. Students, 4. Assistant Professor, Department of Agril. Chem. and Soil Science, Dr. PDKV, Akola

Table 1. Yield and dry matter of cotton, sorghum and soybean crop (q ha^{-1})

Treatments		Cotton 1996		Sorghum 97		Soybean 98	
		Seed cotton	Dry matter	Grain	Fodder	Grain	Stover
T_1	RD NPK through fertilizers + normal tillage	7.49	37.5	37.48	74.5	22.15	34.5
T_2	RD N through organics + normal tillge	6.20	27.3	35.85	61.0	18.94	30.9
T_3	RD N through organics + minimum tillage	5.90	22.3	35.17	60.6	18.30	29.8
T_4	50% RD N through organics + normal tillage	4.78	23.1	30.08	47.7	11.59	19.7
T_5	50% RD N through organics	3.89	19.7	29.39	46.7	11.39	19.4
T_6	50 % RD N through organics + 50% RD N through fertilizer + normal tillage	6.88	34.2	36.99	69.9	19.23	31.1
T_7	Control + normal tillage	3.63	16.7	14.29	37.4	7.65	13.3
T_8	Control + minimum tillage	3.40	15.5	13.15	36.3	6.13	10.91
	SE (m)±	0.44	0.65	1.19	1.58	0.25	0.30
	CD at 5%	1.29	1.89	3.47	4.57	0.78	0.94

Table 2. Uptake of nutrients by cotton, sorghum and soyean crop (kg ha^{-1})

Treatment	Cotton (*kharif* 1996)			Sorghum (*kharif* 1997)			Soybean (*kharif* 98)		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
T_1	54.9	16.4	53.5	96.9	40.9	137	166	18.9	75.1
T_2	40.1	14.3	39.7	78.1	33.4	112	137	14.3	61.4
T_3	32.7	12.9	33.2	76.9	32.5	110	132	13.4	58.5
T_4	34.4	13.1	33.8	61.3	26.4	89	83	8.4	37.7
T_5	30.6	11.7	30.2	60.1	25.0	85	81	7.8	36.7
T_6	49.7	15.2	48.5	89.9	38.3	127	142	15.7	63.9
T_7	25.9	9.6	26.3	29.6	14.1	52	53	4.7	22.9
T_8	24.5	9.2	25.9	27.9	12.8	50	40	3.4	18.5
SE ± (m)	2.36	1.29	2.41	2.23	4.9	2.35	0.019	0.14	0.031
CD at 5%	6.85	3.73	6.96	6.46	14.1	6.82	0.059	0.43	0.098

Soil Fertility :

The fertility of soil particularly in respect to organic carbon and total nitrogen appeared to be improved after the last crop in the rotation with the addition of organics. With the addition of the organics the organic carbon content in soil ranged from 0.71 to 0.73 per cent as against the initial status of 0.67 per cent. Similarly, total N content was improved from 0.054 to 0.061per cent, available N from 244 to 285 kg ha^{-1}, availble P_2O_5 from 33.3 to 41.8 kg ha^{-1} and available K_2O from 336 to 384 kg ha^{-1} on completion of one cycle of crops grown in rotation with the application of 50 per cent N through organic source. This clearly indicated that the inclusion of organics improved the soil fertility status with increased productivity. The results appeared in conformity with the findings of Hundekar *et al.* (1991) and Helkiah *et al.* (1981).

Uptake of Nutrients :

Uptake of nutrients and dry matter production followed similar trend as that observed in case of yield of crops.

Table 3. Soil fertility status after one cycle of cotton-sorghum-soybean as affected by various treatments (1998)

Treatments	Organic carbon (%)	Totan N (%)	Available nutrients (kg ha^{-1})		
			N	P_2O_5	K_2O
T_1 RD NPK through fertilizers + normal tillage	0.70	0.060	278	40.8	368
T_2 RD N through organics + normal tillage	0.72	0.057	274	39.2	373
T_3 RD N through organics + minimum tillage	0.72	0.056	271	38.7	362
T_4 50% RD N through organics + normal tillage	0.71	0.055	268	36.1	359
T_5 50% RD N through organics	0.71	0.055	261	35.2	354
T_6 50% RD N through organics + 50% RD N through fertilizers + normal tillage	0.73	0.061	285	41.8	384
T_7 Control + normal tillage	0.65	0.050	231	33.8	345
T_8 Contro + minimum tillage	0.61	0.048	226	31.8	323
SE $\pm$ (m)	0.023	0.00068	0.87	0.24	3.79
CD at 5%	0.072	0.00204	2.71	0.75	11.70
Initial value	0.067	0.0537	244	33.3	336

LITERATURE CITED

Dhua, S.P., 1975. Organo-mineral fertilizer, A necessisity for Indian Agriculture, Econ. And Political Weekly 10 (5) : 619-623.

Helkiah, J. T.S. Manickam and K. Nagalakashami, 1981. Influence of organic manures alone and in combination with inorganics on properties of black soil and jowar yield. Madras agric. J. 68 (6) : 361-365.

Hundeker, S. T., V.P. Badanur and T. Satyanarayana, 1991. Influence of crop resides in conjuction with fertilizers on soil fertility, nutrient uptake and yield of sorghum. Karnataka J. agric. Sci. 10(1) : 25-31.

Jackson, M.L., 1958. Soil Chemical Analysis, Prentice Hall, Inc., Englewood cliffs, N.J., USA.

Rajeshkumar and K.P. Singh, 1996. Long term effect of fertilizer, lime and FYM on yield, nutrient uptake by soybean and soil properties. J. Res. Birsa Agric. Uni. 8 (2) : 115-118.

Rajput, A.M., V.N. Shroff and S.Z. Deshpande, 1995. Impact of mixed organic farming (O.M. + fertilizer) on soybean and potato. J. Crop. Res. 19(3) : 258-260.

Ramamurthy, B. and J.C. Bajaj, 1969. Available nitrogen, phosphorous and potassium status of Indian soils, Ferti. News 14 : 1-22.

Subbiah, B.B. and G.L. Asija, 1956. A rapid procedure for determination of available nitrogen in soil. Current Sci. 25 : 256-260.

PKV Res. J. Vol. 24 (2) : 2000

Seed Mycoflora of Foxtail and Proso Millet Seeds in Vidarbha and Their Control

Manjusha Gaikwad[1], A.R. Thakare[2] and P.K. Paulkar[3]

ABSTRACT

Seed samples of foxtail millet (*Setaria italica*) and proso millet (*Panicum miliaceum*) collected from two locations of Vidarbha during 1993 and 1994 showed association of 13 and 10 fungi, respectively. Prominent seed borne disease causing fungi of foxtail millet were *Curvularia lunata, Cochiliobolus nodulosus, Fusarium moniliforme* and *Phoma sp.* and that of proso millet, *C. nodulosus*. Among 10 seed treatment the funficides or their combinations, over all, captan, TMTD and carbendazim + iprodion proved most effective against fungi of both the millets.

Foxtail or Italian millet or rala (*Setaria italica* (L) Beauv.) and proso millet (*Panicum miliaceum* L.) are important minor millets grown in various parts of India. Foxtail millet is affected by several diseases like smut (*Ustilaya crameri*), downy mildew (*Sclerospora graminicola*), rust (*Uromyces setariae italica*), blast (*Pyricularia setariae*) and leaf spot or bloth (*Cochiliobolus setariae*) whereas proso millet by head smut (*Sphacelotheca destruens*), downy mildew (*Sclerospora graminicola*) and blast (*Pyricularia grisea*) considering the losses due to the above fungi to the minor millets, and as meagre work reported by Goel *el al.* 1967, Prasad and Narayan, the present investigation was undertaken.

MATERIAL AND METHODS

Seed samples of following susceptible varieties of foxtail and proso millet were collected from two locations of Vidarbha.

Years	Crop entries		Locations
1993	Foxtail millet	SIC-3, RAS-60 and SIA-326	Regional Res. Centre (RRC), Amravati
		SIC-3 and SIC-326	Agril. Res. Station (ARS), Buldana
1994	Foxtail millet	SIC-2622 and SIA-2644	RRC, Amravati
		SIA-326	ARS, Buldana
1993	Proso millet	Co-2 and K-1	RRC, Amravati
		Co-2 and K-1	ARS, Buldana
1994	Proso millet	TNAV-89 and MS-1623	RRC, Amravati

Four hundred seeds of each sample were planted on three layers of moist blotter (25 seeds plate^{-1}) and incubated at room temperature (23 to 30^{0}C) under 12 h light and 12 h darkness cycle for 7 days. Fungi were detected by using stereoscopic microscope. Sample lots of 1993 were tested from July 1994 onwards and those of 1994 between November 94 and February 1995.

Efficacy of 10 fungicides and their combinations viz. TMTD (Teramethyl thiuram disulphide) (Thiram), Captan (captaf), Iprodion (Rovral). Carbendazim (Bavistin), TMTD + Carbendazim (1:1 Proportion), TMTD + Iprodion (1:1), TMTD +Captan (1:1), Carbendazim + Iprodion (1:1), Carbendazim + Captan (1:1) and Captan + Iprodion (1:1), all at the rate of 0.3 per cent were tested by treating seeds of two foxtail millet entries (SIC-3 and SIA-326) and two of proso millet. Four hundred fungicide treated and 400 untreated seed were tested by blotter method (ISTA, 1985) for fungi and for germination equal number of seeds by paper towel method (ISTA, 1985).

RESULTS AND DISCUSSION

Seed borne fungi of foxtail millet varied with the year of cultivations, genotype of crop and location. Thirteen fungi viz. *Alternaria alternata* (0 to 5.5% of seeds), *Aspergillus niger* (0 to 23%), *Cladosporium oxysporum* (0 to 1.5%), *Curvularia lunata* (0 to 14.5%), *Cochiliobolus nodulosus* (0 to 10%). *Drechaslera maydis* (0 to 1%). *D.tetramera* (0 to 5%), *Fusarium moniliforme* (0 to 1.5%), *F. semitectum* (0 to 1%), *Penicillium sp.* (0 to 27.5%), *Phoma sp.* (0 to 3.5%). *Pyricularia grisea* (0 to 1.5%) and *Stemphyllium sp.* (0 to 2.5%) were found associated with

1. Senior Res. Asstt., Sorghum Research Unit, 2 & 3 Senior Research Fellow, Dept. of Plant Pathology, Dr. PDKV, Akola

Table 1. Percentage of seed of various entries of foxtail millet showing association of fungi

Fungi	1993					1994		
	SIC-3		RAS	SIA-326		SIC-2622	SIA-2644	SIA-326
	Amt.	Bul.	Amt.	Amt	Bul.	Amt.	Amt.	Bul.
Alternaria alternata	-	-	2.0	3.5	1.5	-	-	5.5
Aspergillus niger	23.0	23.0	0.5	-	-	-	-	0.5
Cladosporum oxysporum	-	-	1.5	-	1.5	1.5	0.5	-
Curvularia luanata	-	-	13.0	10.5	7.5	1.5	1.0	14.5
Cochliobolus nodulosus	-	-	2.0	10.0	1.0	7.5	4.0	2.5
Drechslera maydis	-	-	-	-	1.0	-	0.5	-
D. tetramera	-	-	-	-	-	4.5	5.0	-
Fusarium monoliforme	0.5	0.5	1.5	0.5	0.5	-	-	-
F. semitectum	-	-	-	-	-	1.0	-	-
Penicillum sp.	27.0	27.0	-	1.5	-	-	-	-
Phoma sp.	0.5	0.5	0.5	3.0	1.5	1.5	1.5	3.5
Pyricularia grisea	-	-	-	-	-	-	-	1.5
Stemphyllium sp.	-	-	-	-	2.5	-	-	-

Amt - Amravati Bul. - Buldana

Table 1. Percentage of seed of various entries of proso millet showing association of fungi

Fungi	1993				1994	
	Co-2		K-1		TNAV-87	MS-1623
	Amt.	Bul.	Amt.	Bul.	Amt.	Amt.
Aspergillus sp.	-	32.5	2.0	1.5	-	-
Curvularia luanata	3.0	1.0	0.5	1.5	-	-
Cochliobolus nodulosus	-	-	0.5	-	21.0	-
Drechslera tetramera	-	-	-	-	2.0	-
Exserohilum halodes	-	-	-	-	0.5	-
Fusarium moniliforme	-	-	1.0	-	-	-
F. semitectum	-	-	0.5	-	0.5	-
Penicillium sp.	3.5	24.5	1.0	3.5	-	10.5
Phoma sp.	-	-	-	0.5	1.0	-
Rhizopus stolonifer	-	-	-	-	-	8.5

Amt - Amravati Bul. - Buldana

seeds of six entries (Table 1). Seed produced at both locations (Amravati and Buldana) in 1993 carried more seed rot and/or disease causing fungi like *Curvularia lunata, C. nodulosus, F. monilioforme* and *Phoma sp.* than in 1994. In 1993, between grainfilling and seed maturity stage (37th to 40th meteorological weeks) the total precipitation was 141.0 mm spread over 8 days at Amravati and 90.6 mm spread over 11 days at Buldana whereas in 1994 during the same period precipitation was only 24.0 mm spread over 2 days at Amravati and 34.3 mm spread over 5 days at Buldana. Between same meteorological weeks, the maximum temperature at Amravati ranged from 31.1 to 32.2°C in 1993 and from 32.0 to 33.7°C in 1994 whereas as at Buldana the temperatures were 27.4 to 29.3°C in 1993 and 28.8 to 29.9°C in 1994. It was thus evident that frequent rains at seed development stages probably played a crucial role in causing more seed infection. Among crop entries of foxtail millet, seeds of SIC-3 appeared to be more tolerant to disease causing fungi at both locations of Vidarbha.

Seed samples of proso millet of 4 entries showed association of 10 fungi viz. *Aspergillus sp.* (0 to 32.5% of seeds) *Curvularia lunata* (0 to 3%), *Cochilobolus nodulosus* (0 to 21%), *Drechslera tetramera* (0 to 2%), *Exserohilum halodes* (0 to 0.5%), *Fusarium moniliforme* (0 to 1%),

Table 3. Association of fungi and germination of fungicide treated and untreated seeds of two entries of foxtail millet

Fungi	Control		Carbendazim		Captan		Iprodion		TMTD		Carbendazim + Iprodion		Carbendazim + TMTD		Cabendazim + Captan		Captan + Iprodion		Captan + Iprodion		TMTD + Captan	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Alternaria alternata	1.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aspergillus sp.	1.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladosporium oxysporum	1.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cochliobolus nodulosus	6.75	2.50	-	-	1.25	-	-	-	-	-	-	-	-	-	0.75	-	-	-	0.50	-	-	-
Curvularia luanata	6.75	14.5	0.25	-	0.25	-	-	-	-	-	-	-	0.25	-	0.5	-	-	-	-	-	0.25	-
Fusarum monoliforme	2.0	-	-	-	-	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penicillium sp.	1.5	-	-	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phoma sp.	1.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Percentage of seed *germination*	88.0	82.0	85.6	86.5	97.25	94.0	94.25	85.5	85.2	92.5	92.2	86.0	91.25	88.75	95.25	84.0	92.0	92.0	93.2	88.2	93.2	86.7

1. SIC - 3 (1993) 2. SIA - 326 (1994)

Table 4. Association of fungi and germination on fungicide treated and untreated seeds of two entries of proso millet

Fungi	Control		Carbendazim		Captan		Iprodion		TMTD		Carbendazim + Iprodion		Carbendazim + TMTD		Cabendazim + Captan		Captan +Iprodion		Captan +Iprodion		TMTD +Captan	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Aspergillus sp.	5.0	0.25	0.5	-	-	-	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cochliobolus nodulosus	-	21.0	-	10.0	-	10.0	-	6.5	-	5.5	-	-	-	4.0	-	2.0	-	8.0	-	2.0	-	12.0
Curvularia luanata	5.5	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drechslera halodes	3.5	0.5	-	-	-	-	-	-	-	-	-	-	-	-	0.75	-	-	-	0.50	-	-	-
Drechslera tetramera	0.5	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusarium semitectum	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penicillium sp.	4.5	-	2.75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-
Phoma sp.	-	1.0	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-
Percentage of seed germination	4.5	4.5	1.0	7.25	1.0	11.0	1.0	3.75	0.5	6.0	3.0	2.25	1.5	7.5	4.5	5.75	2.5	3.5	3.5	7.0	3.25	9.5

1. K-1 (1993) 2. TNAV - 87 (1994)

Fusarium semitectum (0 to 0.5%), *Penicillum sp.* (0 to 24.5%), *Phoma sp.* (0 to 1%) and *Rhizophus stolonifer* (0 to 8.5%) (Table 2). Results showed that among infections fungi, counts of *Cochliobolus nodulosus* was considerably high (21%) in a crop entry TNAV-87 grown at Amravati. This fungus causes leaf spot disease in lower millet. Hence, under field conditions, entry TNAV-87 needs to be watched for susceptibility to leaf spot disease.

In general, proso millet seed appeared less prone to fungal infections compared to foxtail millet. All the fungicides proved effective in reducing seed borne fungi of foxtail millet and improved the germination over control (Table 3). Among fungicides, over all, Captan, TMTD and Carbendazim + Irpodion appeared better.

Like foxtail millet, all fungicides proved effective against seed borne fungi of proso millet also (Table 4). However, surprisingly both treated and untreated seeds of proso millet showed less than 10 per cent germination during both the years and hence effectiveness of fungicides in improving germination could not be ascertained.

LITERATURE CITED

Goel, L.B., S.B. Mathur and L.M. Joshi, 1967. Seed borne infection of *Pyricularia setariae* in *Setaria italica*. Plant Dis. Reptr. 51 (2) : 138.

Grewal, J.S. and M. Pal, 1965. Seed borne fungi of ragi, their distribution and control. Indian Phytopath 18 : 33-37.

ISTA, 1985. International Rules for Seed Testing. International Seed Testing Association, Zurich, Switzerland : 1-520.

Kapkoti, N., H.S. Nayal and K.N. Pandey, 1989. Seed Mycoflora of millets and their control by fungicides. Madras Agric. J. 76 (2) : 710-711.

Prasad, B.K. and N. Narayan, 1981. Seed borne fungi of some millets. Geobios 8(1): 47-48.

PKV Res. J. Vol. 24 (2) : 2000

Comparative Study of Different Methods of Cotton Stalk Removing

C.N. Gangade[1], P.G. Patil[2] and S.S. Dhanphule[3]

ABSTRACT

A comparative study on different methods of cotton stalk removing was carried out. Cost of opertion, effective field capacity and energy requirement of the different methods of cotton stalk removing under study were calculated and it was concluded that though the cost of operation is high in case of tractor drawn implements or machinery. It is recommended to use slasher or 'V' blade for removing the cotton stalks.

The development of cotton stalk uprooting initiated in Gezira (Pothecary *et al.*, 1968). National Institute of Agril. Engg. (NIAE) England developed a machine to pull cotton plants. Mohammad Yusuf (1968) mentioned that more work with pulling machine was completed in 1964 and the first machine was developed known as body machine. The uprooter shredder mulcher (U.S.M.) used in U.S.A. for three consecutive years, mainly in California, Arizona and Georgia (Bendor, 1990). Force and energy requirements for stalk pulling can be used as a basis for design or development work on pulling machinery (Ghoneim *et al.* 1990). Sonkusale (1987) designed and developed bullock drawn cotton stalk uprooter. Pegasus plough which is a new implement for one pass cotton ploughing was developed at the University of Arizona. U.S.A. during a project reducing dust emission from tillage (Thacker, 1997).

MATERIAL AND METHODS

The farmers use different types of traditional and improved methods for cotton stalk removing. Recently, two new machines have been introduced at A.C.D.P., Akola for removal of the cotton plants. Therefore, the study was undertaken to know cost of operation, effective field capacity and energy requirement in the different methods. So as to compare them for adaption for cotton stalks removal in our region.

Effective Field Capacity :

For the measurement of effective field capacity crop area was selected randomly and the machines were put in operation continusouly for 1 hr. and after one hour the uprooted area was measured.

Speed of operation :

The speed of operations were measured by recording the time required to cover one row. Time required for turning was also recorded.

Plant removing efficiency :

The plant removing efficiency of machine was calculated by recording the number of plant present in each row and number of plants uprooted by machine from respective rows. Plant removing efficiency was calculated by the following formula.

$$\text{Plant removing efficiency} = \frac{Pu}{Pp} \times 100$$

Where,

Pu - No. of plants uprooted from each row

Pp - No. of plants present in each row.

Cost of operation :

Data required for the evaluation of cost of operation and comparison of different cotton stalk removing methods was collected from different fields. These methods were compared by calculating the operational charges of tractor and implements 1 hr. basis.

Energy requirement :

The energy utilized in different methods was calculated from the data using following formula. To make the energy comparable, the power was converted into energy equivalent on the assumption that one adult man on an average develops 0.1 HP (0.0746 kW) and a pair of bullok develops 1 HP (0.746 kW).

The formulae used for calcuating energy requirement are as follows :

a) Mechanical energy (cal) = Quantity of diesel (lit) x Calorific value of diesel (cal/kg) x Thermal efficiency (%)

b) Human energy (hp - hr) = 0.1 x No. of human labour x Hrs. of operation x No. of operation followed

1. Associate Prof., Dept. of Farm Power and Machinery, 2. & 3 Students, B.Tech. (Agril. Engg.), CAE & T, Dr. PDKV, Akola

RESULTS AND DISCUSSION

Comparative study of different methods of cotton stalk removing involves measurements of performance under real farm conditions. The performance can be expressed in terms of effective field capacity, plant removing/cutting efficiency, energy requirment and cost of operation (Table1).

It is seen from Table 1 that to remove cotton stalks from 1 ha area 23.8 hrs are rquired by hand pulling, 23.5 hrs by manually operated puller, 1.02 hrs by tractor operated uprooter 1.42 hrs by tractor operated slasher and 2.5 hrs by tractor drawn 'V' blade. It is seen that the tractor operated machines are very fast in working bacause of the speed of the tractor and the working width.

The tractor operated slasher works at a speed of 15 km hr^{-1} with a slashing width of 188 cm, 'V' blade is operated at the speed of 17 km hr^{-1} with the width of coverage 180 cm and tractor operated uprooted works with a speed of 15 km hr^{-1} and working width of 192 cm.

It is also evident from Table 1 that the plant uprooting / cutting efficiency is 100 per cent in case of hand pulling, manually operated puller and tractor operated slasher. Whereas, tractor drawn 'V' blade shows 99 per cent efficiency in plant removing and tractor operated uprooted has 80 per cent efficiency of stalk removing. The plant removing efficiency in case of tractor operated uprooted was less because branches of the cotton plants were not coming in the grip of counter rotating tyres for stalk pulling.

It is observed from the Table 1 that the energy required for removing the cotton stalks by hand pulling and manually operated puller is 0.258 MJ and tractor operated uprooted is 24.59 MJ. While the energy requirement by tractor operated slasher and tractor drawn 'V' blade is 48.45 MJ and 29.34 MJ respectively. The energy requirement is higher in tractor drawn machinery because of high hp tractor used. In case of tractor operated uprooted energy required is 24.59 MJ as it is operated by 60 hp tractor and the fuel consumption is highest among these machines. The energy requirement in case of 'V' blade is 29.34 MJ because the fuel comsumption is more than the tractor operated uprooter.

The Table 1 shows that the operating cost required for hand pulling is Rs. 9 hr^{-1}, for manually operated puller the cost of operation is Rs. 19 hr^{-1}. and for tractor operated uprooter, tractor operated slasher and tractor drawn 'V' blade the cost of operation comes out to be Rs. 625, 275 and 248 hr^{-1} respectively. The cost of operation and the time required for removing 1 ha. area is presented in Fig. 1.

Conclusions :

The important conclusions drawn from the above study are as follows -

1. Time required for removing 1 ha area requires less time for tractor operated uprooter i.e. 1.02 hrs. for tractor operated slasher time required is 1.42 hrs. and for tractor drawn 'V' blade requires 2.5 hrs.

   Whereas, the plant removing/ uprooting efficiency for the tractor operated uprooter, tractor operated shasher

Table 1. Comparative study of different methods of cotton stalk removing/uprooting

S.N.	Parameters	Different methods of cotton stalk removing				
		Hand pulling	Manually operated chimta	Tractor operated uprooter	Tractor operated slasher	Tractor drawn 'V' blade
1.	Variety of cotton	AHH-468	AHH-468	PKV hy-4	Rajat	AKH-4
2.	Spacing (cm)	76 x 76	76 x 76	96 x 50	94 x 37	60
3.	Stem dia (cm)	1.8	1.8	2.2	2.25	0.79
4.	Depth of tap root (cm)	23	23	37	32	19
5.	Moisture content, % (with date)	11.38 22/5/99	11.38 22/5/99	16.5 6/3/99	– 9/4/99	8.8 23/5/99
6.	Area covered (ha hr^{-1})	0.042	0.043	0.980	0.70	0.40
7.	Area covered (ha day^{-1} of 8 hr)	0.336	0.344	7.84	5.6	3.2
8.	Time required for uprooting 1 ha area in hr	23.80	23.50	1.02	1.42	2.5
9.	Plant uprooting efficiency (%)	100	100	80	100	99
10.	Fuel consumption (Lit. hr^{-1})	–	–	2.5	4	3
11.	Energy consumption (MJ)	0.258	0.258	24.39	48.45	29.34
12.	Prime mover	Manual	Manual	Tractor 60 hp	Tractor 60 hp	Tractor 45 hp
13.	Cost of operation (Rs. hr^{-1})	9	19	652	275	248

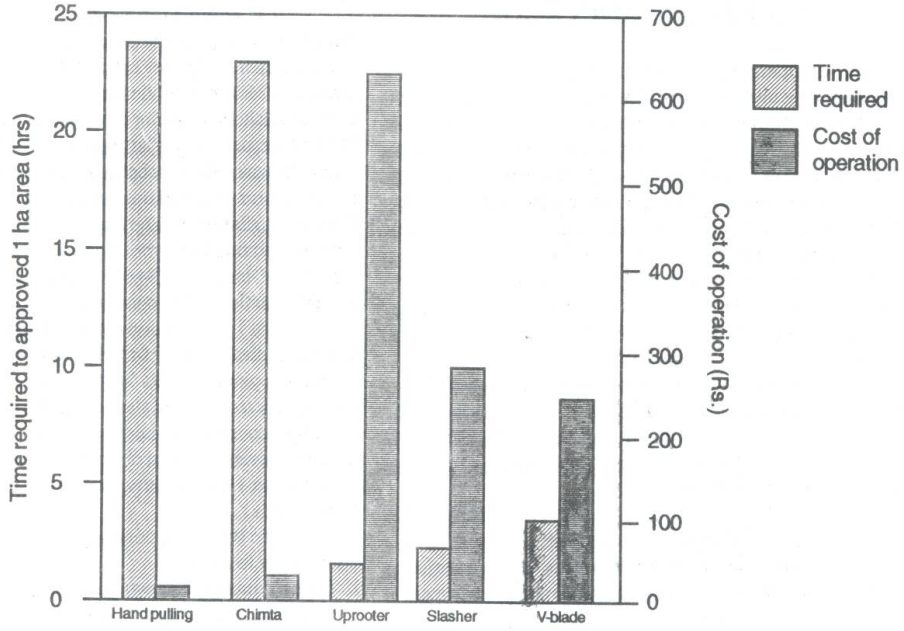

Fig. 1. Comparison of different methods of cotton removing/uprooting in terms of time requirement and cost of operation

and tractor drawn 'V' blade was found 80 per cent, 100 per cent and 99 per cent respectivley.

2. Energy required for removing / uprooting the cotton stalks by tractor operated uprooted, tractor operated shasher and tractor drawn 'V' blade is 24.39 MJ, 48.45 MJ and 29.34 MJ. Whereas for hand pulling and manually operated puller was found 0.258 MJ.

From the Table 1 it is also concluded that the removing operation by hand pulling and manually operated puller needs 23.8 and 23.5 hrs. to remove 1 ha area respectively. The time required by tractor operated uprooter, tractor operated slasher and tractor drawn 'V' blade to remove 1 ha area is 1.02, 1.42 and 2.5 hrs respectively. Considering the recent shift of farm labours and their own availability on the farm the timeliness of operation is the very important factor. Though the cost of operation is high in case of tractor drawn implements, it is recommended to use or 'V' blade for removing / uprooting the cotton stalks as the cost of operation and plant removing efficiency is almost same in both of these machines.

LITERATURE CITED

Bendor, Y., 1990. Beltwide cotton production conference, Las Vegas, USA : 10-11.

Choniem, K.Y. and M.N. Nikib, 1990. Cotton stalk pulling force and energy requirement. International conference on Agril. Mechanisation, Zaragoza, Spain, Vol (I): 283-287.

Mohammad Yusuf, 1976. Increased power from domestic animals. Agriculture Engineer : 89-92

Pothecary, B.P. and R.J. Ofield, 1968. Destruction of old cotton for pest and disease control, World crops : 39-43

Sonkusale, D.S., 1987. Design development and evaluation of cotton stalk uprooter. Unpublished thesis PKV, Akola

Thacker, G.W., 1997. National cotton council, Pegasus Machinery Company, Tuscon, Arizona, USA : 56-57.

PKV Res. J. Vol. 24 (2) : 2000

ET Prediction of Some Crops Under Semi-arid Region of Western Vidarbha

M.R. Zade[1] and S.S. Hiwase[2]

ABSTRACT

The ET of some crops at four locations of semi-arid region of Western Vidarbha were obtained from climatic parameters using the guideline suggested by Doorenbos and Pruitt (1977). The value were 1782.00 - 2098.87 mm for sugarcane, 472.95 - 569.91 mm for wheat, 694.00 - 833.85 mm for cotton and 728.77 - 816.15 mm for summer groundnut. Variation in crop evapotranspiration was observed at each location due to climatic variation.

Information on evapotranspiration of crops of a region is essential for design and operation of irrigation system/ project. Knowing the area of crops to be grown and their water requirement, it is possible to plan the water resources for storage and distribution from reservoir, ponds, lakes etc. Owing to the difficulty of obtaining the accurate direct field measurement and those methods are however, laborious, costly and time consuming. Therefore, estimate of reference evapotranspiration is generally based on histrorical climatological data. The approaches followed are to relate the magnitude and variation of evapotranspiration to one or more climatic factors such as temperature, day length, humidity, wind velocity, sunshine etc.

MATERIAL AND METHODS

The guideline and methodology given by Doorrenbos and Pruitt (1977) was followed for estimating crop evapotranspiration (ET crop) of principal crops grown in Western Vidarbha viz. Akola (Lat. 20° 70' N, Long. 77° 00' E, ht above MSL 307.41 m), Amravati (Lat 20° 89' N, Long. 77° 32' E, ht above MSL 370.0 m), Yavatmal (Lat.24° 84'N, Long. 78° 58'E, ht above MSL 451.00 m) and Buldana (Lat. 20° 34' N, Long. 75° 98' E, ht above MSL 650.00m). The steps followed were as below.

Reference crop evapotranspiration :

Reference crop evapotranspiration which is defined as the rate of ET from an extensive surface of 8 to 10 cm green grass cover of uniform height, actively growing, completely shading the ground and no restriction of moisture. Reference crop evapotranspiration (ETo) is an account of various climatic factors. There are four methods of estimating ETo viz, Blaney-Criddle, Thornthwaite, Penman and Christiansen. The Panman's method has been used for present study as it gives accurate and reliable result (Mohan, 1991).

ETo values have been computed using weekly meteorological data collected from IMD, Pune for the year 1970 to 1995. Penman's method requires values for adjustment factor 'C' obtained from tables. Since using table is cumbersome and introduce uncertainities, therefore, analysis approach has been followed and equation for correction factor is used as suggested by Kotsopoulos and Babajimopoulos, 1997.

Kc Values :

The estimates of ET crop required value of crop coefficient. (Kc) have been calculated by method suggested by Doorenbos and Pruitt (1977). The Kc values vary with crop growth stages and hence following stages of crop development were taken in to consideration.

Initial stage	-	Sowing to germination
Crop development stage	-	Initial stage of effective full ground cover
Mid season stage	-	Crop development stage to start of maturity
Late season stage	-	Mid season stage to attainment of maturity

Data on planting date, irrigation frequency and Kc values for initial stage have been taken from local sources.

Factors affecting ET crop :

The important factors which ET crop gets affected are variation with time, distance, altitude, date of planting, ground cover, day-night wind condition, etc. The above factors singly or in combination, may change the ET crop.

RESULTS AND DISCUSSION

Predicted values of crop evapotranspiration according to crop growth stage are presented in Table 1.

The seasonal crop evapotranspiration of sugarcane was found to 2034.39, 2098.87, 1899.25 and 1782.06 mm for Akola, Amravati, Yavatmal and Buldana respectively. Estimated values were higher than reported by Subramaniam and Rao 1985 at Pune station which was 1573.3 mm. Whereas, Kadam *et al.* 1978 reported water requirement of sugarcane as about 2237.60 mm. Predicted values of ET crop of sugarcane at Buldana and Yavatmal were lower than other

1. P.G. Student, 2. Head, Dept. of Irrigation and Drainage Engineering, Dr. PDKV, Akola

Table 1. Crop evapotranspiration, ET crop values of some crops of Western Vidarbha

Crops	Planting	Initial state				Crop development stage				Mid season stage				Late season stage				Total	Seasonal
	weeks	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	growing period (weeks)	ET crop (mm)
I) Akola																			
Sugarcane	01	4	0.52	137.70	71.60	17	0.71	971.46	689.73	21	1.14	785.89	895.90	10	1.00	377.16	377.16	52	2034.39
Wheat	44	2	0.48	77.00	36.96	4	0.79	145.11	114.63	7	1.08	245.14	264.75	4	0.63	171.78	108.22	17	524.56
Cotton	21	4	0.51	231.17	118.16	7	0.77	262.50	202.12	8	1.06	252.07	267.19	7	0.85	270.00	229.50	26	816.97
Groundnut	05	4	0.48	171.78	82.45	5	0.85	255.64	217.30	6	0.95	395.78	375.99	2	0.68	148.26	100.81	18	776.55
II) Amravati																			
Sugarcane	01	4	0.52	148.47	77.20	17	0.71	1027.20	729.34	21	1.14	788.48	898.86	10	1.00	393.50	393.50	52	2098.87
Wheat	44	2	0.48	82.81	39.74	4	0.79	152.25	120.27	7	1.08	258.02	278.66	4	0.63	208.32	131.24	17	569.91
Cotton	21	4	0.51	176.33	89.92	7	0.77	251.44	193.60	8	1.06	269.85	286.04	7	0.85	310.94	264.29	26	833.85
Groundnut	05	4	0.48	209.02	100.32	5	0.85	300.37	255.31	6	0.95	402.85	382.70	2	0.68	115.71	78.68	18	816.95
III) Yavatmal																			
Sugarcane	01	4	0.52	130.20	67.70	17	0.71	936.81	665.13	21	1.14	748.58	853.38	10	1.00	313.04	313.04	52	1899.25
Wheat	44	2	0.48	65.38	31.38	4	0.79	123.79	97.71	7	1.08	220.15	237.76	4	0.63	170.10	107.16	17	474.01
Cotton	21	4	0.51	203.28	103.67	7	0.77	253.47	195.17	8	1.06	245.98	260.73	7	0.85	237.30	201.70	26	761.27
Groundnut	05	4	0.48	170.10	81.64	5	0.85	257.04	218.48	6	0.95	376.81	357.90	2	0.68	127.19	86.48	18	744.56
IV) Buldana																			
Sugarcane	01	4	0.52	135.94	80.68	17	0.71	914.62	649.38	21	1.14	668.78	762.40	10	1.00	299.60	299.60	52	1782.06
Wheat	44	2	0.48	64.82	31.11	4	0.79	119.63	94.50	7	1.08	219.66	237.23	4	0.63	174.79	110.11	17	472.95
Cotton	21	4	0.51	182.56	93.10	7	0.77	217.91	167.79	8	1.06	221.69	234.99	7	0.85	233.10	198.13	26	694.01
Groundnut	05	4	0.48	174.80	83.89	5	0.85	261.87	222.58	6	0.95	360.36	342.34	2	0.68	117.60	79.96	18	728.77

A - Duration in weeks, B- Kc value, C-Reference crop evapotranspiration mm (ETo), D- Crop evapotranspiration mm (ET crop)

two location. This indicates the fact that sugarcane can be economically grown in Buldana and Yavatmal since rainfall at Yavatmal is higher by about 20 to 30 per cent than other three locations, thereby amount of irrigation needed is comparatively less. In case of Buldana, the water requirement is less and therefore irrigation needs of the crop are lower.

The ET crop values of wheat were found to be 542.26, 569.91, 474.01 and 472.94 mm at Akola. Amravati, Yavatmal and Buldana, respectively. The estimated value of ET crop shows that wheat crop requires more water to meet its requirement at Amravati followed by Akola, Yavatmal and Buldana. ET crop of wheat is nearly equal at Yavatmal and Buldana. ETc value was in close agreement with the estimated by Gadekar and Patil, 1990 at Nagpur which was about 565.18 mm. Estimated values were higher as compared to predicted value by Kadam *et al.* 1978 and Subramaniam and Rao, 1985 due to climatic variation, planting period and duration of crops.

Estimated values of water requirement of cotton were found to be 816.97, 833.85, 761.27 and 694.01 at Akola, Amravati, Yavatmal and Buldana, respectively. As seen from ET crop of cotton , that crop needs comparatively less water at Yavatmal and Buldana than Akola and Amravati. Differences in ET crop are attributed to the variation in temperature and RH as the average annual temperature at Buldana and Yavatmalranges between 29.64°C to 18.73°C and in case of Amravati and Akola it ranges, from as high as 35.08°C to 21.94° C. Whereas, mean RH varies from 80.30 to 28.40 per cent at Buldana and Yavatmal and 76.85 to 23.14 per cent at Amravati and Akola.

Similar results were obtained by Kadam *et al.* 1978 who reported the water requirement of cotton as 837.37 mm at Parbhani. Gadekar and Patil (1990) reported the ET crop of cotton to be 939.80 mm in Nagpur agroclimatic conditions.

The ET crop of summer groundnut were found out to be 776.55, 816.95, 744.56 and 728.77 mm at Akola, Amravati, Yavatmal and Buldana, respectively. Subramaniam and Rao, 1985 reported water requirement of *Kharif* groundnut as 350.00 to 390.40 mm at various climatic conditions of Pune, Jalgaon, Akola and Nagpur. The estimated ET crop in present study was much higher than those reported in literature because of the change in sowing period of groundnut that is taken in 1st week of February i.e. 5th met. week and reference crop evapotranspiration value in the *summer* was much higer than rainy and winter season. The short *summer* groundnut required two times more water to meet its ET crop demand than *kharif* groundnut. Therefore, economics of *summer* groundnut needs to be considered before sowing, as the total seasonal water requirement of *summer* groundnut needs to satisfy by developing the surface as well as ground water resources only.

In general Akola and Amravati has higher ET crop than Yavatmal and Buldana for the crops in consideration and from difference in ET crop in the region one can imagine the economic of water for growing crops at different stations.

LITERATURE CITED

Doorenbos, J. and W. O. Pruitt, 1977. Guidelines for predicting crop water requirement. FAO Irrigation and Drinage paper No. 24.

Gadekar, S.R. and V.P. Patil, 1990. Climatological water requirement of some *kharif, rabi* and *summer* crops under Nagpur agroclimatic condition. PKV Res. J. 14 (2) : 141-147.

Kadam, D.M., G. Ramkrishna Rao and S.B. Varade, 1978. On predication of reference crop ET and comsumptive use of different crops. Annals of Arid Zone. 17 (1) : 99-110.

Kotsopoulos, S. and C. Babajimopoulos, 1977. Analytical estimation of Modified Penman equation parameter. J. Irrigation and Drainage Engg. ASCE 123 (4) : 253-256.

Mohan, S., 1991. Intercomparison of ET estimate. Hydral Science J. 366 : 447-460.

Subramaniam, A. R. and A. Sambasiva Rao, 1985. Prediction of ET of some crops under semi-arid and dry humid climate of Maharashtra. Mausam 36 (1) : 67-70.

PKV Res. J. Vol. 24 (2) : 2000

Probability Analysis of Rainfall at Akola, Maharashtra

A.R. Pimpale[1], S.S. Hiwase[2], P.A. Gawande[3] and P.G. Patil[4]

ABSTRACT

The knowledge of rainfall pattern (amount and probability) helps in planning of crops grown in the region and also in the watershed management. Therefore monthly and annual rainfall data for 29 years (1970-1998) for the station Akola has been collected and its analysis has been attempted. The monthly rainfall data has been analysis for finding out drought, normality and abnormality probability. The analysis indicated that the rainfall is mainly confined in four months of June to September having average annual rainfall 825.11 mm. August is the wettest month (average rain-222.0 mm) and April is the driest month (average rain -3.82 mm). August have good regularity of rainfall (C.V. 46.0%). Next to August rainfall in July and June is also regular (C.V. 47 and 55%, respectively) whereas in April and March it is most irregular (C.V. 193 and 184 %). The S.D. and C.V. for annual rainfall were found to be 192.8 mm and 23.0 per cent respectively.

Rainfall distribution varies greatly over time and space. Its analysis over a number of years helps in crop planning. Most of the watershed management treatments are based on the amount, intensity and distribution of rainfall of the area. The rainfall suggested the proper management treatment for the study area. the random nature of rainfall occurrence suggested need for sound statistical and its logical interpretation. Therefore, probaility distribution of drought, normal and abnormal events (months and years) were carried out for Akola (M.S.).

MATERIAL AND METHODS

Rainfall data of 29 years, from 1970 to 1998 were collected from Meteorological observatory, Akola, situated at latitude of 20°42' and longitude of 77°2' and 307.4 m above mean sea level. The data were arranged in twelve sets, corresponding to each month where every month has 29 rainfall events. Monthly and yearly events were then classified as drought, normal and abnormal, depending upon the following criteria (Sharma, *et al.* 1979).

If $\bar{x}$ is the mean monthly rainfall, the month receiving rainfall less than A_1 is defined as drought month, in-between A_1 and A_2 is normal month and above A_2 is abnormal month, where, $A1 = \bar{x}/2$ and $A2 = 2\bar{x}$. Also $\bar{y}$ is mean annual rainfall the year is said to be drought, normal and abnormal when it receives rainfall less than, in the interval $[(\bar{y} - s), (\bar{y}+s)]$ and above $\bar{y} + s$ where s is the standard deviation of yearly rainfall.

Test for trend in time series :

If the observations in given series are ranked in increasing order of magnitude R_t, then correlation between these ranks and numbers x_t representing a natural number of the observations can be used for detection of trend in a series (Kanji, 1995).

Rank correlation is given by :

$r = 1 - 6S/n(n^2-1)$

where,

$S = \Sigma(x_t - R_t)^2$

also for $n > 10$ (large samples) the test statistics $T = [6S-n(n^2-1)/(n+1)/(n+1)\sqrt{n-1}]$ may be compared with the tables of standard normal distribution.

RESULTS AND DISCUSSION

Estimation of mean, standard deviation and coefficient of variation for monthly and annual rainfall series have been worked out and shown in Table 1. August is the wettest (average rain = 222.0 mm) April is the driest month with verage rainfall of just 3.82 mm. The wettest month next to August is July and June have 46 and 55 per cent coefficients of variation indicating good regularity of rains. April month has highest coefficient of varition i.e. 193.0 indicating irregularity of rains in this month. The months January, February, March, May, October, November and December showed C.V. greater than 100. Assured rainfall may be expected during months of June to September only. Out of 248 months in 29 years drought, normal and abnormal months are found to be 42.24, 46.55 and 11.20 per cent respectively. That is the expected number of drought, normal and abnormal months in a year are 5.06, 5.58 and 1.34 respectively. Table 2 shows probability of drought, normal and abnormal months in a year.

Monthly distribution of drought, normality and abnormality and percentage of total years having a given month as a drought, normal and abnormal is shown in Table 3. Information provided by this analysis may be used for

1. Technical Assistant, T-4 (Agril. Engg.), NRC for Citrus (ICAR), Amravati Road, Nagpur. 2. Head, Deptt. of Irrigation and Drainage Engg., College of Agril. Engg., Dr. PDKV, Akola 3. Research Associate, NRC for Citrus (ICAR), Nagpur 4. Officer Incharge, Ginning Training Centre (ICAR), Nagpur

Table 1. Monthly rainfall statistics at Akola from 1970-1998

Months	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Mean	9.54	8.53	10.1	3.82	10.1	151	212	222	114	52.2	21.9	9.8
S.D.	14.37	10.96	18.65	7.38	18.85	82.68	99.87	101.9	89.18	55.46	10.11	15.45
C.V.	1.51	1.29	1.84	1.93	1.86	0.55	0.47	0.46	0.78	1.06	1.83	1.58
A_1	4.769	4.264	5.06	1.91	5.06	75.43	105.94	111.15	57.012	26.097	10.96	4.89
A_2	19.08	17.06	20.24	7.64	20.24	301.74	423.76	444.6	228.05	104.39	43.82	19.59
DM	17	15	17	19	14	4	4	2	8	12	18	17
NM	7	8	8	8	13	24	25	26	19	10	7	7
AM	5	6	4	2	2	1	0	1	2	7	4	5

A_1 - Drought limit; A_2-Abnormality limit; DM-Drought month; NM- Normal month; AM - Abnormal month

Table 2. Distribution of drought, normal and abnormal months

Drought months (DM)			Normal Months (NM)			Abnormal Months (AM)		
No. of DM	Probability	Years (%)	No. of NM	Probability	Years (%)	No. of AM	Probability	Years (%)
7	0.276	27.59	12	0.035	3.45	3	0.138	13.79
6	0.448	17.24	9	0.070	3.45	2	0.414	27.59
5	0.724	27.59	8	0.105	3.45	1	0.793	37.93
4	0.794	6.89	7	0.208	10.35	0	0.207	20.69
3	0.897	10.35	6	0.145	20.69			
2	0.964	6.89	5	0.760	34.48			
0	0.035	3.45	4	0.932	17.24			
			3	1.00	6.90			

Table 3. Monthly distribution of drought, normality and abnormality

Months	Drought months (DM)		Normal Months (NM)		Abnormal Months (AM)	
	P(D)*	% of months having a given months as DM	P (N)*	% of months having a given months as NM	P(A)*	% of months having a given months as AM
January	0.116	58.62	0.043	24.14	0.128	17.24
February	0.102	57.72	0.049	75.59	0.154	20.69
March	0.116	58.62	0.049	27.59	0.102	17.79
April	0.129	65.62	0.049	27.59	0.051	6.90
May	0.095	48.28	0.080	44.83	0.051	6.90
June	0.027	13.79	0.148	82.76	0.026	6.90
July	0.027	13.79	0.154	86.21	0.00	0.00
August	0.014	6.90	0.160	89.65	0.026	3.45
September	0.054	27.59	0.111	65.52	0.051	6.90
October	0.082	41.38	0.062	34.48	0.179	24.14
November	0.122	62.10	0.043	24.14	0.103	13.79
December	0.155	58.62	0.043	24.14	0.128	17.24

P (D)*, P(N)* and P(A)* are probabilities of drought, normal and abnormal months falling in a given month.

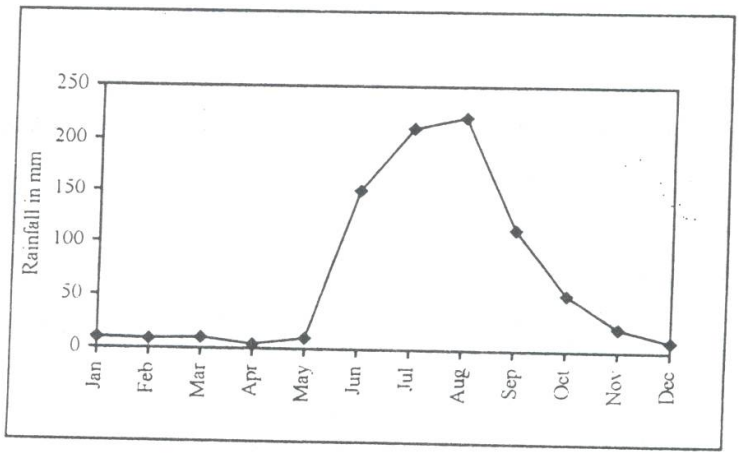

Fig. 1. Mean monthly rainfall at Akola

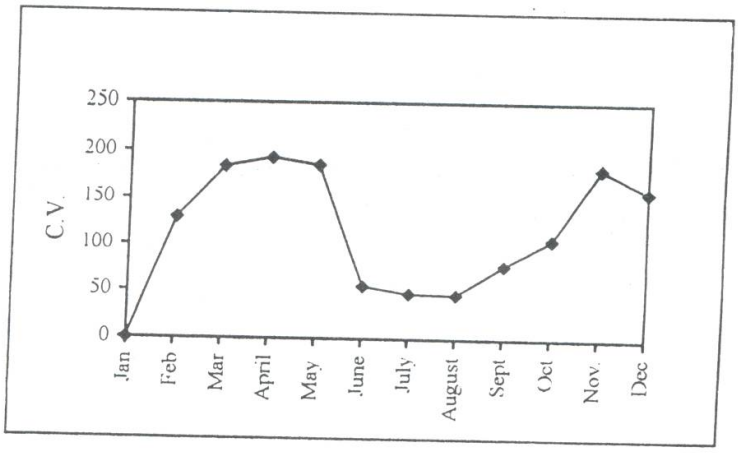

Fig. 2. C.V. plot for rainfall at Akola

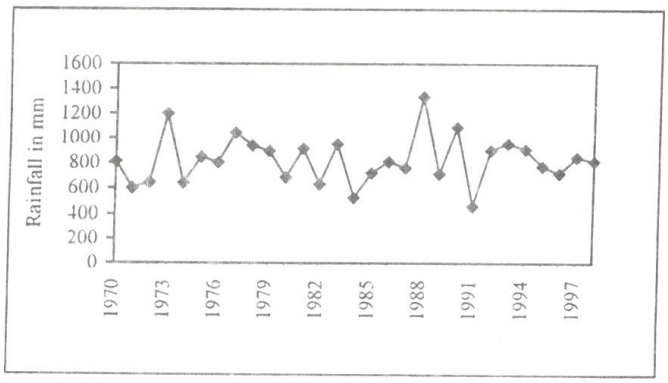

Fig. 3. Mean annual rainfall at Akola

planning of various crops. The command area of this observatory covers Akola and nearby part of Vidarbha region of Maharashtra in which sorghum, cotton, pigeonpea, acid lime, oranges, etc. are main crops.

Relationship between coefficient of variation and average monthly rainfall indicates that in general, the coefficient of variation has an inverse relationship with the rainfall. That is coefficient of variation decrease as the months tend to become wet and increase for months having sporadic rainfall (Fig. 1 and 2). The month of April is of maximum uncertainity (C.V. 193%). May, March and November months are deficient in overall rain but have more uncertainity of rainfall followed by April.

It is clear from the analysis that most of the rainfall occurs in the months of June, July and August. Years having August as a normal month are 89.65 per cent, whereas that for July and June are 86.21 and 82.76 per cent, respectively. Probability of August, July and June month being a normal month is 0.160, 0.154 and 0.148, respectively.

The estimates of mean and standard deviation of annual rainfall are 825.11 mm and 192.58 mm, respectively. Therefore the year receiving rainfall between 632.53 mm and 1017.69 mm is a normal year. Thus, as per above definition the percentage of drought, normal and abnormal years are 12.7, 79.2 and 8.33, respectively. In the 29 year duration there were only four drought years (1971, 1982, 1984 and 1991) and four abnormal years (1973, 1977, 1988 and 1990).

A plot of total annual rainfall data for 29 years periods showing the exceptional values (peaks in 1973 and 1988 and troughts in 1984 and 1991) is given in Fig. 3 it reflects that total annual rainfall at Akola oscillates around the average and series also exhibits a moderately constant pattern (C.V. = 23.0).

Rank correlation test for randomness (Kanji 1995) has been applied for detecting trend in annual series. Analysis of data does not reject the hypothesis of no correction. Hence, we conclude the absence of trend in the annual rainfall series.

LITERATURE CITED

Sharma, H.C., H.C., Chauhan and Ram Sewa, 1979. Probability analysis of rainfall for crop planning, J. Agric. Engg. XVII (3) 87-94.

Kanji, G.K. 1995. 100 statistical tests, Sage publication, New Delhi : 111

Hooda, B.K. and B.K. Thakur, 1998. Probability analysis at Nauni, Himachal Pradesh. Indian J. Soil Cons., 26 (2) : 153-157.

Mohanty, S., R.A. Marathe and Shyam Singh, 2000. Probability models for prediction of Annual maximum daily rainfall for Nagpur, J. Soil & Water Conservation (44) : 38-40.

PKV Res. J. Vol. 24 (2) : 2000

Probability Models for Prediction of Annual Maximum Daily Rainfall at Akola, Maharashtra

A.R. Pimpale[1], S.S. Hiwase[2], P.A. Gawande[3] and P.G. Patil[4]

ABSTRACT

The knowledge of one day maximum rainfall plays vital role in hydrological design of various soil conservation structures, drainage structures and their planning and ultimately watershed development. Considering this fact, annual daily rainfall data for thirty years (1969-1998) for station Akola has been collected and frequency analysis of maximum daily rainfall has been attempted. The maximum daily rainfall has been fitted to four different probability distribution functions i.e. Normal, Log-normal, Extreme Value Type-I and Long Pearson Type-III distributions and probable rainfall values for different return periods has been estimated. These estimated values have been compared with the values obtained by Weibull's method. The analysis indicates that, the Lognormal distribution gives closets fit to the observed data and hence can be used to predict maximum daily rainfall for higher return periods.

Akola (20°42' N latitude and 77° 02'E longitude and 307.4 m above mean sea level altitude) lies in Vidarbha region of Maharashtra. The average annual rainfall of the station is about 825 mm. But the rainfall is highly erratic and irregular. Many times the rainfall occurs with high intensity causing severe erosion at many places.

Under such circumstances, hydraulic structures and soil conservation structures such as water harvesting pond, conservation ditches as well as drainage channels are requried. For correct hydraulic design of these structures, the engineers often require data of maximum daily rainfall of different return periods.

Probability analysis can be used for prediction of occurrence of future events from available records of rainfall with the help of statistical method (Kumar and Kumar 1989). Using the theoretical probability distributions, it would be possible to forecast the rainfall of various magnitudes with different periods. Several distributions have been used for hydrological analysis as given by Chow *et al.* (1988). Probability analysis of one day rainfall has been attempted for different places (Sharda and Bhushan, 1985; Agrawal *et al.* 1988; Anil Kumar, 1999 and Mohanty *et al.* 2000). An attempt has been made in present study to estimate the probable maximum daily rainfall for different return periods for Akola by four probability distribution functions so as to select the best one.

MATERIAL AND METHODS

The daily rainfall data were collected from Meteorological Observatory of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The values of maximum daily rainfall of 30 years from 1969 to 1988 were arranged in descending order and the return period T was obtained using Weibull's formula

$$T = (n - 1)/m$$

Where T is the return period in years, n is the total number of years of record and m is the rank of the observed rainfall values. The probability of exceedence of rainfall is reciprocal of the calculated return period. The annual maximum daily rainfall of Akola were fitted to four probability distribution functions i.e. Normal, Log Normal, Extreme Value Type-I and Log Pearson Type III distribution to predict one day maximum rainfall. Four probability distribution functions (Chow *et al.* 1988) for fitting hydrological data are given as follows.

Normal distribution :

The probability density function of this distribution is given by

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[- \frac{(x - \mu)^2}{2\sigma^2} \right]$$

Where μ and σ are mean and standard deviation of variate x respectively.

Log Normal Distribution :

The probability density function of this distribution is given by

$$f(x) = \frac{1}{x\,\sigma\sqrt{2\pi}} \exp\left[- \frac{(y - \mu_y)^2}{2\sigma_y^2} \right]$$

1. Technical Assistant, T-4 (Agril. Engg.), NRC for Citrus (ICAR), Amravati Road, Nagpur. 2. Head, Deptt. of Irrigation and Drainage Engg., College of Agril. Engg., Dr. PDKV, Akola 3. Research Associate, NRC for Citrus (ICAR), Nagpur 4. Officer Incharge, Ginning Training Centre (ICAR), Nagpur

Table 1. Comparison of maximum daily rainfall for different probability distribution functions

S.N.	Return Period (T)	Observed Rainfall value (O)	Expected rainfall (E)				$(O - E)^2 / E$			
			Normal	Log normal	Extreme value type I	Log pearson type III	Normal	Log nornal	Extreme value type I	Log pearson type III
1	1	18.70	4.13	32.03	27.78	22.58	5.55	3.53	15.08	3.95
2	1.25	76.00	67.89	65.19	68.10	68.16	0.97	1.79	0.00	0.13
3	2	98.20	67.89	97.38	99.60	98.20	13.53	0.01	10.10	0.01
4	5	134.60	147.77	145.48	141.99	145.87	1.17	0.81	0.24	0.00
5	10	186.40	168.87	179.51	170.05	166.11	1.82	0.26	0.01	1.08
6	15	217.20	183.00	2000.5	186.30	177.65	6.39	1.39	0.06	2.94
7	25	232.50	191.41	213.2	201.60	185.87	8.82	1.65	0.52	4.17
8	30	244.85	196.80	238.75	205.10	191.50	11.73	0.16	0.34	11.66
9	50	-	205.8	259.33	231.81	197.13	-	-	-	-
10	100	-	219.09	296.05	257.92	206.43	-	-	-	-
						Total	49.99	9.61*	26.32	23.94

* Lowest value

Where $y = \log x$, μ_y and σ_y are mean and standard deviation of variate y respectively.

Extreme Value Type - I Distribution

The probability density function of this distribution is given by

$$f(x) = 1/\alpha \exp \left[- \frac{x - u}{\alpha} - \exp \frac{x - u}{\alpha} \right]$$

Where, $\alpha = \sqrt{6}\ s_x / \pi$, $u = \bar{x} - 0.5772\ \alpha$, $\bar{x}$ and s_x are mean and standard deviation of variate x respectively.

Log Pearson Type - III Distribution

The probability density function of this distribution is given by

$$f(x) = \lambda^{\beta}(y-\varepsilon)^{\beta-1} e^{-\lambda (y-\varepsilon)} / x\,(\beta)$$

Where

$\lambda = s_y / \sqrt{\beta}$, $\beta = [2/(C_s(y))]^2$

$\varepsilon = \bar{y} - sy$, $y = \log x$

$\bar{y}$, s_y and C_s (y) are mean standard deviation and skewness coefficient of variate y respectively.

All four probability distribution functions are compared by Chi-square (X^2) test of goodness of fit given as per the equation.

$X^2 = \Sigma (O - E)^2 / E$

Where O is the observed value obtained by Weibull's method and E is the estimated value by probability distribution functions.

RESULTS AND DISCUSSION

The probable rainfall values for different probability distribution functions and their comparison with observed value have been shown in Table 1. The best probability function was determined by comparing Chi-square values obtained by each distribution and selecting function that gave smallest Chi-square value. (Bhatt *et al.* 1996).The Chi-square values calculated are 9.98, 9.60, 26.32 and 23.94 for Normal, Lognormal, Extreme Value type I and Log Pearson Type III distribution, respectively (Table 1). This suggests that Lognormal distribution is the best for predicting annual maximum daily rainfall at Akola. Hence approximate planning of soil conservation and drainage measures and hydrological design of structures, based on maximum rainfall in this region can be based on predictions from Lognormal distribution with reasonable accuracy.

LITERATUE CITED

Agrawal, M.C., V.S. Katiyar and Ram Babu, 1988. Probability analysis of annual maximum daily rainfall of U.P. Himalaya. Indian J. Soil Cons. 16 (1) : 35-42.

Anil Kumar, 1999. Probability analysis for prediction of daily maximum rainfall for Pantnagar. Indian J. Soil Cons. 27 (2) : 171-173.

Bhatt, V.K., A.K. Tiwari and A.K. Sharma, 1996. Probability Models for prediction of annual maximum daily rainfall of Datia. Indian J. Soil Conc. 24 (1). 25-27.

Chow, V.T., D.R. Maidment and L.W. Mays, 1988. Applied Hydrology, Me Graw Book Co. 11, 12 : 371-415

Kumar, D. and S. Kumar, 1989. Rainfall distribution pattern using frequency analysis J. Agric. Engg. 26 (1) : 33-38.

Mohanty, S., R.A. Marathe and Shyam Singh, 2000. Probability Models for prediction of daily maximum rainfall for Nagpur. Indian J. Soil and Water Cons. 44(1) : 38-40.

Sharda, V.N. and Bhushan, 1985. Probability analysis for prediction of annual maximum daily rainfall for Agra. Indian J. soil Cons. 13(1) : 16-20.

Research Notes

Effect of Different Herbicides on Growth and Yield of Soybean (*Glycine max* L.) Merrill

Soybean is an important pulse and oilseed crop growing in both rainy and summer season. Intensive weed competition is one of the main constraints of low productivity in soybean. The reduction in yield due to weeds varied from 35-50 per cent (Chandel and Saxena, 1988). Hand weeding and interculture methods of weed control are costly and time consuming. Under such circumstances some herbicides have been identified for control of weeds as substitute. The present investigation was conducted during rainy season of 1996 at Central Campus farm of Vidyapeeth, Rahuri. The treatments comprised as pre and post emergence application. Sixteen treatments were tested in randomised block design

Table 1. Effect of different herbicide on growth and yield of soybean

Treatments		Plant height (cm)	No.of branches plant^{-1}	No. of pods plant^{-1}	Length of pods plant^{-1} (mm)	Number of grains plants^{-1}	Weight of grain plant^{-1} (g)	Weed dry-matter (q ha^{-1})	Weed inten-sity (m. sq.)	Yield (q ha^{-1})
T_1	Anilofos 5G 1.0 PPI	84.30	3.84	36.40	27.24	108.00	17.28	3.98	5.32	26.30
T_2	Anilofos 5G 1.5 PPI	84.92	3.96	38.15	26.85	128.00	21.42	3.23	3.87	28.40
T_3	Anilofos 5G 1.0 PE	84.20	3.81	36.05	25.98	104.00	16.66	4.08	5.73	26.10
T_4	Anilofos 5G 1.5 PE	85.33	3.92	37.75	29.40	100.00	20.47	3.68	4.45	27.50
T_5	Anilofos 30 EC 1.0 PPI	83.30	3.70	35.80	23.79	92.00	14.96	4.43	6.33	25.37
T_6	Anilofos 30 EC 1.5 PPI	88.40	4.08	41.27	31.31	138.00	23.46	2.50	2.72	30.50
T_7	Anilofos 30 EC 1.0 PE	82.30	3.61	35.15	23.00	88.00	14.72	4.62	6.92	24.50
T_8	Anilofos 30 EC 1.5 PE	84.60	3.90	36.90	28.42	111.00	18.32	3.90	5.14	27.30
T_9	Anilofos 30 EC 1.0 Po-em	83.08	3.76	36.00	25.83	98.00	16.64	4.27	6.19	25.50
T_{10}	Anilofos 30 EC 1.5 Po-em	87.60	4.06	41.10	31.00	132.00	25.47	2.92	3.35	29.23
T_{11}	Fluchloralin 45 EC 1.0 PPI	88.30	4.12	43.70	31.37	142.00	22.72	2.40	2.45	31.10
T_{12}	Pendimethaline 30 EC 1.0 PPI	88.20	4.01	39.15	30.98	131.00	22.44	3.09	3.56	28.53
T_{13}	Unweeded (control)	81.41	3.43	38.05	22.78	82.00	13.94	18.35	79.75	22.10
T_{14}	Metribuzin 70% WP 1.0 PE	86.30	3.94	34.15	29.93	125.00	20.86	3.50	4.36	27.87
T_{15}	Alachlor 10 G 2.0 PE	89.40	4.32	44.20	32.90	140.00	23.81	2.25	2.14	32.20
T_{16}	Weed free (HW at 20 & 40 DAS)	89.83	4.45	46.50	33.66	143.00	29.31	-	-	33.40
	S.E.±	0.88	0.50	-	-	-	-	0.43	0.50	0.88
	CD at 5%	3.42	1.45	-	-	-	-	1.25	1.45	3.42

PPI - Preplant incorporation Po-em - Post emegence PE - Pre emergence HW - Hand weeding

with three replications (Table 1) and compared with two weedings (at 20 and 40 days after sowing, weed free) and an unweeded control.

All the herbicides, except granular formation, were sprayed through 500 litres of water ha^{-1}. The quantities of water and the herbicides to be applied $plot^{-1}$ were calculated on the area basis before spraying. The crop was dibbled on 3 July 1996 at spacing of 30 cm x 10 cm. A basal dose of 50 kg N ha^{-1} and 100 kg P_2O_5 ha^{-1} was applied uniformly to all the treatments. Irrigations were applied as and when required.

The data presented in Table 1 revealed that the growth and yield contributing characters viz. plant height, number of branches, number of pods $plant^{-1}$, weight of pods $plant^{-1}$, number of grain and weight of grain $plant^{-1}$ were maximum in weed free plot which reflected on higher grain yield of 33.40 q ha^{-1}. These results are in confirmity with those obtained by Halvankar *et al.* (1995). Significantly less weed intensity was registered in all the weed control treatments than weedy check and maximum dry matter was observed in weed free check. Pre-emergence application of alachlor 10 G @ 2.0 kg a. i. ha^{-1} (32.20 q ha^{-1}), fluchloralin 45 EC @ 1 kg a.i. ha as pre plant incorporation and anilofos either 5 G or 30 EC @ 1.5 a.i. ha^{-1} applied as pre-plant incorporation and post emergence were found equally effective for grain yield. Similar results were reported by Sahadeva Singh *et al.* (1995). Due to effecrtive control of weeds in both the methods (mechanical and chemical) the increase in yield was observed to be 68.17 and 66.63 per cent, respectively. More over, maximum reduction in grain yield was observed in unweeded control, while less reduction in grain yield was observed in weed free check (two hand weedings). Secondly, less reduction in grain yield was noticed with the pre-emergence application of alachlor 10 G @ 2.0 Kg a.i. ha^{-1}.

LITERATURE CITED

Chandel, A.S. and S.C. Saxena, 1988. Technology for raising soybean in U.P. Indian Farming 38 : 10-12.

Halvankar C.B., V.P. Raut, S.P. Taware and V.P. Patil, 1995. Intergrated weed control in soybean J. Oilseed Res. 12 (1) : 69-73.

Sahadeo Singh, A.N. Singh and V.M. Bhan, 1995. Studies on chemical control of weeds in soybean. Indian J. Weed Sci. 27 (3 & 4) : 160-163.

Mahatma Phule Krishi Vidyapeeth,
Rahuri - 413 722 (MS)

S.R. Chavan
R.H. Borse
A.D. Tumbare

Losses Caused Due to *H. turcicum* Leaf Blight Disease in the Grain Yield of Maize

H. turcicum leaf blight caused by *Helminthosporium turcicum* was recorded for 4-5 years on AMC 1, AMC 2, Manjari composite, Kargil 633 and some maize strains under maize breeding programme at Akola. The disease was common in *Kharif* season. The disease initially appears on the lower leaves as slightly oval, water - soaked small spots and continues increasing in size and number as the plant develops. These spots grow into elongated spindle shaped, necrotic lesions until a complete buring of the foliage occurs (Leon, 1978). It affects the vegetative growth of the plant and also the size of the cobs. Therefore, it was decided to study the grain yield losses caused due to *turcicum* leaf blight disease in maize.

A field trial was conducted in factorial randomized block design with eight treatments in three replications at Wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 1995-96 to 1997-98. The varieties viz. AMC 1, AMC 2, Manjari composite and Kargil 633 were sown in the first fortnight of July. The plots of these varieties were artificially inoculated with the spore suspension of *Helminthosporium turcicum* at 45 DAS to create the incidence of *turcicum* leaf blight. The un-inoculated plots of these varieties were maintained disease free with the fungicidal spray of Carbendazim 50 WP (0.1%) as control plots. The observations on leaf blight incidence of inoculated and un-inoculated plots were recorded on 25 plants from each plot as per 1-9 scale described by Mayee and Datar (1986). The per cent disease index (PDI) was calculated as per formula described by Kotasthane and Agrawal (1976) as given below

Table 1. Losses caused due to turcicum leaf blight disease in the grain yield of maize

Treatments		Pooled mean		
		Disease intensity (%)	Yield (q ha^{-1})	% losses in yield over inoculated (protected)
AMC 1	Inoculated	39.23	27.00	18.77
AMC 1	Un-inoculated and protected with carbendazim 50 WP (0.1%)	15.91	33.24	-
AMC 2	Inoculated	35.46	29.55	15.45
AMC 2	Un-inoculated and protected with carbendazim 50 WP (0.1%)	14.75	34.95	-
Manjari composite	Inoculated	33.61	31.71	13.81
Manjari composite	Un-inoculated and protected with carbendazim 50 WP	13.90	36.79	-
Kargil 633	Inoculated	31.42	34.27	10.50
Kargil 633	Un-inoculated and protected with carbendazim 50 WP (0.1%)	12.80	38.29	-
'F' Test		Sig	Sig	
SE m ± for variety		0.20	0.14	
CD at 5%		0.61	0.43	
SE m ± for inoculation		0.14	0.10	
CD at 5%		0.43	0.30	
SE m ± for interaction for (V x I)		0.28	0.20	
CD at 5%		0.86	0.60	
CV%		3.44	1.79	

$$PDI = \frac{\text{Numerical rating}}{\text{Total no. of plants observed x Maximum rating}} \times 100$$

The arc-sine values of PDI were noted. The grain yield of net plot (2.40 M x 5 M = 12 M^2) was recorded. The yield hectare^{-1} was calculated. The three year data on disease intensity and grain yield were pooled analysed.

The data presented in Table 1 revealed that significantly highest i.e. 39.23 per cent intensity of *turcicum* leaf blight disease was recorded in inoculated AMC1 plots due ot *turcicum* leaf blight in maize.

followed by AMC 2 (35.46%), Manjari composite (33.61%) and Kargil 633 (31.42%). The disease caused significant losses i.e. 18.77 per cent in AMC 1, 15.45 per cent in AMC 2, 13.81 per cent in Manjari composite and 10.50 per cent in Kargil 633 were recorded in artificially inoculated plots as compared to protected and un-inoculated plots. The incidence of *turcicum* leaf blight was also common at Hyderabad in maize crop. Field experiment conducted at Maize Research Station, Hyderabad (Anon, 1989) also recorded high incidence of disease and grain losses caused

LITERATURE CITED

Anonymous, 1989. Agricultural Information and Communication Centre, APAU, Hyderabad - 30, Maize Tech. Bull 21 : 21.

Leon, C.D., 1978. Maize diseases, A guide for field identification. Inf. Bull. 11(2) : 32-33.

Kotashane, S.R. and S.C. Agrawal, 1976. Control of foliar diseases of mung bean by fungicides. Pesticides 10 (8) : 35-36.

Mayee, C.D. and V.V. Datar, 1986. Scale for recording of *turcicum* leaf blight disease incidence of maize Phytopathometry Tech. Bull. 1, MAU, Parbhani: 218.

Wheat Research Unit,
Dr. Panjabrao Deshmukh Krishi Vidyapeeth,
Akola

S.K. Shivankar
R.S. Shivankar

Studies on Vegetative Propagation in Custard Apple (*Annona squamosa* L.)

Custard apple trees are mainly propagated through seed. Therefore, it exhibits great genetic variability in growth, yield and quality. However, some seedling trees produce good quality fruits and high yields. If such elite promising trees are identified and propagated vegetatively, the desirable types can be multiplied and orchard with uniform fruit quality can be established.

The reports on the development of superior and known varieties are meager, as very little efforts in this direction have been made. Hence, it is of prime importance to standardise the methods and period of vegetative propagation in custard apple.

The present trial was laid out in FRBD with three replications. In all there were three methods of propagation and it was carried out at monthly intervals i.e. from March to October, 1997. Ten plants in each treatment formed a unit. The trial included three main treatment i.e. shield budding (M_1), patch budding (M_2) and softwood grafting (M_3) and eight sub treatments i.e. time of propagation first week of March to first week of October. In all there were twenty four treatment combinations.

For grafting and budding one year old custard apple seedlings of local cv. were used as root stock. The known cv. Balanagar was used as scion. The past season growth was used for budding and grafting purpose. The observations on percentage of bud take, percentage of bud sprouting period required for sprouting/graft union were recorded timely and analysed statistically.

It was revealed from Table 1 that highest percentae of bud take (74.44%) was noticed in August month followed by July (69.99%) and April (65.55%). The lowest percentage of bud take was recorded in the month of May (36.66%). Method of propagation treatments and interaction between methods and period were found to be non-significant. The possible reason or maximum success in grafting/budding in the month of July, August may be that both scion and root stock were in good sap flowing conditions and also humidity is more in atmosphere. Same findings were also recorded by earlier researchers Teaotia *et al.* (1963) in jack fruits and Nagwade (1986) in custard apple.

It is clear from Table 1 that maximum percentage of bud sprout was obtained in the month of August (62.22%) followed by July (57.77%). In respect of method of propagation shield (63.33%) and patch budding (53.33%) showed better response. These results are in confirmity with Venkataraiman and Satyanarayanaswamy (1956).

It is clear from Table 1 that minimum number of days (42.51) were required for sprouting in March followed by April (44.89) and May (50.83). In case of methods of propagation, shield budding (40.70) took minimum number of days for sproutings as compared to patch budding (41.08) and softwood grafting (63.68). The possible reason may be that, custard apple is a deciduous plant, in which there is a natural leaf fall during *summer* season. This helps to activated the bud on scion more effectively during *summer* season. These results also indicates that survival of plant earlier in budding than grafting. The earlier research worker Singh *et al.* (1979) reported same result in Jamun.

Table 1. Mean bud take percentage, bud sprout percentage and number of days required for sprouting in various propagation methods during different periods

Methods		March	April	May	June	July	Aug.	Sept.	Oct.	Mean (Methods)
Shield budding	% bud take	50.00	60.00	30.00	56.66	66.66	70.00	50.00	40.00	52.91
		(45.00)	(50.77)	(33.21)	(48.79)	(54.70)	(56.79)	(45.00)	(39.23)	(46.66)
	% bud sprout	43.33	53.33	23.33	50.00	56.66	63.33	36.66	33.33	44.99
		(41.15)	(46.89)	(28.86)	(45.00)	(48.79)	(52.71)	(37.23)	(35.24)	(42.07)
	Days required for sprouting	38.56	39.56	41.21	42.64	36.00	41.21	44.62	42.25	40.70
		(6.20)	(6.28)	(6.41)	(6.52)	(6.00)	(6.41)	(6.67)	(6.50)	(6.37)
Patch budding	% budtake	40.00	46.66	26.66	60.00	63.33	66.66	43.33	46.66	49.66
		(39.23)	(43.05)	(31.65)	(50.99)	(52.71)	(54.70)	(41.15)	(43.05)	(44.48)
	% bud sprout	26.66	36.66	16.66	46.66	50.00	53.33	33.33	30.00	36.66
		(31.05)	(37.23)	(24.04)	(43.05)	(45.00)	(46.89)	(35.24)	(33.21)	(37.23)
	Days required for sprouting	36.50	40.57	42.64	39.18	45.56	38.19	43.56	42.90	41.08
		(6.04)	(6.36)	(6.52)	(6.25)	(6.74)	(6.17)	(6.60)	(6.54)	(6.40)
Softwood grafting	% bud take	76.66	90.00	53.33	66.66	80.00	86.66	73.33	50.00	72.08
		(61.07)	(71.56)	(46.89)	(54.70)	(63.44)	(68.53)	(58.89)	(45.00)	(58.05)
	% bud sprout	63.33	80.00	40.00	56.66	66.66	70.00	60.00	46.66	60.41
		(52.71)	(63.44)	(39.23)	(48.79)	(54.70)	(56.79)	(50.77)	(43.05)	(51.00)
	Days required for sprouting	53.98	55.65	71.57	65.28	55.20	64.00	74.64	72.99	63.68
		(7.31)	(7.45)	(8.45)	(8.07)	(7.42)	(8.00)	(8.63)	(8.54)	(7.97)
Mean (Period)`		5.55	65.55	36.66	61.10	69.99	74.44	55.55	45.55	
		(48.16)	(54.03)	(39.23)	(51.41)	(56.73)	(59.60)	(48.16)	(42.42)	
		44.44	56.66	26.66	51.10	57.77	62.22	43.33	36.66	
		(41.78)	(48.79)	(31.05)	(45.63)	(49.43)	(52.06)	(41.15)	(37.23)	
		42.51	44.89	50.83	48.30	45.15	47.05	53.29	51.69	
		(6.51)	(6.70)	(7.12)	(6.94)	(6.71)	(6.85)	(7.30)	(7.18)	

		Methods	Period	Method x Propagation
% bud take	SE (m)±	2.15	3.52	6.10
	CD at 5%	-	10.17	-
% bud sprout	SE (m)±	1.79	2.92	5.06
	CD at 5%	-	-	14.63
Days required for sprouting	SE (m)±	0.0429	0.0701	0.121
	CD at 5%	0.123	0.202	0.350

Figures in parenthesis are arcsin values

LITERATURE CITED

Nagwade, R.N., 1986. Effect of gibberellic acid on germination and grade of root stocks for custard apple. Thesis submitted to MPKV, Rahuri.

Teotia, S.S., K. Dayat and M.P. Asthana, 1963. Propagation of jackfruit by budding. Sci. and Cut. 29 : 46-47.

Venkatramain, L. and G. Satyanarayswamy, 1956. Vegetative propagation of sitaphal. Indian J. Hort 13 (4) : 90-101.

Singh, U.R. , I.C. Pandey and R.S. Prasad, 1979. Propagation of jamun by budding. Punjab Hort J. 19 (142) : 74-75.

Department of Horticulture,
Dr. PDKV, Akola

P.S. Joshi
P.S. Bhalerao
V.K. Mahorkar
B.J. Jadhav

Hydraulic Performance Evaluation of Microsprinkler System

The ideal microirrigation system assumes the delivery of equal volume of water from all emitting devices. But practically it is difficult to achieve this as the flow from emitting device is affected by variation in water pressure and coefficient of manufacturing varition. The uniform water distribution pattern is of vital inportance in design of microirrigation system, which is described in general in terms of emission uniformity, uniformity of application and wetting diameter. Considering these factors the study was undertaken in 1998 at Instructional and Research Farm Laboratory of Soil and Water Conservation Engineering Department, College of Technology and Agricultural Engineering, Udaipur (Rajasthan).

The microsprinkler (120 lph) were spaced 3m apart on the lateral of 16 mm diameter. The discharge from each emitting device was measured by volumetric method for operating pressures of 0.5, 0.7, 1.0, 1.2, 1.5 and 1.7 kg/cm^2 and at stake height of 15, 30 and 45 cm. This data of pressure and discharge was used to develop pressure-discharge relationship, coefficient of manufacturing variation (cv) and emission uniformity (EU) using following equations.

$q = k\,p^x$ - (Keller and Karmeli, 1974)

$cv = S/M$ - (Soloman, 1979)

$EU = (q_n/q_a) \times 100$ - (Keller and Karmeli, 1974)

Where,

q = emitter discharge rate, lph
k = constant of proportionality
p = operating pressure, kg/cm^2
x = nozzle discharge exponent
S = standard deviation of flow rates of sample emitters
M = mean flow rate
q_n = average of lower quarter discharge rates
q_a = average discharge of sample emitters

To determine uniformity of application the catchcans were placed at grids of 70 x 70 cm over the wetted area. The system was run one hour continuously and then the volume caught was converted into equivalent depth and used to calculate the coefficient of uniformity (CU), distribution uniformity (DU) and distribution characteristics (DC) using following formulae :

$$CU = 1 - \left(\frac{\Sigma x}{m.n.}\right) \times 100$$

$$DU = \frac{\text{Average of lower quarter depth caught}}{\text{Average depth caught}}$$

$$DC = \frac{\text{Area receiving more than average depth}}{\text{Total wetted area}}$$

where,

x = absolute deviation of depth caught from mean depth,
m = mean depth
n = number of emitting devices

The wetting diameter is determined by running the system for 15 minutes in the field.

The results revealed that the flow rate increase with increase in operating pressure whereas with increase in stake height. The pressure - discharge relationship developed is as follows.

$q = 100.33\,p^{0.455}$; $r^2 = 0.99$ (h = 15.0 cm)
$q = 98.35p^{0.465}$; $r^2 = 0.99$ (h = 30.0 cm)
$q = 95.89\,p^{0.475}$; $r^2 = 0.99$ (h = 45.0 cm)

Where,

q = discharge rate, lph
p = operating pressure, kg/cm^2
h = stake height, cm
r^2 = correlation coefficient

Based on nozzle exponent values microsprinklers are classified as non-pressure compensating with partially turbulent flow (Karmeli and Todd, 1985).

The emission uniformity is found to be in the range of 96-98%. It is also observed that the value of emission uniformity increase with increase in operating pressure but decrease with increase in stake height.

The coefficient of manufacturing variation is found in the range of 0.016 - 0.029. On the basis of these values the microsprinklers are classified as excellent (Soloman, 1979).

It is also observed that the wetting diameter increase with increase in operating pressure and stake height as well. But it is also observed that the rate of increase of wetting diameter decrease with increase in operating pressure irrespective of stake height. In general it is observed that for a pressure variation from 0.5 - 1.7 kg/cm^2 (240%) the wetting diameter approximately increase from 4 to 7.5 m (87.50%).

Uniformity coefficient (CU), distribution uniformity (DU) and distribution characteristics (DC) decrease with increasing operating pressure irrespective of stake height, while it increase with increase in stake height. CU, DU and DC ranged between 36-47 per cent, 17-23 per cent and 44-47 per cent respectively for pressure variation from 0.5-1.7 kg/cm^2.

LITERATURE CITED

Karmeli and Todd., 1985. Emitter flow variation and uniformity for trickle irrigation. A compilation of trickle irrigation papers. (ASAE, 1980-85).

Keller, T. and D. Karmeli, 1974. Trickle irrigation design parameters. Trans. ASAE, 17 (4) : 678-684.

Soloman, K. 1979. Manufacturing variation of trickle emitters. Trans. ASAE, 22(5) : 1034-1037.

M.Tech. Agril. Engineering (Irrigation & Water Management) — M. U. Kale
Associate Professor, S.W.C.E., Deptt. C.T.A.E., Udaipur (Raj.) — Rajvir Singh
Prof. & Head, S.W.C.E., Deptt. C.T.A.E., Udaipur (Raj.) — Avdesh Chandra
B.Tech. Student — S. P. Lambe

Balance Sheet of Soil Nitrogen and Phosphorus of Legumes, Oilseeds Inclusive Crop Sequences in Vertic Ustochrept

The component crops grown in a sequence remove considerable amount of nutrients from the soil. Thus information on harvest of nutrients and the nutrient balance over a period is useful to understant the drain on soil nutrients (Deka and Singh, 1994). The cropping sequence should aim to maintain soil fertility and productivity. Hence inclusion of legume crops in a sequence is advocated (Singh and Singh, 1991). The present investigation was, therefore, undertaken to study the nutrient harvest, budgeting of major nutrients and soil fertility status in different crop sequences.

Field experiment was conducted on Vertic Ustochrept at Cropping Systems Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 1994-95 to 1996-97. The soil of the experiment was slightly alkaline, with pH 7.7 electrical conductivity 0.20 dSm^{-1} , organic carbon 0.47 per cent and total nitrogen 0.044 per cent. The available N, P and K content was 183, 13 and 80 kg ha^{-1}, respectively. Twelve crop sequences with two crops in a year were tried in a RBD with four replications. The sequences were (i) sorghum-wheat (S_1), (ii) sorghum-chickpea (S_2), (iii) sorghum-sunflower (S_3), (iv) cotton-wheat (S_4) (v) cotton-chickpea (S_5) (vi) maize-wheat (S_6), (vii) maize-chickpea (S_7), (viii) maize-mustard (S_8), (ix)soybean-wheat (S_9), (x) soybean-chickpea (S_{10}), (xi) soybean-groundnut (S_{11}) and (xii) greengram-safflower (S_{12}). Recommended doses of N, P_2O_5 and K_2O were applied to each crop in each season (Table 1 and 2) as per package of practices of respective crops. After harvest of each crop, grain and plant samples excluding roots were collected, processed and analysed for N, P_2O_5 and K_2O content as per method described by Chapman and Pratt, (1961). The soil samples drawn before sowing of *kharif* crops in 1994-95 and at the harvest of *rabi* crops (1996-97) were analysed for available nitrogen as described by Jackson (1967). Total uptake of nutrient was calculated and balance sheets for N and P were computed.

A. Nitrogen harvest (Uptake and balance of available N) :

The data (Table 1) revealed that soybean-chickpea, crop sequence registered the highest N uptake (94.3 % of the initial + added N) which was closely followed by soybean-groundnut sequence (84.4 %). The lowest N harvest (36.5 %) was recorded by sorghum-wheat crop sequence. It was observed that sorghum-wheat and soybean-chickpea sequences recorded the highest and the lowest expected N balance, respectively. However, highest apparent N gain was recorded in soybean-chickpea (68.3 %), followed by soybean-groundnut (62.1 %), cotton-chickpea (29.3%), maize-wheat (24.2 %), greengram-safflower (8.0 %), maize-mustard (4.1 %) and maize-chickpea (2.6 %), respectively. Apparent loss of N was more in sorghum-wheat (34.7 %), cotton-wheat (19.6 %), sorghum-sunflower (4.0 %) and sorghum-chickpea (3.5 %), respectively. The higher N loss might have been due to losses through volatilization and leaching. Similar results have been reported by Yadav *et al.* (1991), they observed negative N balance (added-removal) in rice-maize-maize+cowpea (F) sequence.

However, there was an improvement in the availability of N as evidenced in fertility status of the soil after completion of the study. The sequence greengram-safflower recorded higher actual N gain (30.18 %) over initial N status. In other crop sequences, N gain was in order of soybean-groundnut (8.40 %), maize-chickpea (8.38 %), maize-mustard (7.23 %), maize-wheat (6.25 %) and soybean-chickpea (6.03%). The highest N loss was observed in sorghum-sunflower crop sequence (20.86 %) followed by sorghum-chickpea (14.15 %) and sorghum-wheat (4.54 %). Inclusion of legume crops in the sequence resulted in building up or maintanance of N availability in the soil despite heavy N harvest by cereal or component crops. These results are in agreement with the findings of Rana *et al.* (1983).

B. Phosphate harvest (Uptake and balance of available P) :

The data (Table 2) revealed higher phosphate harvest (51.9 %) in sorghum-sunflower followed by cotton-wheat (50.7 %) sequence. Inclusion of cereal and oilseed crop resulted in higher P uptake. Other sequences recorded decreasing P uptake in order of maize-wheat (48.3 %), sorghum-chickpea (46.9 %), maize-chickpea (45.5%), maize mustard (44.1%), soybean-wheat (40.1%), sorghum-wheat (39.1 %), cotton-chickpea (36.8%), soybean-groundnut (35.8%), soybean-chickpea (32.5%) and greengram-safflower (32.3%) respectively.

In all the sequence, P harvest did not exceed the added P. Legumes harvested lower quantity of P and increase the yields of succeeding crops (Maliwal, 1990). Lower uptake of P might be due to P fixation in all the sequences as observed from apparent loss of available P. Greater loss (55 %) was recorded in soybean-chickpea and the lowest in cotton-wheat sequence. Budgeting of P in all the sequences exhibited apparent loss of available P. Other sequences showed decreasing apparent P losses in order of greemgram-safflower (51 %), soybean-wheat (50.4%), soybean-groundnut (49.9%), soybean-wheat (47.5%), cotton-chickpea (47.4%), maize-mustard (42.1%), maize-wheat (42 %), maize-chickpea (40.4%), sorghum-chickpea (38.2%), cotton-wheat (35.5%), sorghum-sunflower (33.9%). Similar results are reported by Yadav *et al.* (1991) they observed positive apparent P balance (added P - removal of P in rice-wheat+mustard-greengram and rice-maize-maize+cowpea (F) sequences.

Table 1. Balance of available N kg ha^{-1} in crop sequences 1994-95 to 1996-97

Crop sequence	Initial fertility status	Added nutrient	Nutrient uptake	Expected balance	Actual fertility status 1996-97	Apparent gain (E-D)/ loss (D-E)	Actual gain (E-A)/ loss (A-E)
	A	B	C	D	E	F	G
Sorghum-wheat 100:50:40-120:60:60 (S_1)*	286	660	345 (36.5)**	601	273	-328 (34.7)**	-13 (4.5)**
Sorghum-chickpea 100:50:40-25:50:0(S_2)	369	375	401 (53.9)	343	317	-26 (3.5)	-52 (14.1)
Sorghum-sunflower 100:50:40-40:60:00 (S_3)	369	420	464 (58.8)	325	292	-33 (4.2)	-77 (20.9)
Cotton-wheat 50:25:00-120:60:60 (S_4)	298	510	404 (50.0)	404	302	-102 (19.6)	-4 (1.3)
Cotton-chickpea 50:25:00-25:50:00 (S_5)	358	225	374 (64.2)	209	380	+171 (29.3)	+22 (6.2)
Maize-wheat 120:60:60-120:60:60 (S_6)	405	240	520 (80.6)	125	281	+156 (24.2)	-124 (30.6)
Maize-chickpea 120:60:60-25:50:00 (S_7)	358	435	426 (53.7)	367	388	+21 (2.6)	+30 (8.4)
Maize-mustard 120:60:60-50:40:00 (S_8)	346	510	520 (60.7)	336	371	+35 (4.1)	+25 (7.2)
Soybean-wheat 30:60:00-120:60:60 (S_9)	405	450	545 (63.7)	310	316	+6 (1.3)	-89 (22.0)
Soybean-chickpea 30:60:00-25:50:00 (S_{10})	381	165	515 (94.3)	31	404	+373 (68.3)	+23 (6.0)
Soybean-groudnut 30:60:00-25:50:00 (S_{11})	381	165	472 (84.4)	74	413	+339 (62.1)	+32 (8.4)
Greengram-safflower 20:40:00-50:50:00 (S_{12})	381	210	280 (47.4)	311	358	+47 (8.0)	+115 (30.2)

* Recommended fertilizer dose (kg ha^{-1}) for a crop

** Per cent of uptake or gain or loss

Table 2. Balance of available P kg ha^{-1} in crop sequences 1994-95 to 1996-97

Crop sequence	Initial fertility status	Added nutrient	Nutrient uptake	Expected balance	Actual fertility status 1996-97	Apparent gain (E-D)/ loss (D-E)	Actual gain (E-A)/ loss (A-E)
	A	B	C	D	E	F	G
Sorghum-wheat 100:50:40-120:60:60 (S_1)*	28	330	141 (39.4)**	217	47	-170 (47.5)**	+19 (67.9)**
Sorghum-chickpea 100:50:40-25:50:0(S_2)	30	300	155 (47.0)	175	49	-126 (38.2)	+19 (63.3)
Sorghum-sunflower 100:50:40-40:60:00 (S_3)	32	330	188 (51.9)	174	51	-123 (33.9)	+19 (59.4)
Cotton-wheat 50:25:00-120:60:60 (S_4)	37	255	143 (50.7)	139	39	-100 (35.5)	+2 (5.4)
Cotton-chickpea 50:25:00-25:50:00 (S_5)	48	225	119 (36.8)	204	51	-153 (47.4)	+3 (6.3)
Maize-wheat 120:60:60-120:60:60 (S_6)	50	360	198 (48.3)	212	40	-172 (42.0)	-10 (20.0)
Maize-chickpea 120:60:60-25:50:00 (S_7)	44	330	170 (45.5)	204	53	-151 (40.4)	+9 (20.5)
Maize-mustard 120:60:60-50:40:00 (S_8)	41	360	177 (44.1)	224	55	-169 (42.1)	+14 (34.1)
Soybean-wheat 30:60:00-120:60:60 (S_9)	39	360	160 (40.1)	239	38	-201 (20.4)	-1 (2.6)
Soybean-chickpea 30:60:00-25:50:00 (S_{10})	48	390	149 (32.5)	289	48	-241 (55.0)	0 (0.0)
Soybean-groudnut 30:60:00-25:50:00 (S_{11})	39	330	132 (35.8)	237	53	-184 (49.9)	-14 (35.9)
Greengram-safflower 20:40:00-50:50:00 (S_{12})	30	270	97 (32.3)	203	50	-153 (51.0)	+20 (66.7)

* Recommended fertilizer dose (kg ha^{-1}) for a crop

** Per cent of uptake or gain or loss

It could be concluded from the study that the sorghum-sunflower crop sequence showed highest P harvest while soybean-chickpea registered highest N uptake as compared to other crop sequences. Inclusion of legume crop in a sequence resulted in maintenance of soil N.

LITERATURE CITED

Chapman, H.D. and P.F. Pratt, 1961. Methods of analysis for soil, plant and water, Uni. Calif. USA.

Deka, J.C. and Y. Singh, 1984. Studies on rice based multiple crop sequences, III. Nutrient uptake studies. Indian J. Agron. 29 (4) : 490-494.

Maliwal, L. 1990. Response of phosphorus application in different phases of groundnut (*Arachis hypogea*)-wheat (*Triticum aestivum*) system on crop productivity and phosphorus uptake. Indian J. Agric. Sci. 60 (2) : 145-147.

Rana, D.S., S. Singh, K.N. Sharma, M.L. Kapur and J.S. Sodhi, 1983. Long term effect of nine different multiple cropping systems on some soil properties of a tolewal lomy sand (Typic Usthochrept). Indian J. Agric. Sci. 53(8) : 690-694.

Ravankar, H.N., R.B. Puranik and P.W. Deshmukh, 1998. Soil Fertility management with legume-wheat sequence. PKV Res. J. 22(1) : 15-18.

Singh, Kanwar and Kurinder Singh, 1991. Different wheat (*Triticum aestivum*) based cropping systems and their fertilizer requirement, yield and economic returns. Indian J. Agric. Sci. 61 (10) : 709-714.

Subbiah, B. and G.L. Asja, 1956. A rapid procedure for the determination of available nitrogen in soils. Curr. Sci. 25 : 259-260.

Verma, K.P., 1997. Productivity and economic of different crop sequences, Indian J. Agron. 42 (3) : 392-395.

Yadav, D.S. Alok Kumar, R.M. Singh and Achal Ram, 1991. Yield, economics and nutrient balance in cropping systems based on rice (*Oryza sativa*). Indian J. Agric. Sci. 61 (2) : 872-876.

Cropping System Research,
Main Centre,
Dr. PDKV, Akola

P. T. Kharkar
V. R. Thosar
R. K. Kolhe

Effect of Plant Densities and Age of Teak on Major Nutrient Status of Soil

Agroforestry is one of the land use system that involves deliberate retension, introduction or mixture of trees of other woody perennials in crop / animal production (Nair, 1984). The concept of this system implies the intengration of farming with forestry practice on the farm for the benefit of agriculture. Under this system trees contribute beneficial effects on soil through nitrogen fixation, uptake of nutrients from lower horizons, reduction in soil erosion, addition of organic matter etc. That help in improvement in soil properties. Keeping in view the benefits of agroforestry, the present study was taken up to assess the performance of teak on soil enrichment under the present semi arid conditions.

A field study was carried out at AICRP on Agroforestry, Futala farm, College of Agriculture, Nagpur during the year 1996-97 with an object to characterise the properties of soil under teak plantation having two age groups and different spacings. The teak plantation was done in the year 1991 with spacings viz. 2 x 1, 2 x 2, 3 x 1.5, 8 x 2 and 12 x 2 metre and in 1994 with a spacing of 3 x 3 metre.

The survey of the experimental site was carried out and taking into consideration the slope, drainage, soil colour and other surficial features, the sampling sites were selected. Pits were dug at the selected sampling sites under different spacing of teak plantation and the representative soil samples were collected horizonwise. The composite surface samples were also taken from all the spacing and both the age groups of teak plantation. The soil samples were air dried and crushed to pass through 2 mm sieve and were analysed as per the standard procedure (Jackson, 1967).

The data pertaining to the major nutrient status of soil and the increase over the initial nutrient status under different densities and age of teak plantation are presented in Table 1 and 2, respectively.

Total Nitrogen :

The data presented in Table 1 indicated that the total nitrogen content of the experimental site ranged from 0.052 to 0.074 per cent and it decrease with depth in all the pedons. The effect of teak on soil having different age and various spacings of teak plantation showed that the total nitrogen content increased from 13.72 to 195.8 per cent over initial value (Table 2). This increase was more in 1991 plantation than 1994 plantation. In case of spacing, it was observed that the increase in the total nitrogen content was more in closer spacing than wider spacing.

Available Phosphorus (P_2O_5) :

The available phosphorus content of the soil ranged from 44.17 to 59.49 kg ha^{-1}. The maximum available phosphorus was observed on pedon P_1 whereas minimum was recorded in pedon P_4. The available phosphorus content also decreased with depth.

The data presented in Table 2 revealed that the available phosphorus content increased in all the spacings and age of trees over the initial value. The increase was more in narrow spacing than the wider spacing. Amongst them 2 x 1 m spacing showed the highest increment (44.32%) in 1991 plantation. The 1994 plantation showed minimum rise

Table 1. Major nutrient status of soils under teak plantation

Pedon	Year of plantation	Spacing (m)	Horizon	Depth (cm)	Total N (%)	Avail. P_2O_5 (kg ha^{-1})	Avail. K_2O (kg ha^{-1})
P_1	1991	2 x 1	Ap	0-19	0.071	59.49	315.84
			A	19-39	0.067	45.48	295.68
			C_1	39-57	0.052	36.03	208.32
			C_2	57-86	0.045	43.05	141.12
P_2	1991	2 x 2	Ap	0-17	0.052	44.19	201.30
			C	17-37	0.047	31.83	107.09
P_3	1991	3 x 1.5	Ap	0-18	0.055	47.04	255.36
			C	18-35	0.046	38.98	235.20
P_4	1994	3 x 3	Ap	0-19	0.058	44.17	224.00
			C	19-35	0.054	38.97	203.34
P_5	1991	8 x 2	Ap	0 -18	0.061	45.04	239.34
			C	18-50	0.059	22.36	103.82
P_6	1991	12 x 2	Ap	0-18	0.061	46.88	254.40
			AC	18-45	0.057	24.78	161.28
			C	45-57	0.056	18.56	80.64
P_7	1991	12 x 2	Ap	0-14	0.074	48.69	252.42
			A	14-32	0.070	46.64	170.49
			C	32-63	0.053	43.92	164.78

Table 2. Changes in fertility status of surface soil under teak plantation

Year of plantation	Spacing (m)	Total N (%)		Avail. P_2O_5 kg ha^{-1}		Avail. K_2O kg ha^{-1}	
		A	B	A	B	A	B
1991	2 x 1	0.024	0.071 (195.80)	41.22	59.49 (44.32)	175.80	315.85 (79.65)
1991	2 x 2	0.024	0.052 (116.66)	41.22	44.19 (7.20)	175.80	201.30 (14.50)
1991	3 x 1.5	0.024	0.055 (129.16)	41.22	47.04 (14.11)	175.80	255.36 (45.25)
1994	3 x 3	0.051	0.058 (13.72)	43.80	44.17 (0.84)	175.80	224.00 (27.41)
1991	8 x 2	0.051	0.061 (19.60)	43.80	45.04 (2.83)	218.70	239.34 (9.43)
1991	12 x 2	0.051	0.061 (19.60)	43.80	46.88 (7.12)	218.70	254.40 (16.32)
1991	12 x 2	0.051	0.074 (45.09)	43.80	48.69 (11.16)	218.70	252.42 (15.41)

Note : A - indicates before plantation B - indicates after plantation
Figures in parenthesis indicates the per cent increase over initial value

in available phosphorus content. Similar results were also reported by Hazra (1990) and Prasad *et al.* (1985).

Available Potassium :

The available potassium content of soils ranged from 201.30 to 315.84 kg ha^{-1}. The pedon P_1 recorded the maximum (315.84 kg ha^{-1}) available potassium content whereas the pedon P_2 recorded minimum (201.30 kg ha^{-1}).

The various spacing and age of teak plantation showed increase in available potassium content over the initial value. The maximum (79.65%) increase in available potassium was noticed in 2 x 1 m spacing and minimum (9.43%) in 8 x 2 m spacing of 1991 plantation. In 1994 plantation, available potassium content increased from 175.80 to 224.00 kg ha^{-1} (27.41%) in 3 x 3 m spacing. Thus narrow spacing showed maximum increment than wider spacing and younger plantation. The increase in the available potassium content under plantation was also reported by Osman *et al.* (1995).

Hence, from the above discussion it is clear that closer spacing had enriched the soil comparatively more than wider spacing in terms of total nitrogen, available phosphorus and potassium content. This enrichment might be due to maximum litter fall which added organic matter to the soil causing more microbial activity in the soil. However, in general teak plantation helped to build up the nutrient status of these soils.

LITERATURE CITED

Hazra, C.R., 1990. Forage from subabool based agroforestry system and its influence on soil productivity. J. Soil and Water Conser. Indian 34 : 157-161.

Jackson, M.L. 1967. Soil chemical analysis, Printice hall of India Pvt. Ltd., New Delhi.

Nair P.K.R., 1984. Soil productivity aspects of agroforestry, ICARAF, Nairobi, Kenya.

Osman, K.T., S.M.S. Haque and N.M. Rahman, 1995. Effect of forest plantation on soil properties at Keochia silvipastural research station, Chittagaon. Ind. For. 121 (2) : 1108-1117

Prasad, K.G., S.B. Singh, G.N. Gupta and M. George, 1985. Studies on changes in soil properties under different vegetation. Ind. For. 111 (10) : 794-800.

AICRP on Agroforestry,
College of Agriculture, Nagpur

Nitu Khobragade
D.B. Matte
B.N. Patil
V.V. Gabhane
P.C. Pagar

Response of Chickpea (*Cicer arietinum* L.) Kabuli ICCV-2 to Irrigation and Fertilizer Levels

Chickpea (*Cicer arietinum* L.) is an most important pulse crop of India. Chickpea productivity is declining in Central Vidarbha Zone of Maharashtra state, there is a scope to enhance the production potential of crop with appropriate cultivars, an use of nitrogenous or phosphatic fertilizers with supplementary irrigation. In Chickpea pod development stage is the most critical inrespect of soil moisture stress but irrigation at early vegetative growth (branching) also benefit the crop in light soils (AICPIP, 1987). Since meagre information is available on conbined effects of irrigation and fertilizer levels on growth and yield of chickpea. Hence, an investigation was undertaken to evaluate the response of Kabuli cultivar (ICCV-2) of chickpea to irrigation and fertilizer.

A field experiment was conducted at National Reserch Project, Yavatmal during *rabi* seasons 1994-95, 1995-96 and 1996-97. The experimental soil was shallow low in N and available P_2O_5 and high in potash with soil pH 7.5 to 8.0. The treatments comprised of five (5) irrigation levels as a main plot and three (3) fertlizer levels as a sub-plot treatments. Main plot treatments consisted of I_1-30 DAS, I_2-45 DAS, I_3-30 + 45 DAS, I_4-45+65 DAS, I_5-35 + 45 + 65 DAS and sub-plot treatments were F_0- no fertilizer; F_1 = 9.23 kg N, P_2O_5 ha^{-1} (50 kg DAP ha^{-1}), F_2 - 18:46 kg N, P_2O_5 ha^{-1} (100 kg DAP ha^{-1}). These treatments are replicated thrice in a split-plot design. The cultivar used was ICCV-2 (Kubuli).

Three irrigation at 35, 45 and 65 DAS to chickpea crop at the stage of flowering, pod filling and pod development stages markedly contributed to increase in grain yield, recorded the significantly superior to one and two irrigation i.e. 35 ad 45 DAS from (Table 1). The availability of moisture along with nutrients at these cirtical stages of chickpea obiviously contributed to increase in growth attributes (Naresh *et al.*, 1985). The increased dry matter producing in turn might have resulted in greater synthesis of photosynthetic contributing to increase in pods plant^{-1}. The better plant growth and development of more pods plant^{-1} finally led to higher grain yields. In present investigation I_5 treatments recorded 11.57, 18.31, 25.22 and 31.55 per cent more yield than I_4, I_3, I_2 and I_1 respectively. Two irrigation i.e. I_3 recorded 8.46 and 16.2 per cent more grain yield than I_2 and I_1 i.e. at pod filling and flowering stage. Under irrigation contraints of irrigation at 45 and 65 DAS with 18 kg N + 46 kg P_2O_5 ha^{-1} (two bags of DAP ha^{-1}) resulted in higher grain yield. These results are in close confirmity with those of Reddy and Ahlawat (1988).

An application of (18 kg N + 46 kg P_2O_5 ha^{-1}), two bags of DAP ha^{-1} recorded higher yield (10.93 q ha^{-1}) of chickpea cv. ICCV-2 and it was significantly superior to control and half dose of N and P_2O_5 (9 kg N + 23 kg P_2O_5 ha^{-1}), (Table 1). The variable response of growth attributes in this treatment could be attributed to greater availability of two major nutrients i.e. N and P as compared to other treatments (Reddy

Table 1. Grain yield (q ha^{-1}) of chickpea as influenced by irrigation and fertilizer

Treatments	Grain yield (q ha^{-1})			Mean
	1994-95	1995-96	1996-97	
A. Irrigation				
I_1-30 DAS	8.66	9.58	7.42	8.22
I_2-45 DAS	9.37	9.56	8.01	8.98
I_3-30 + 45 DAS	10.56	10.01	8.88	9.81
I_4-45 + 65 DAS	11.45	10.95	9.47	10.62
I_5-30 + 45 + 65 DAS	12.80	13.55	9.68	12.01
SE ±	0.33	0.17	0.55	0.035
CD at 5%	0.99	0.53	1.67	0.73
B. Fertilizer levels				
F_0-0 kg N P_2O_5 ha^{-1}	9.15	10.20	7.18	8.84
F_1-9:23 kg N P_2O_5 ha^{-1}	10.53	10.57	8.95	10.01
F_2- 18:46 kg N P_2O_5 ha^{-1}	12.02	10.82	9.95	10.93
SE±	0.21	0.10	0.39	0.029
CD at 5%	0.62	0.28	1.12	0.49
C. Interation (A x B)				
SE±	0.49	0.23	0.89	0.065
CD at 5%	–	–	–	0.08

and Ahlawat, 1998). Appliction of N and P might have directly catered to the need of these nutrients to the crop. In fertilizer levels F_2 recorded significantly 19.2 and 8.41 per cent more yield than no fertilizer and 9:23 kg N and P_2O_5 treatment respectivley (Table 1). Improvement in yield is due to fertilizer with increased supply of P may be due to profuse nodulation leading to increased N-fixation which is in turn had positive effect of photosynthetic organs and rate. This is close agreement with the findings of Jain *et al.* (1999).

In view of the above, it can be concluded that, to obtained highest yield of chickpea (ICCA-2), the crop should be fertilized with 9 kg N + 23 kg P_2O_5 ha^{-1} (one bag of DAP ha^{-1}) with three irrigation at 30, 45 and 65 DAS. Under irrigation constraints two irrigations at 45 and 65 DAS be given with 18 kg N + 46 P_2O_5 ha^{-1} (two bags of DAP ha^{-1}) to chickpea crop.

LITERATURE CITED

AICPIP,1987. Consolidated report on *rabi* pulses (Agronomy) Project, Directorate of Pulses Research, Kanpur : 23-25.

Jain, P.C., P.S. Kushwaha, W.S. Dhakad, H. Khan and S.K. Trivedi, 1999. Response of chickpea (*Cicer arietinum* L.) to phosphorus and biofertilizer. Legume Research, 22 (4) : 241-244.

Naresh, N.R.N. and I.P.S. Ahlawat, 1998. Response of chickpea (*Cicer arietinum*) genotypes to irrigation and fertilizers under late-sown conditions. Indian J. Agron. 43 (1) : 95-101.

Asstt. Prof. of Agronomy, NARP, CVZ, Yavatmal
Research Associate, Dept. of Horticulture, Dr. PDKV, Akola
Asstt. Prof. of Entomology, NARP, CVZ, Yavatmal
Senior Research Assistant, NARP, CVZ, Yavatmal

N.D. Parlawar
R.M. Adpawar
P.V. Yadgirwar
S.B. Bhoyte

Reaction of Cotton Genotypes to Bollworms Under Rainfed Condition

Bollworms are the most destructive among the pests of cotton causing heavy losses in yield as reported by Krishnamoorthy and Paul in 1973. It has also been estimated by these workers that nearly 93 per cent of bolls and floral parts are shed due to bollworm attack. Hence the present study was undertaken to find out reaction of various cotton genotypes/varieties to bollworms grown in demonstration plots under rainfed condition.

A non replicated field experiment was conducted at Cotton Research Project, Dr. PDKV, Akola during 1999-2000 *kharif* season under rainfed condition. Seven *Gossypium arboreum* genotypes/varieties, 12 *G. hirsutum* genotypes/ varieties and 11 *intra hirsutum* hybrids were grown in 3.6 x 7.2 m plot size with a recommended spacing and other agronomic practices. No plant protection measures were undertaken on *arboreum* varieties while four sprays viz. monocrotophos 36 EC 0.06 per cent, endosulfan 35 EC 0.05 per cent + COC, carbaryl 50 WP 0.2 per cent and fenvalerate 20 EC 0.0125 per cent were applied on *hirsutum* varieties/ genotypes and *intra hirsutum* hybrids to control pests and diseases. Observations were recorded on open boll damage due to bollworm complex at harvest, loculi damage due to

Table 1. Reaction of various cotton genotypes to bollworm complex at harvest under rainfed condition

S.N.	Cotton variety/ genotype	Av. % damage due to bollworm complex in open bolls at harvest	Av. % locule damage due to bollworm complex	Av. % locule damage due to pink bollworm
A. *Arboreum* varieties/genotypes				
1	AKH-4	53.33	16.56	8.69
2.	AKA-5	20.00	6.52	2.17
3	AKA-8401	37.50	12.24	6.12
4	AKA-7	40.00	13.33	4.44
5	Y-1	43.75	14.28	8.16
6	PA-141	20.00	6.52	2.17
7	PA-183	20.00	6.52	4.35
B. *Hirsutum* varieties/genotypes				
1	DHY-286	53.33	13.33	10.00
2	AKH-081	40.00	11.66	8.33
3	PKV-Rajat	37.50	9.23	4.61
4	AKH-8801	43.75	12.50	7.81
5	AKH-8931	31.25	8.19	4.92
6	AKH-8263	40.00	9.83	6.56
7	AKH-8828	20.00	4.92	3.28
8	LRA-5166	28.57	10.71	5.36
9	LRK-516	40.00	9.83	4.92
10.	JLH-168	42.86	10.71	5.36
11.	PH-93	16.66	4.16	2.08
12.	NH-452	40.00	11.47	4.92
C. *Intra hirsutum* hybrids				
1	PKV Hy-2	53.33	13.11	4.92
2	PKV Hy-3	50.00	14.58	8.33
3	PKV Hy-4	40.00	10.00	6.66
4	PKV Hy-5	33.33	8.33	5.00
5	CAHH-25	40.00	11.66	5.00
6	CAHH-70	46.15	15.38	9.61
7	CAHH-98	38.46	9.43	5.66
8	NHH-44	40.00	9.68	4.84
9	PHH-316	26.66	6.66	3.33
10	H-8	26.66	6.56	3.28
11	H-10	40.00	11.47	8.19

bollworm complex and pink bollworm at harvest by plucking opened bolls from randomly selected five plants from each plot after last picking was over.

The data presented in Table 1 revealed that in seven *arboreum* varieties/genotypes, the open boll damage at harvest, loculi damage due to bollworm complex and pink bollworm ranged from 20.00 to 53.33 per cent, 6.52 to 19.56 per cent and 2.17 to 8.69 per cent, respectively. Minimum open boll damage and loculi damage due to bollworm complex was recorded in AKA-5, PA-141, PA-183, where as minimum loculi damage due to pink bollworm was recorded in AKA-5 and PA-141. In twelve *hirsutum* varieties/genotypes the open boll damage, loculi damage due to bollworm complex and pink bollworm ranged from 16.66 to 53.33 per cent, 4.16 to 13.33 per cent and 2.08 to 10.00 per cent, respectively. Minimum open boll damage and loculi damage due to bollworm complex was recorded in PH-93 followed by AKH-8828. In 11 *intra hirsutum* hybrids/genotypes the open boll damage, loculi damage due to bollworm complex and pink bollworm ranged from 26.66 to 53.33 per cent, 6.56 to 15.38 per cent and 3.28 to 9.61 per cent, respectively. Minimum open boll damage and loculi damage due to bollworm complex was recorded in H-8 followed by PHH-316 and PKV Hy-5.

It is concluded from the present study that amongst *arboreum* varieties/genotypes minimum bollworm complex damage at harvest was recorded on AKA-5, PA-141 and PA-183 under unprotected condition where as amongst *hirsutum* on PH-93 and amongst *intra hirsutum* hybrids on H-8 under protected condition.Anonymous (1997) reported similar type of results in respect of *arboreum* varieties/genotypes.

LITERATURE CITED

Anonymous, 1997. Annual progress report of cotton research (Entomology) 1996-97.

Krishnamoorthy, C. and Deenbandhu M. Paul, 1973. Chemical control of bollworm on deshi cotton (*Gossypium arboreum*) in Andhra Pradesh Ind. *Cott. Grow. Rev.* 17 (4) : 222-225.

Asstt. Entomologist, AICCIP, Dr. PDKV, Akola — H.G. Dandale
Asstt. Prof. of Entomology, Dr. PKDV, Akola — N.G.V. Rao
Junior Research Fellow, Dept. of Entomology, Dr. PDKV, Akola — S.N. Tikar

Effect of Square Planting of Cotton PKV-Rajat on Bollworm Incidence Under Rainfed Condition

A non replicated field expriment was conducted during 1997-98 to 1999-2000 for cropping seasons, under rainfed condition to see the possibility of adopting square planting in rainfed cotton PKV-Rajat and its effect on bollworm incidence at Cotton Research Unit, Dr. PDKV, Akola. The cotton variety PKV-Rajat was sown as per treatments : 1) Recommended spacing of 60 x 30 cm with one plant hill^{-1} 2) Square planting at 60 x 60 cm spacing with 2 plants hill^{-1} 3) Planting at 90 x 20 cm spacing with one plant hill^{-1}. The gross plot size was 37.2 x 15.0 m^2 and net size was 36 x 13.8m^2 for treatments no. 1 and 2, and 36 x 13.50 m^2 for treatment number 3. The other agronomical practices were followed as per recommendations for raising the crop. Three sprays of recommended chemical insecticides and one spray of fungicide were given on all the treatment plots to control pests and diseases.

The observations on open boll damage at harvest, loculi damage due to bolloworm complex and pink bollworm were recorded by plucking opened bolls from randomly selected 5 plants from each plot after last picking. Yield of seed cotton was also recorded. From the data of 3 years (1997-98 to 1999-2000) average open boll damage at harvest, average loculi damage due to bollworm complex, average loculi damage due to pink bollworm and average yield of seed cotton was calculated and presented in Table 1. From the data presented in Table 1, it was revealed that minimum open boll damage at harvest was 36.36 per cent, minimum loculi damage due to bollworm complex was 15.94 per cent, minimum loculi damage due to pink bollworm was 8.08 per cent and maximum yield of seed 8.73 q ha^{-1} was recorded in 60 x 30 cm spacing with one plant hill^{-1} followed by the planting treatment of 90 x 20 cm spacing with one plant hill^{-1}. Least effective was the square planting of cotton PKV-Rajat at 60 x 60 cm spacing with two plants hill^{-1}.

It can be concluded that the recommended spacing of 60 x 30 cm with one plant hill^{-1} for cotton variety PKV-Rajat is most suitable under rainfed condition, taking into consideration the minimum bollworm incidence and maximum yield of seed cotton obtained in this spacing under rainfed condition. Identical results were reported by Anonymous (1998 and 1999).

Table 1. Effect of various planting spacings in cotton variety PKV-Rajat on bollworm incidence and yield of seed cotton (1997-98 to 1999-2000)

S.N.	Treatments	Av. % damage due to bollworm complex in open bolls at harvest	Av. % locule damage due to bollworm complex	Av. % locule damage due to pink bollworm	Average yield of seed cotton (qt ha^{-1})
1.	60 x 30 cm spacing with one plant hill^{-1}	36.36	15.94	8.08	8.73
2.	60 x 60 cm spacing with two plants hill^{-1}	55.01	21.93	11.51	5.97
3.	90 x 20 cm spacing with one plant hill^{-1}	43.27	20.38	14.98	7.54

LITERATURE CITED

Anonymous, 1998. Annual Progress Report of Cotton Research (Entomology) 1997-98 submitted by plant protection R.R.C. meeting held on 20th and 21st April 1998 :55-56.

Anonymous, 1999. Annual Progress Report of Cotton Research (Entomology) 1998-99 submitted by plant protection R.R.C. meeting held on 12th and 13th April 1999 :66-68.

Asstt. Entomologist, AICCIP, Dr. PDKV, Akola
Asstt. Prof. of Entomology, Dr. PKDV, Akola
Junior Research Fellow, Dept. of Entomology, Dr. PDKV, Akola

H.G. Dandale
N.G.V. Rao
S.N. Tikar

Occurrence of Rust and Other Diseases on Soybean in Yavatmal District

Soybean (*Glycine max* L. Merril) is an important oilseed and pulse crop of India. During last few years, the area under soybean is now fast increasing in the Central Vidarbha as sole crop and as intercrop with cotton. Studies were, therefore undertaken to collect information of the incidence of soybean rust and other disease in the area.

During the year 1999-2000 and 2000-2001, survey of July sown soybean crop was undertaken in Yavatmal district. In soybean field, 1 x 1 m area at two locations were marked for recording disease observations. Intensity of foliar diseases was worked out as per the scale 1-9 given by XVII Annual Soybean Workshop held at Indore (1986-87).

The survey report revealed that *Myrothecium* leaf spot, bacterial pustules and collar rot diseases were commonly observed in the area during both the year. However, rust infection was noticed only in the year 1999-2000. Rust disease incited by *Phakopsora pachyrhizi* Syd. (Sathe, 1972) was observed on cv. JS-335 and PKV-1 at crop maturity stage in october, 1999 especially at Yavatmal and Arni tahsils. Rust infection was observed only on leaves with numerous, reddish brown rust pustules on the lower surface (Fig. 1). Severely infected plants are defoliated. Infection was not observed on pods. The rust severity was 11.44 - 11.85 per cent. The symptoms were more or less similar to the symptoms reported by Rao *et al.* (1995) who have reported disease from Sangli and Kolhapur district. Information regarding occurrence of rust in Yavatmal district is not available so far.

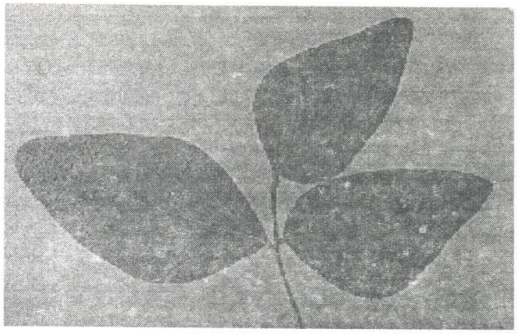

Fig. 1. Leaflets of soybean (PKV-1) showing rust symptoms caused by *Phakopsora pachyrhizi* Syd.

Intensity level of bacterial pustules (*Xanthomonas phaseoli* cv. sojense) was 13.3 - 27.2 per cent on cv. PKV-1 and JS-335 at pod development stage. While intensity level of *Myrothecium* leaf spot disease was 12.6-23.7 per cent at preflowering stage on both the cultivar. Manglekar and Raut (1997) reported cv. JS-335 free from bacterial pustules infection at Yavatmal. But noticed infection on variety PKV-1 and Monneta at pod development stage (at Yavatmal) and *Cercospora* leaf spot at Tharsa (Dist. Nagpur).

Collar rot caused by *Sclerotium rolfsii* was noticed on cv. JS-335 and had 0-11 per cent disease incidence. Severity of disease was higher at pod development stage than seedling stage. Manglekar and Raut (1997) reported infection of *S. rolfsii* only at Akola during the survey.

LITERATURE CITED

Manglekar, R.K. and J.G. Raut, 1997. Survey of soybean disease in Vidarbha and influence of few diseases on plant and yield parameters. PKV Res. J. 21(1) : 103-104.

Rao, V.G., V.M. Raut and V.P. Patil, 1995. Out-break of soybean rust in Maharashtra. J. Maharashtra Agric. Univ. 20 (3) : 479-480.

Sathe, A.V., 1972. Indentity and Nomenclature of soybean rust from India. Curr. Sci. 41 : 264-265.

Zonal Agricultural Research Station,
C.V. Zone, Waghapur Road,
Yavatmal

S.W. Khodke
D.V. Mali
U.S. Kulkarni
A.A. Bhopale

Nitrogen Content in Fruit Rotting Fungi of Chilli in Relation to the Virulence

In Vidarbha region of Maharashtra *Alternaria alternata* (Fr.) Keissler, *Colletotricum dematium* (Fr.) Groove and *Rhizoctonia bataticola* (Taub) Bult. are the predominant fruit rotting fungi of chilli. Nitrogen is used for both structual and functional purpose by fungi and various nitrogenous compound essential for metabolic activities of living organisms have also determined in several fungi (Bilgrami and Roy, 1977). Total nitrogen in fungi ranging from 1.34 per cent to 9.27 per cent have been reported (Norman,1933). Nitrogen contents of fungi varied with species, its age and composition of medium (Ghosh and Sen, 1973). An increase in the amount of nitrogen in the medium usually leads to increase in cellular nitrogen upto a certain limit (Bilgrami and Roy, 1977, Somani and Raut, 1984).

In the present investigations an attempt has been made to determine the nitrogen content in the fungal structure in relation to the degree of pathogenicity.

Czapek's Dox medium was taken as a basal medium. Sodium nitrate was added seperately to be the basal medium to obtain nitrogen concentration ranging from 72.94 mg to 291.79 mg 100 ml^{-1}. One hundred ml of basal medium was distributed in 250 ml conical flask, sterilized and inoculated with 5 mm disc of week old actively growing culture on PDA and incubated at room temperature for ten days. At the termination of experiment, sporulation was observed and the mycelial weights were recorded. Total nitrogen of each isolate was determined by using rapid micro-Kjeldahl's method (Concon and Soltess, 1973). Percentage of fruits infected by organisms grown on different nitrogen concentation was determined by inoculation spore suspension on ripe chilli fruits *in vitro*. The inoculated fruits were kept in moist chambers for 10 days at room temperature and after inoculation period, the per cent disease intensity were recorded and calculated as per the pathometric scale suggested by Mayee and Datar, 1986. The data was converted into per cent disease intensity by using formula suggested by Mayee and Datar, 1986.

On the basis of data given in Table 1, none of the fungi viz., *A. alternata, C. dematium and R. bataticola* were able to consume total amount of nitrogen during the incubation period. In case of *A. alternata* 1.5 to 2.0 g of sodium nitrate $litre^{-1}$ gave maximum dry mycelial yield. The dry mycelial yield of *C. dematium* was highest when 1.5 g sodium nitrate was added in the medium. However, in case of *R. bataticola* dry mycelial weight was maximum when 1 to 2 g of sodium nitrate was incorporated in the medium. The mycelial yield of *A. alternata* and *C. dematium* decreased with the increased nitrogen content in the medium, whereas in case of *R. bataticola* no linear increase or decrease in mycelial yield was noticed with increase in nitrogen content in the medium. Ghosh and Sen (1973) reported that dry weight of *Macrophomina phaseoli* was increased with concentration upto 0.1 per cent N but a level of 3 per cent there was a distinct fall in the dry weight of the isolate S_1 obtained from roots of wilted *Justica gendarusa* L.

Sporulation in *A. alternata* was noticed only when 1.5 to 2 g sodium nitrate was added in the medium. However, in *C. dematium* abundant sporulation was noticed at lowest N dose. The sporulation was moderate where 3 g sodium nitrate $litre^{-1}$ of medium was added but thereafter with increasing N dose there was a reduction in sporulation. As regards to sclerotial formation in *Rhizoctonia*, 2 to 3 g sodium nitrate $litre^{-1}$ of medium was found best.

Per cent nitrogen assimilated by *A. alternata* could not be correlated with virulence of the fungus. However, nitrogen content in *C. dematium* and *R. bataticola* culture was found to reflect on the degree of virulence of each of these pathogens. Similar results are reported by Bilgrami and Roy (1977), Somani and Raut (1984) in case of *C. capsici*. Ghosh and Sen (1973) opined that dry mycelial production related to virulence is a general phenomenon however this could not possible be used a parameter for virulance rating. Information regarding *Alternaria sp.* on these aspect is not available so far.

Table 1. Nitrogen content in fruit rotting fungi of chilli and its relation with virulence

Quantity of Nitrogen in Sodium Nitrate per litre of medium (g)	100 ml of medium (mgs)	Mean dry wt. of fungal structure (mgs) Av. of three			Sporulations/Sclerotial formation			Per cent N assimilated 100 mg^{-1} of fungal structure			Per cent disease intensity (PDI)		
		Aa	Cd	Rb	Aa	Cd	Rb	Aa	Cd	Rb	Aa	Cd	Rb
1.0	72.94	401.00	429.00	100.33	NIL	Abundant	Medium	4.48	1.12	4.20	18.51	19.66	41.66
1.5	109.42	435.00	629.66	99.33	Medium	Good	Medium	5.04	3.08	2.24	46.66	53.33	29.16
2.0	145.89	479.33	305.66	99.66	Good	Good	Good	5.32	3.36	3.64	56.66	58.33	33.33
2.5	182.37	462.00	262.33	70.33	NIL	Good	Good	7.56	1.82	1.96	54.16	30.00	27.77
3.0	218.84	395.00	205.66	74.33	NIL	Medium	Good	5.32	2.94	2.24	41.16	38.88	30.55
3.5	255.32	382.00	167.00	76.00	NIL	Poor	Medium	5.04	2.89	3.92	16.16	33.33	36.66
4.0	291.79	313.00	164.00	76.66	NIL	Poor	Medium	4.20	1.96	2.52	08.33	30.95	33.33

Aa = *Alternaria alternata*
Cd = *Colletotricum dematium*
Rb = *Rhizoctonia bataticola*

LITERATURE CITED

Bilgrami, K.S. and A.K. Roy, 1977. Nitrogen content in four isolates of *Colletotricum dematium* in relation to their virulence. Indian phytopath 30 (2) : 262-263.

Concon, J.M. and d. Soltess,1973. Rapid micro-kjeldahl's digestion of cereals grains and other biological materials. Anal Biochem. 53 : 35-41.

Ghosh S.K. and C. Sen, 1973 a. Nitrogen requirements of four isolates of *Macrophomina phaseoli* (Maub) Ashby. Proc. of the Indian Nat. Sci. Academy 39 (i) Part - B, Bio. Sci. : 221-227.

Ghosh, S.K. and C. Sen, 1973 b. Comparative physiological studies on four isolates of *Macrophomina phaseoli*. Indian phytopath 26 (4) : 615-621.

Mayee, C.D. and V.V. Datar, 1986. Phytopathometry. Tech. Bulletin - 1 : 18-24 (Marathwada Agril. University, Parbhani).

Norman, A.G., 1933. Ann. Appl. Bio. 20 : 146-164.

Somani, R.B. and B.T. Raut, 1984. Nitrogen content in ten isolates of *Colletotricum capsici* in relation to the virulence. PKV Res. J. 8 (2) : 69-70.

Zonal Agricultural Research Station,
C.V. Zone, Waghapur Road, Yavatmal

S.W. Khodke

Pathogenicity of *Alternaria alternata* (Fr.) Keissler Causing Leaf Spot Disease of Chilli

Infected chilli leaves of cv. G-4 collected from cultivators field in Yavatmal district in the month of March, 1999. The infected leaves were showing circular, brown or black spots of varying sizes with concentric zonation.

The fungus, *Alternaria alternata* was isolated in pure culture. For pathogenicity, chilli seedling of variety Jayanti were raised in earthen pot with sterilized soil under controlled conditions. Ten chilli plants inoculated with spore/ mycelial suspension, inoculation were made by making injury with little quantity of carborendum powder (600 mesh). For fruit inoculation followed detached fruit method. Inoculated plants and ripe fruits were incubated under controlled conditions for 10-15 days.

The inoculated chilli leaves developed characteristic disease sysmptom as recorded in the field. The ripe chilli fruits showed infection of the fungus.

The identity of causal fungus was confirmed by comparing the morphological and cultural characters with the description of fungus published by Ellis (1971) and Sreekantiah *et al.* (1973).

Out of six solid media tested, *A. alternata* grows well on all media except plain agar media (Table 1). The best growth of the fungus and abundant sporulation was observed on Richards agar, potato dextrose agar, Czapek's agar and oat meal agar media. Moderate growth and sporulation was found on Asthana and Hawkers media whereas no growth was observed on plain agar media. Similar results were noted by Gaddankeri and Kulkarni (1988) in *A. alternata* causal agent of leaf blight of turmeric.

Table 1. Growth and sporulation of *A. alternata* on different cultural media

S.N.	Cultural media	Av. colony diameter (mm) on 8th day after inoculation	Sporulation
1.	Asthana and Hawkar	51.3	Moderate
2.	Czapek Dox agar	78.3	Abundant
3.	Oat meal agar	72.6	Abundant
4.	Potato dextrose agar	81.6	Abundant
5.	Richards agar	85.6	Abundant
6.	Plain agar	–	Nil

LITERATURE CITED

Ellis, M.B., 1971. *Dematiaceous hypomycetes*, Kew, survey CMI, England : 465-466.

Gaddankeri, M. and S. Kulkarni, 1998. Nutritional studies on *Alternaria alternata* (Fr.) Keissler - A causal agent of leaf blight of Turmeric (*Curcuma longa* L.) Karnataka J. Agric. Sci. II (4) : 1098-1100.

Sreekantiah, K.R., K.S. Nagaraja Rao and T.N. Ramchandra Rao, 1973. A virulent strain of *Alternaria alternata* causing leaf and fruit spot of chilli. Indian phytopath 26 : 600-603.

Zonal Agricultural Research Station,
C.V. Zone, Waghapur Road,
Yavatmal

S.W. Khodke
R.V. Pawar
A.A. Bhopale

Biochemical Changes in Rotted Chilli Fruits

Fruit rot is a serious disease of chilli in Vidarbha region of Maharashtra, causing both qualitative and quantitative losses. The disease is caused by *Collectotricum dematium* (Pers. ex. Fr.) Groove, *Alternaria alternata* (Fr.) Keissler and *Rhizoctonia bataticola* (Taub) Butl. To ascertain the qualitative losses, the biochemical changes in the infected fruits brought about by these fungi were studied in present investigations.

Chilli fruit sample of var. CA-960 from healthy and diseased lots showing 50 per cent and above infection were analysed for various biochemical constituents. Nitrogen was estimated by rapid micro-Kjeldahl's method (Concon and Soltess, 1973). Ascorbic acid, sugars and capsaicin contents were determined following method suggested by Ranganna (1977), Brown and Zerban (1941) and Bajaj and Kaur (1979) respectively. Due to non availability of pure capsaicin, the healthy fruit extract was taken as a check and compared with the extract obtained from infected fruits on Spectronic-20 at 760 nm by absorbtion and prepared a graph.

It is evident that ascorbic acid, sugar (total, reducing and non reducing and capsaicin content (Fig.1) were reduced however, nitrogen content was increased in *A. alternata, C. dematium* and *R. bataticola* infected fruits than healthy (Table 1). The decrease of ascorbic acid in infected chilli fruits were also reported by Azad, 1991. According to Tandon (1970), the losses of Vit. C under pathogenesis may be due to the production of ascorbic acid degenerating enzymes either by the fungus alone or by the host pathogen complex. The considerable reduction in quantity of sugars in diseased fruits may be due to its utilization by the fungi for their

Table 1. Biochemical changes in healthy and infected chilli fruit of cv. CA 960

S.N.	Biochemical constituent	Healthy fruits	Infected fruits due to *A. alternata*	Increase (+)/ decrease (-) over healthy	*C. dematium*	Increase (+)/ decrease (-) over healthy	*R. bataticola*	Increase (+)/ decrease (-) over healthy
1.	Nitrogen (per cent)	2.10	2.33	+10.95	2.44	+16.19	2.48	+18.10
2.	Ascorbic acid (mg 100 g^{-1})	48.02	8.32	-82.67	6.79	-85.86	5.66	-88.21
3.	Sugar (per cent)							
	Reducing	0.92	0.56	-39.13	0.45	-51.09	0.46	-50.00
	Non Reducing	0.60	0.30	-50.00	0.32	-46.67	0.27	-55.00
	Total	1.52	0.86	-44.57	0.77	-48.86	0.73	-52.20

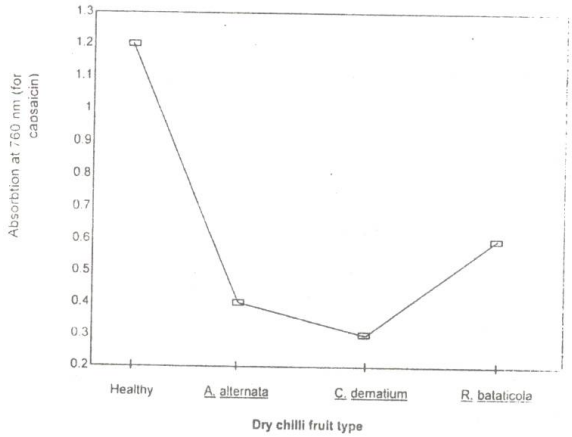

Fig. 1. Diagramatic representation of capsaicin content in healthy and diseased chilli fruit of cv. CA-960 by absorbtion on Spectronic-20 at 760 nm

growth and development. Anahosur and Naik (1988) recorded similar observations. Reduction in capsaicin content in chilli fruits were reported by Azad, 1991. The Nitrogen content in chilli fruits infected with all the studied fungi was increased. However, Azad (1991) reported reduction in nitrogen content in chilli fruits due to *Colletotricum capsici.*

LITERATURE CITED

Anahosur, K.H. and S.T. Naik, 1986. Changes in sugar and phenol content of root and stalk of sorghum due to *Macrophomina phaseolina* infection. Indian Phytopath 39(3) : 440-441.

Azad, P., 1991. Fate and role of chemical constituents of chilli fruits during infection with *Colletotricum capsici.* Indian Phytopath 44(1) : 129-131.

Bajaj, K.L., and S. Kaur,1971. Microchemic Acts 1 : 81-86.

Brown, C.A. and W. Zerban, 1941. Physical and chemical methods of sugar analysis, 3rd Edn. John Willey and Sons. Inc. London.

Concon, J.M. and D. Soltess, 1973. Rapid Micro-Kjeldahl's digestion of cereals grain and other biological materials, Anal. Biochem 53 : 35-41.

Ranganna, S., 1977. Manual of analysis of fruits and vegetable products. Tata Mc. Grow Hill pub. Co. Ltd., New Delhi : 94-96

Tandon, R.N., 1970. Certain problems of post harvest diseases of fruits and vegetales. Indian Phytopath 23 (1) : 1-15.

Zonal Agricultural Research Station,
C.V. Zone, Waghapur Road, Yavatmal

S.W. Khodke
S.G. Wankhede

Particulars about PKV Research Journal as per Press and Regulation of Book Act (Clause 8)

FORM IV

1.	Place of publication	: Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
2.	Periodicity of publication	: Six Monthly
3.	Printers name	: Sau. Sunita Thakre
4.	Nationality	: Indian
5.	Address	: Pooja Prints, Maharshidwar Apartment, Raut Wadi, Akola Ph. 2451864
6.	Publishers name	: Dr. S.V. Sarode
7.	Nationality	: Indian
8.	Address	: Director of Research, Dr. PDKV, P.O. Krishi Nagar, Akola
9.	Editor-in-Chief	: Dr. S.V. Sarode
10.	Nationality	: Indian
11.	Address	: Editor-in-Chief, Dr. PDKV, P.O. Krishinagar Akola - 444 104 (Maharashtra)
12.	Owners Name	: Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

I Dr. S.V. Sarode declare that the particulars given above are true to the best of my knowledge and belief.

Date : Feb. 2003

Dr. S.V. Sarode
Publisher

SUGGESTIONS FOR AUTHORS

General : The PKV Research Journal is published twice a year to promote the cause of research and disseminate the knowledge in the field of agricultural Sciences. Subject matter should fall in the categories of (i) Original research articles (ii) Research notes and (iii) Review papers.

Manuscript : It should be typed on full scape good quality, double spaced, on one side of the page only, with sufficient margin, 5 cm on the left side and 2.5 on each of the remaining sides. The author(s) may submit paper in duplicate. He may not type his name, designation and acknowledgement on the first copy. All sheets in the copy should be of one side only and should not ordinarily exceed 10 in number including tables. Writing style should be simple, concise and precise. Presentation of article should have the components in the following sequence : Title, Name(s) of author(s), FOOT NOTE, ABSTRACT, INTRODUCTION (without heading), MATERIAL AND METHODS, RESULTS AND DISCUSSION, ACKNOWLEDGEMENT if any and LITERATURE CITED. Format of Research note may be as per the pattern of PKV Res. J. Vol. 17 No. 2 of 1992. All calculations, tables, figures, names, quotations, citations, etc. should be carefully verified before submission.

The metric system of measurements should be followed and standard abbreviations be used.

The paper need necessarily to be accompanied by an undertaking that it is not published earlier in any journal. The author(s) are advised to adhere to the format of this journal strictly. In the event of not following the format, the paper(s) may not be attended to.

Title : The title of the article should be short and precise and should be followed in the next line, by name(s) of author(s). Foot note on the first page should include the department(s) contributing the article, designation and present address of author(s).

Abstract : Concise summation of findings not exceeding 200 words should be written at the begining of the papers. The abstract should start with the objective. It should bring out the salient features of the work. It should be intelligible without reference to the original paper. It should be written in such a way that will facilitate abstracting of the paper in the world of abstracts.

Table : Type each table on a separate sheet. They should be numbered in arabic numerals with title of the table in the same line. Table should be placed at the end of the manuscript, but its place in the text should be indicated.

Figures : Identify graphs, line drawings and photographs with cosecutive arabic numbers as Fig. 1, Fig. 2. Place figures after tables. Photographs must be clear, glossy prints. Original graphs and drawing must be in Indian ink or equivalent on plain white drawing paper. Lettering should be large and bold enough to permit reduction. Each figure number should placed on the back of each figure in pencil for identification.

Nomenclature : The latin binomial or trinomial and authority must be shown for all plants, insects and pathogens at first listing either in the title or when first mentioned in the text. Crop varieties (not experimental lines and strains) should be identified by a single quotation mark at first listing only. Generic and specific names should be in Italic e.g. *Lycopersium esculentum* Mil Morgtobe.

References : They should be double spaced throughout and arranged alphabetically according to author's names and should be placed under the heading **"LITERATURE CITED"** at the end of the article. Each reference should contain the name of author with initials, the year of publication, title of article, the abbreviated title of publication, volume and page e.g.

Deshmukh, V.A. and V.R. Padole, 1981. Effect of carbofuran on yield and uptake of NPK by hybrid sorghum CSH 1. J. Maharashtra agric. Univ. 6(1) : 25-27.

Taley, Y.M.,B.S. Rajurkar and K.R. Thakare, 1981. Bionomics of *Atherigona soccata* Rondani (Diptera: Anthomyidae) PKV Res. J. 5(1):62-68.

In the text, the reference should be indicated by author's name followed by year of publication. When more than one paper by the same author appears in a single year they should be distinguished as a,b,c.....

Please refer to annexure of PKV Res. J. Volume 11(2), 1987 for abbreviations of journals to be given under **LITERATURE CITED.**

Correspondence : Manuscripts should be sent in duplicate directly to Editor-in-Chief, PKV Research Journal, Directorate of Research, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola - 444 104 (Maharashtra). Manuscripts are examined by the Editorial Board and referred to competent referees.

The Editorial Board takes no responsiblity for the facts of the opinions expressed in the journal which rests entirely with the authors.

Published by Dr. S.V. Sarode, Director of Research, Dr. PDKV, Akola for and on behalf of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India in 2003 and Printed by him at Pooja Prints, Raut Wadi, Akola. Ph. (0724) 2451864