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Effect of Zinc With and Without FYM on Forage Production, Quality and Zinc Nutrition of Forage Sorghum Genotypes

P. C. Patel and J. R. Patel

A. I. C. R. P. on Forage Crops, Gujarat Agricultural University, Anand Campus, Anand

ABSTRACT

A field trial was conducted in an alluvial soil (Orchrept) using six important genotypes of forage sorghum and five Zn levels with and without FYM at Forage Research Farm, Anand (Gujarat). Among six genotypes, promising hybrids AS-15 and AS-22 produced significantly higher green forage (GF) and dry matter (DM) yields as compared to the existing varieties in total of two cuts in the pooled analysis. Hybrid AS-11 was at par with the M.P.Chari and S.S.G.59-3 for DMY. These hybrids were found to be relatively more responsive, S-1049 was least responsive and AS-11, M. P .Chari and S.S.G. 59-3 were medium responsive to Zn application. Application of ZnSO_4 produced significantly higher DM and CP yields as compared to no Zn (control). Application of 25 kg ZnSO_4 alongwith 10 T FYM/ha showed significantly higher DM accumulation as compared to Zn alone during 1988, 1989 and in pooled analysis indicating the addition effect of FYM. Zinc content of forage sorghum was higher in Zn levels having FYM as compared to those without FYM. Application of 25 kg ZnSO_4 alongwith 10 T FYM/ha significantly enhanced the Zn uptake by the crop as compared to Zn alone which ultimately increased DM and CP yields of sorghum. Among existing varieties, application of 25 kg ZnSO_4 /ha alone and alongwith 10 T FYM/ha to the variety S.S.G. 59-3 gave 10 and 20 per cent higher CPY, respectively over control. Application of 25 kg ZnSO_4 alongwith 10 T FYM/ha to S.S.G. 59-3 showed the maximum total return *in vitro* dry matter digestibility and digestible dry matter whereas higher incremental cost benefit ratio of 1:4.47 was obtained when 25 kg ZnSO_4 /ha was applied.

(Received on 10th July, 93)

INTRODUCTION

Dry matter production of forage sorghum varieties was increased due to application of zinc sulphate in the soil (Nair, 1980). Dangarwala *et al.* (1983) reported Zn status of soils of Kheda district, Gujarat State as deficient in 14 % , medium in 43 % and sufficient in 43 % of soils. zinc deficiency is not only adversely affects plant growth but also impairs health of milch animals. The use of

organic manures may play a significant role in increasing the availability of Zn in deficient soil by formation of complexes with polyvalent cations. Relatively little work has been reported in Gujarat regarding the efficiency of zinc alone or in combination with FYM to forage sorghum. Thus, the experiment was conducted on multicut types of forage sorghum to find out the effect of zinc, with and without FYM on growth and forage production of sorghum during summer season.

TABLE 1

Green forage, dry matter and crude protein yields of forage sorghum genotypes as influenced by zinc treatments with and without FYM (total of two cuts).

[illegible]

MATERIALS AND METHODS

A field experiment was conducted during the summer seasons of 1987 to 1989 on an alluvial soil (Orchrept) having pH 8.3, low in N (163.3 kg/ha), medium in available phosphorus (38.1 kg P_2O_5 /ha) and potassium (238 kg K_2O /ha), EC 0.22 mmhos/cm and low DTPA extractable Zn (0.54 ppm). A basal dose of 40 kg N/ha each of N and P_2O_5 was given as urea and superphosphate, respectively. Another 40 kg N/ha was given in two splits at thirty days and at first cut. The first and second cuts were taken at 50% flowering stage. There were six forage sorghum genotypes (AS-11, AS-15, AS-22, S-1049, M. P. Chari and S.S.G. 59-3) and five combinations of Zn, i.e. 0 kg $ZnSO_4$ /ha, 25 kg $ZnSO_4$ /ha, 25 kg $ZnSO_4$ + 10 T FYM/ha, 50 kg $ZnSO_4$ /ha and 50 kg $ZnSO_4$ + 10 T FYM/ha (Zn_0 , Zn_1 , Zn_1F , Zn_2 and Zn_2F , respectively) in split plot design having three replications. After recording dry matter yield, the plant samples were digested in di-acid mixture as described by Jackson and Ulirich (1969). The acid extract was used for analysis of different nutrients viz. P and Zn. Phosphorus in the acid extract was determined by

Vanadomolybdo phosphoric yellow colour method and Zn by atomic-absorption spectrophotometer. The total N was estimated from dry matter by conventional Kjeldhal's method. Subsequently the protein content of dry matter was computed for each treatment by multiplying its nitrogen percentage with conversion factor 6.25.

Recommended cultivation practices were followed for raising the crop.

RESULTS AND DISCUSSION

Green forage and dry matter yield

The results (Table 1) indicated that green forage yields of promising hybrids AS-11, AS-15 and AS-22 were found significantly superior than the existing varieties S-1049, M. P. Chari and S.S.G. 59-3 during the year 1987 and in the pooled in total yields of two cuts, however, all of them were at par. Promising hybrids AS-15 and AS-22 produced significantly higher dry matter yield as compared to the existing varieties, however, these were at par during all the individual years and in the pooled analysis. The higher

TABLE 2

Interaction effect of G X Zn for crude protein yield (q/ha) on pooled basis (total of two cuts).

G/Zn	Zn_0	Zn_1	Zn_1F	Zn_2	Zn_2F
G ₁	8.75	8.29	7.92	8.00	8.81
G ₂	8.58	10.64	7.84	7.92	9.88
G ₃	7.53	9.28	10.45	9.67	8.50
G ₄	7.08	8.05	9.34	8.60	7.78
G ₅	7.63	7.41	9.24	7.78	8.15
G ₆	7.45	8.19	8.93	9.82	9.34
S. Em. $\pm$		0.58			
C.D. at 5%		1.61			

TABLE 3

Zn content (first cut and second cut) in forage sorghum.

Treatment	Content in ppm							
	First cut				Second cut			
	1987	1988	1989	Pooled	1987	1988	1989	Pooled
Getotype								
G ₁	24.95	24.61	22.02	23.86	17.82	18.78	17.78	18.13
G ₂	22.68	20.99	18.50	20.72	9.40	13.35	12.36	11.70
G ₃	26.43	26.71	23.11	25.42	14.42	14.28	13.47	14.05
G ₄	22.84	25.99	22.74	23.86	6.97	12.86	12.09	10.64
G ₅	25.76	25.86	23.04	24.89	5.67	12.52	14.14	10.78
G ₆	22.36	24.33	22.10	22.93	12.31	13.77	14.39	13.49
S. Em. $\pm$	0.82	0.70	0.67	0.42	0.90	0.32	0.70	1.09
C. D. at 5%	NS	2.54	2.45	1.28	3.28	1.16	2.55	3.43
Zinc level								
Zn ₀	25.11	24.12	21.10	23.44	9.86	12.73	12.34	11.64
Zn ₁	22.01	24.06	21.09	22.38	11.88	14.55	14.25	13.56
Zn ₁ F	23.63	25.40	22.59	23.87	9.45	15.32	14.68	13.15
Zn ₂	23.90	23.70	21.14	22.91	11.34	14.14	14.10	13.19
Zn ₂ F	26.21	26.48	23.66	25.45	12.96	14.56	14.82	14.11
S. Em. $\pm$	0.95	0.75	0.75	0.48	0.66	0.65	0.57	0.36
C. D. at 5%	NS	NS	NS	1.34	1.93	NS	NS	1.03

yield might be due to higher plant height. Hybrid AS-11 was at par with the existing varieties M. P. Chari and S.S.G. 59-3 for dry matter yield when results were pooled. Patel (1985) found that hybrid AS-15 yielded higher green forage (528 q/ha), dry matter (153 q/ha) and crude protein (6.61 q/ha) yields than M. P. Chari (402, 128.6 and 5.32 q/ha GF, DM & CP yields) and pioneer hybrid X-988 (437, 79.6 and 5.20 q/ha GF, DM and CP yields) during the *kharif* season of 1983 under Anand condition. Raj and Patel (1989) also reported that promising hybrid AS-15 produced significantly higher dry matter yield than M. P. Chari during the *summer* season of 1983 at the Forage Research Farm, GAU, Anand. Similar type of results were also observed by Patel and Patel (1988).

Effect of Zn

The green forage yield of forage sorghum increased markedly due to application of 25 kg and 50 kg ZnSO_4 /ha over control during all the individual years and in the pooled but the differences were non-significant. Application of 25 kg and 50 kg ZnSO_4 /ha produced significantly higher dry matter yield as compared to no application of Zn during 1989, and in pooled analysis but both these levels were at par. The reason for significant increase in the yield of dry matter due to application of zinc over no zinc as the soil contained deficient available zinc. Application of Zn significantly increased the Zn uptake by the crop, which in dry matter rose from 108.4 q/ha under no-zinc to 118.7 q/ha and 118.2 q/ha under 25 kg and 50 kg ZnSO_4 /ha treatments, respectively. The crude protein yield also increased from 7.84 to 8.64 and 8.63 q/ha due to zinc application. The results are in accordance with the results reported by Hegde and Relwani (1974), Patel and Patel (1988), Tikande (1985) and Raj *et al.* (1989).

Promising hybrids AS-15 and AS-22 were found to be relatively more Zn responsive, S-1049 was least responsive and AS-11, M.P. Chari and S.S.G. 59-3 were medium in zinc response.

Application of FYM

In the presence of Zn at the rate of 25 kg ZnSO_4 /ha, application of 10 T FYM/ha gave higher green forage yield as compared to Zn alone in two cut of three years but these differences were non-significant. The higher yield might be due to higher plant height. Application of 25 kg ZnSO_4 alongwith 10 T FYM/ha produced significantly higher dry matter yield as compared to Zn alone during 1988, 1989 and in pooled analysis indicating the addition effect of FYM. However, further increase in the rate of Zn application (50 kg ZnSO_4 /ha) with 10 T FYM/ha reduced yield significantly during 1988, 1989 as well as on pooled basis, which might be due to nutrient imbalance in soil plant systems. The concentration of Zn in forage sorghum of first cut and second cut (Table 3) was higher in Zn levels having FYM as compared to those without FYM. The increase in Zn content by the application of FYM was due to production of complexing agents which form stable organometallic complexes with Zn that facilitates its efficient utilization by plants resulting in increased yield and concentration (Stevenson & Ardakani, 1972 and Patel and Patel, 1988).

The significantly higher phosphorus was removed by the genotype AS-15 than other genotypes except AS-11 and AS-22 in total of two cuts in pooled analysis (Table 4). Highest uptake of phosphorus was recorded for the treatment recording higher dry matter and crude protein yields of sorghum. Application of

TABLE 4

Phosphorus and Zn uptake of forage sorghum genotypes as influenced by zinc levels with and without FYM (total of two cuts).

Treatment	Phosphorus uptake (kg/ha)			Pooled	Zn uptake (g/ha)			Pooled
	1987	1988	1989		1987	1988	1989	
Genotypes								
G ₁	50.93	40.00	36.30	42.41	298.3	260.2	253.1	270.6
G ₂	50.37	59.83	46.85	52.28	220.2	283.9	227.0	243.7
G ₃	49.44	45.66	50.00	48.33	302.0	260.9	301.3	288.1
G ₄	31.11	35.93	43.89	36.98	119.8	170.9	200.4	163.7
G ₅	40.74	39.44	34.63	38.27	160.9	184.6	180.2	175.2
G ₆	34.63	38.00	31.30	34.82	172.8	199.4	184.8	185.7
S. Em. ±	1.35	2.97	3.69	3.26	8.3	8.1	20.1	16.3
C. D. at 5%	4.91	10.79	NS	10.27	30.1	29.5	73.0	51.5
Zn levels								
Zn ₀	46.14	41.05	41.51	42.90	189.8	188.1	200.5	192.8
Zn ₁	41.20	43.06	40.74	41.67	209.1	218.8	220.8	216.3
Zn ₁ F	45.83	48.30	44.44	46.19	223.0	270.5	264.0	252.5
Zn ₂	41.51	42.75	39.51	41.26	190.9	226.9	220.8	212.9
Zn ₂ F	39.66	40.74	36.27	38.89	248.9	229.0	216.2	231.4
S. Em. ±	1.96	1.52	2.91	1.28	15.1	11.4	13.8	7.8
C. D. at 5 %	NS	4.43	NS	3.57	NS	33.3	NS	22.0

farmyard manure alongwith 25 kg ZnSO_4/ha caused a considerable and significant increase in uptake of P_2O_5 from the soil (46.19 kg/ha). In addition to being a source of P, farmyard manure is known to build up available P in the soil and improvement of certain physical characteristics of soil. Higher yield and uptake of phosphorus due to application of farmyard manure may be attributed to increasing availability of phosphorus from soils to plants (Sharma, 1987). Application of farmyard manure alongwith higher dose of Zn (50 kg ZnSO_4/ha) failed to increase in uptake of P_2O_5 from the soil might be due to nutrient imbalance in soil-plant systems. The significantly higher Zn uptake recorded by the genotype AS-22 than other genotypes except AS-11 and AS-22 in total of two cuts in pooled analysis. Among the existing varieties, S.S.G. 59-3 showed the higher Zn uptake than S-1049 and M. P. Chari

in pooled analysis. Application of 25 kg ZnSO_4 alongwith 10 T FYM/ha significantly increased the Zn uptake by the crop, which in dry matter rose from 108.4 q/ha (no-zinc) to 133.8 q/ha. The crude protein yield was also increase from 7.84 to 9.29 q/ha due to 25 kg ZnSO_4 + 10 T FYM/ha.

Crude protein yield

Hybrid AS-15 showed higher crude protein than other genotypes, however, these differences were non-significant (Table 1) in total yield of two cuts in the pooled analysis. Application of 25 kg or 50 kg ZnSO_4/ha alone produced significantly higher crude protein yield than control (Tikande, 1985). In the presence of Zn 25 kg ZnSO_4/ha , application of 10 T FYM/ha gave 10.2 per cent higher yield as compared to Zn alone in pooled analysis indicating the addition effect of FYM. Higher

TABLE 5

Pooled green forage yield of S.S.G. 59-3 at 25 kg ZnSO_4/ha level alone and alongwith FYM and their economics.

<i>Treatment</i>	<i>Pooled GFY (q/ha)</i>	<i>Total return Rs/ha</i>	<i>Additional return over control Rs/ha</i>	<i>Additional Cost Rs/ha (Zn & FYM level)</i>	<i>Gross ICBR</i>	<i>Net ICBR</i>
S.S.G. 59-3 X No Zinc	341	10,230	—	—	—	—
S.S.G. 59-3 X 25 kg ZnSO_4/ha	382	11,460	1,230	225	1:5.47	1:4.47
S.S.G. 59-3 X 25 kg ZnSO_4 + 10 T FYM/ha	428	12,840	2,610	725	1:3.66	1:2.66

Selling price of green forage yield of sorghum = Rs.30/0

Cost of zinc sulphate @ Rs.9/-kg

Cost of FYM @ Rs.50/- per Metric Tonnes.

TABLE 6

Chemical composition of S.S.G. 59-3 at 25 kg ZnSO₄/ha level alone and with FYM during Summer, 1989 season (calculated production of DDM on the basis of av. yield of DM of three years).

Treatments	Per cent			Production(q/ha)		
	IVDMD			DDM		
	1st cut	2nd cut	av.	1st cut	2nd cut	Total of two cuts
S.S.G. 59-3 x No Znic	34.98	37.25	36.12	17.14	13.30	30.44
S.S.G. 59-3 X 25 kg ZnSO ₄ /ha	36.00	43.74	39.87	18.76	21.65	40.41
S.S.G. 59-3 X 25 kg ZnSO ₄ + 10 T FYM/ha	49.60	39.96	44.78	26.69	22.50	49.19

IVDMD = *In Vitro* Dry Matter Digestibility.

DDM = Digestible Dry Matter.

dose of Zn alone (50 kg ZnSO₄/ha) and alongwith FYM did not show any effect over low dose of Zn alone or alongwith FYM but it was significantly superior than control.

Genotype X Zn interaction

Application of 25 kg ZnSO₄/ha synthesized higher crude protein by AS-15 and AS-22 as compared to control indicating the effect of Zn (Table 2). Likewise, the application of 10 T FYM/ha alongwith 25 kg ZnSO₄/ha gave higher yield as compared to Zn alone indicating additional effect of FYM for hybrid AS-22 only.

Thus, from the present experiment, it was observed that promising hybrids were better as compared to the existing varieties, including local

one. Application of 25 kg ZnSO₄ + 10 T FYM/ha can give significantly higher dry matter and crude protein yields as compared to control.

Among existing varieties, application of 25 kg ZnSO₄/ha alone and 25 kg ZnSO₄ + 10 T FYM/ha to the sorghum variety S.S.G. 59-3 gave 10 and 20 per cent higher crude protein yield over no application of Zn on pooled basis (Table 2).

Data on economics presented in table 5 revealed that application of 25 kg ZnSO₄ alongwith 10 T FYM/ha to forage sorghum variety S.S.G. 59-3 produced the maximum total return Rs.12,840/- as compared to no application of Zn (Rs.10,230/-) and application of 25 kg ZnSO₄/ha alone (Rs.11,460/-).

Application of 25 kg $ZnSO_4$ alongwith 10T FYM/ha to forage sorghum variety S.S.G. 59-3 also showed the maximum IVDMD content (44.78 %) and DDM production (49.19 q/ha) as shown in Table 6.

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Influence of Bio-Fertilizers and Nitrogen Levels on Forage Sorghum

J. R. Patel, A. C. Sadhu, P. C. Patel and K. R. Thaker

A.I.C.R.P. on Forage Crops, Gujarat Agricultural University, Anand Campus, Anand

ABSTRACT

A field experiment was conducted on forage sorghum for three years at Anand to study the influence of biofertilizers and nitrogen levels on yield of forage sorghum variety S.S.G. 59-3. The results revealed that treatment of Azotobacter produced the maximum green forage production. It also gave significantly higher dry matter production (67.1 q/ha) than no bio-fertilizer and treatment of Azospirillum. Increasing N application from 0 to 25, 50 and 75 kg N/ha increased green forage production by 19.1, 32.8 and 36.1 per cent and dry matter yield by 22.4, 35.0 and 45.9 per cent respectively, on pooled basis. The successive increase in N levels also increased the crude protein yield of forage sorghum and application of 75 kg N/ha produced the highest crude protein yield (5.81 q/ha) on average of three years. However, application of 50 kg N/ha to forage sorghum was found better for getting economic and higher green forage, dry matter and crude protein production in single cut management.

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INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) is grown for green as well as dry forage production over wider areas, particularly during *kharif* season in Gujarat State. Nitrogen fertilizers plays an important role in increasing forage production of sorghum with better nutritive value. As the cost of nitrogenous fertilizers is very high, it becomes imperative to study the optimum requirement of nitrogen of forage sorghum alongwith bio-fertilizer treatments. The efficacy of two bio-fertilizers i.e. Azotobacter and Azospirillum were evaluated alongwith four levels of nitrogen on forage sorghum variety S.S.G. 59-3 at Forage Research Farm, Gujarat Agricultural University, Anand.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* seasons of 1988, 1989 and 1990 on alluvial soils, low in available nitrogen (169 kg N/ha) and medium in available P_2O_5 (47.1 kg P_2O_5 /ha) and K_2O (233 kg K_2O /ha). The soil pH was 8.3. Twelve treatment combinations comprising three treatments of bio-fertilizers (No bio-fertilizer, Azotobacter and Azospirillum) and four levels of N (0, 25, 50 and 75 kg/ha) were tested in randomized block design with three replications.

The crop was sown with recommended package of practices on 1st August in 1988 and 11th and 10th July in 1989 and 1990, respectively. Half of the required N in the form of urea

TABLE 1

Green forage, dry matter and crude protein yields of forage sorghum as influenced by bio-fertilizers and nitrogen levels.

Treatments	Green forage yield (q/ha)			Dry matter yield (q/ha)			Crude protein yield (q/ha)					
	1988	1989	1990	Pooled	1988	1989	1990	Pooled	1988	1989	1990	Mean
Bio-fertilizers (B)												
No bio-fertilizer	129	236	298	221	40.1	71.1	75.5	62.2	2.88	5.81	5.57	4.75
Azotobacter	146	235	295	225	45.8	74.0	81.5	67.1	3.06	6.28	5.92	5.09
Azospirillum	128	235	306	223	40.5	68.3	78.8	62.5	2.80	6.20	5.89	4.96
S. Em. $\pm$	8	7	9	5	2.6	2.1	2.4	1.4	-	-	-	-
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	3.9	-	-	-	-
Nitrogen levels (N) (kg/ha)												
0	79	201	269	183	23.1	60.2	69.2	50.8	1.63	5.47	4.36	3.82
25	122	225	307	218	37.8	66.9	81.7	62.2	2.23	5.50	6.12	4.62
50	157	258	314	243	49.0	77.8	79.2	68.6	3.28	6.83	6.35	5.49
75	180	258	309	249	58.5	79.6	84.3	74.1	4.50	6.59	6.33	5.81
S. Em. $\pm$	9	8	10	8	3.0	2.5	2.7	3.1	-	-	-	-
C.D. at 5%	27	24	30	29	8.7	7.3	8.0	10.8	-	-	-	-

and entire quantity of P_2O_5 (Single superphosphate) @40 kg/ha were applied at the time of sowing and the remaining half of the N was topdressed one month after sowing. The crop was harvested at 50 per cent flowering stage which occurred between 65 to 70 days after sowing. Nitrogen content of plant was estimated by conventional Kjeldhal's method and crude protein content was worked out on dry weight basis.

RESULTS AND DISCUSSION

Effect of bio-fertilizer

The results (Table 1) indicated that the seeds of forage sorghum inoculated with *Azotobacter* produced the highest green forage yield during 1988 as well as on pooled basis, however, the differences were not significant. The dry matter yield of forage sorghum was

also the highest due to *Azotobacter* inoculation during all the individual years. *Azotobacter* inoculum produced significantly higher dry matter yield (67.1 q/ha) than the treatments of no bio-fertilizer and *Azospirillum* inoculum on pooled basis. Inoculation of *Azotobacter* also synthesized the maximum crude protein yield followed by *Azospirillum* inoculum. The leaf to stem ratio due to *Azotobacter* treatment was markedly reduced as compared to that of no bio-fertilizer treatment during all the individual years as well as on an average of three years (Table 3). Tilak *et al.* (1982) reported that inoculation of sorghum seeds with *Azotobacter* gave higher dry matter yield of 75 days old plants of sorghum than uninoculated control. Inoculation of *Azotobacter* in forage sorghum also increased green forage and dry matter accumulation at IGFR, Jhansi (Anonymous, 1985).

TABLE 2

Economics of forage sorghum as influenced by nitrogen levels.

Treatments	Pooled green forage yield (q/ha)	Total return Rs./ha	Additional return over control Rs./ha	Additional cost Rs./ha	Gross ICBR	Net ICBR
Nitrogen levels						
0 kg N/ha	183	5490	—	—	—	—
25 kg N/ha	218	6540	1050	133.75	1:7.85	1:6.85
50 kg N/ha	243	7290	1800	267.50	1:6.73	1:5.73
75 kg N/ha	249	7470	1980	401.25	1:4.93	1:3.93

Selling price of green forage of sorghum Rs.30/q.

Cost of nitrogen @S.5.35 per kg of nitrogen from urea.

TABLE 3

Crude protein content and ancillary observations of forage sorghum as influenced by bio-fertilizers and nitrogen levels.

Treatments	Crude protein content (%)			Plant height (cm)			Tillers/M row			Leaf-stem ratio						
	1988	1989	1990 Mean	1988	1989	1990 Mean	1988	1989	1990 Mean	1988	1989	1990 Mean				
Bio-fertilizers																
No bio-fertilizer	7.03	8.21	7.33	7.52	164.7	179.2	190.6	178.2	39.8	21.5	37.3	32.9	1.42	1.51	0.93	1.29
Azotobacter	6.64	8.44	7.25	7.44	177.3	180.0	190.1	182.5	39.5	22.3	37.3	33.0	1.07	1.26	0.88	1.07
Azospirillum	6.88	9.14	7.46	7.83	167.5	181.1	192.6	180.4	35.0	22.8	40.3	32.7	1.06	1.33	0.94	1.11
Nitrogen Levels (N) (kg/ha)																
0	7.05	9.13	6.31	7.50	151.3	177.6	192.7	173.9	33.3	21.7	38.3	31.1	1.33	2.21	1.22	1.59
25	5.91	8.17	7.46	7.18	172.4	178.2	192.5	181.0	35.7	22.3	41.7	33.2	1.17	1.19	0.99	1.12
50	6.68	8.80	8.06	7.85	177.6	182.9	191.9	184.1	42.0	22.0	36.0	33.3	1.10	1.31	0.83	1.08
75	7.76	8.28	7.55	7.86	178.0	181.7	187.3	182.3	41.3	22.7	37.0	33.7	1.14	0.75	0.61	0.83

Effect of nitrogen

Increasing levels of nitrogen increased the green forage and dry matter yields. Application of 50 and 75 kg N/ha produced significantly higher green forage yield over 0 and 25 kg N/ha during 1988 and 1989 and both the levels were also significantly superior than control (0 kg N/ha) during 1990 and on pooled basis. The differences between 50 and 75 kg N/ha were at par for green forage production. The dry matter yield increased significantly with increasing nitrogen application from 0 to 25, 50 and 75 kg N/ha during 1988. Application of 50 and 75 kg N/ha being at par produced significantly higher yield during 1989, than other levels of nitrogen. During 1990, application of 25, 50 and 75 kg N/ha produced significantly higher yield over control. Application of 50 and 75 kg N/ha being at par with each other produced significantly higher dry matter yield over control when results were pooled. The highest level of nitrogen also produced significantly higher yield than 25 kg

N/ha. The successive increments of nitrogen application increased the crude protein yield and decreased the leaf to stem ratio. The highest level of N (75 kg N/ha) synthesized the highest crude protein yield (5.81 q/ha) and recorded the lowest leaf to stem ratio (0.83) on an average of three years. Increasing level of N application from 0 to 25, 50 and 75 kg N/ha increased the crude protein yield by 20.9, 43.7 and 52.1 per cent, respectively. The results are in agreement with the results obtained by Hedge and Relwani (1974) Patel *et al.* (1990) and Sadhu *et al.* (1991). The higher net ICBR of 1:6.85 and 1:5.73 were obtained with an application of 25 kg and 50 kg N/ha, respectively (Table 2). The results indicated that seeds of forage sorghum variety S.S.G. 59-3 should be treated with *Azotobacter* to produce higher dry matter and crude protein production in single cut management and an application of 25 to 50 kg N/ha should be given for getting higher forage production with better nutritive value.

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Influence of Cutting Management and Nitrogen Levels on Seed Production in Oats

J. R. Patel, A. C. Sadhu, P. C. Patel and K. R. Thaker

Forage Research Project, Gujarat Agricultural University, Anand Campus, Anand

ABSTRACT

A field experiment on oats comprising three cutting management practices (no cut, one cut for forage at 50-55 days and then left for seed and one cut for forage at 70-75 days and then left for seed) and three nitrogen levels (40, 80 and 120 kg N/ha) was conducted at Forage Research Farm, Anand during *rabi* seasons of 1988, 1989 and 1990. The results indicated that the cutting practices of no cut and one cut at 50-55 days for forage produced significantly higher seed yield of oats than the system of one cut for forage at 70-75 days and then left for seed. Early cutting of oats crop at 50-55 days for forage marginally reduced the seed yield by 12.9% and total dry matter yield by 10.7% but gave an additional green forage yield of 244 q/ha as compared to no cut system. The seed yield did not differ significantly due to nitrogen levels. However, increase in nitrogen levels from 40 to 80 and 120 kg N/ha showed linear response in increasing green forage and crude protein yields. Application of 120 kg N/ha being at par with 80 kg N/ha produced significantly higher dry matter yield during 1989, 1990 and on pooled basis. Application of 80 kg N/ha to oats crops was found optimum and economic dose as it produced the highest seed yield (1350 kg/ha) and cost benefit ratio (2 : 01).

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INTRODUCTION

Oats (*Avena sativa*, L.) is one of the most important forage crops in India for *rabi* season and used as both feed and fodder. It is, therefore, essential to increase its production through agronomic management. Oats offers several advantages such as early forage availability, high yield potential, better regeneration capability, nutritive forage and high dry matter content. Provision of seed in sufficient quantities is important in forage production programme, therefore this experiment was planned to asses seed production potential of oats, variety Kent after taking cut for forage production

MATERIALS AND METHODS

A field experiment was conducted at the Forage Research Farm, Gujarat Agricultural University, Anand in the *rabi* seasons of 1988, 1989 and 1990 to study the effect of cutting management and nitrogen levels on seed production of oats. The soil was alluvial type and neutral in reaction, low in available nitrogen (193.2 kg N/ha), medium in available phosphorus (51.0 kg P₂O₅/ha) and medium in available potash (228.5 kg K₂O/ha).

The treatment consisted of three cutting managements [(1) no cut (2) one cut for forage at 50-55 days and then left for seed

TABLE 1

Effect of cutting management and nitrogen levels on the seed yield, dry matter and crude protein yields of oats.

Treatment	Seed yield (kg/ha)			Dry matter yield (q/ha)			Crude protein yield (q/ha)		
	1988	1989	1990	Pooled	1988	1989	1990	Pooled	Mean
Cutting management									
No cut (only seed)	1457	917	3067	1813	87.5	108.3	125.7	107.2	4.72
One cut at 50-55 days, then left for seed	1309	754	2674	1579	98.9 (273)	93.2 (325)	95.0 (133)	95.7 (244)	7.02
One cut at 70-75 days, then left for seed	431	226	1090	583	83.2 (455)	83.3 (492)	79.5 (275)	82.0 (407)	7.17
S.E.m. $\pm$	90	70	180	204	3.1	2.3	2.6	7.1	-
C.D. at 5%	270	209	539	803	9.3	6.8	7.9	NS	-
Nitrogen levels (kg/ha)									
40	961	619	2328	1303	84.4 (315)	89.5 (386)	95.3 (173)	89.7 (291)	5.38
80	1170	686	2194	1350	94.0 (372)	95.1 (418)	98.8 (205)	95.9 (332)	6.26
120	1065	592	2308	1322	91.2 (405)	100.2 (421)	106.1 (234)	99.2 (353)	7.27
S. Em. $\pm$	90	70	180	71	3.1	2.3	2.6	1.6	-
C. D. at 5%	NS	NS	NS	NS	NS	6.8	7.9	4.4	-

Figures in parentheses indicate green forage yield of oats during first cut.

TABLE 2

Effect of cutting management and nitrogen levels on crude protein content and other ancillary characters of oats.

Treatment	Crude protein content (%)				Plant height (cm)				No. of tillers/m row at harvest				1000 grain weight (g)			
	1988	1989	1990	Mean	1988	1989	1990	Mean	1988	1989	1990	Mean	1989	1990	Mean	
Cutting management																
No cut (only seed)	5.19	5.77	2.69	4.55	123.5	123.4	165.4	137.4	82	58	51	64	44.5	38.7	41.6	
One cut at 50-55 days, then left for seed	5.45	4.54	2.70	4.23	76.5	105.5	133.8	105.3	86	69	52	69	37.6	37.6	37.6	
One cut at 70-75 days, then left for seed	5.31	6.05	3.17	4.84	118.9	93.8	110.5	107.7	75	50	70	65	34.6	39.5	37.1	
Nitrogen levels (kg/ha)																
40	4.83	5.03	2.66	4.17	103.0	110.3	134.2	115.8	80	56	57	64	39.0	38.5	38.8	
80	5.29	4.94	2.77	4.33	108.1	107.0	139.2	118.1	87	60	58	68	37.6	39.1	38.4	
120	5.82	6.39	3.13	5.11	107.8	105.3	136.4	116.5	77	61	58	65	40.1	38.2	39.2	

TABLE 3
Economics of oats as influenced by cutting management and nitrogen levels. (Av. of three years).

<i>Treatment</i>	<i>Seed yield (kg/ha)</i>	<i>Dry fodder yield (q/ha)</i>	<i>Green fodder yield (q/ha)</i>	<i>Total income (Rs/ha)</i>	<i>Cost of production (Rs/ha)</i>	<i>C.B.R.</i>	<i>Net realization (Rs/ha)</i>
Cutting management							
No cut (only seed)	1813	123.5	—	11863	6918	1.72	4945
One cut at 50-55 days, then left for seed	1579	84.4	244	13297	7348	1.81	5949
One cut at 70-75 days, then left for seed	583	31.2	407	9664	7348	1.32	2316
Nitrogen levels (kg/ha)							
40	1303	74.3	291	12457	6490	1.92	5967
80	1350	81.3	332	13494	6704	2.01	6790
120	1322	83.5	353	13749	6918	1.99	6831

Selling price of seed, dry fodder and green fodder of oats was considered Rs. 4.5/kg, Rs. 30/q and Rs. 15/q, respectively.
Cost of harvesting of green forage was considered Rs. 440/ha and cost of nitrogen fertilizer was considered Rs. 5.35/kg N.

and (3) one cut for forage at 70-75 days and then left for seed)] with three levels of nitrogen (40, 80 and 120 kg N/ha). The experiments were conducted in factorial randomized block design with three replications. The gross and net plot sizes were 5.0 m x 3.0 m and 4.0 m x 2.0 m respectively. A basal application of fertilizer @ 40 kg P_2O_5 /ha and half of nitrogen as per treatment was made before sowing. The remaining dose of nitrogen as per treatments was applied in two equal splits at tillering and boot stage for no cut treatment, while remaining half dose of nitrogen in both the treatments of one cut at 50-55 days and one cut at 70-75 days for forage and then left for seed production was applied after first cut. The crop was harvested as per cutting management treatments for forage production and was left for seed formation. Green forage and dry matter yield were recorded from cuttings taken for forage, while straw yields were recorded at maturity along with data on seed yield. The crude protein percentage was worked out from oven dried samples of fodder by micro-Kjeldahl's method.

RESULTS AND DISCUSSION

Effect of cutting management

The results indicated that the practice of no cut and one cut at 50-55 days for forage and then left for seed production gave significantly higher seed yields than the practice of one cut at 70-75 days for forage and then left for seed production during all the individual years as well as on pooled basis (Table 1). However, differences between no cut and one cut at 50-55 days for forage were not significant. The practice of one cut at 50-55 days also gave the highest cost benefit ratio (CBR) of 1:81 as well as net realization of Rs.5949/ha (Table 3). The treatment of one cut at 70-75 days produced higher green forage

yield than one cut at 50-55 days during all the three years and it also gave the highest crude protein yield (7.17 g/ha) and crude protein content (4.84 %) on an average of three years. No cut treatment produced higher total dry matter yields than one cutting management treatment during 1989 and 1990, but the differences among cutting treatments were not significant on pooled basis.

The reduction in grain yield of oats due to cut taken for forage production at 70-75 days seems to be due to loss of plant vigour after cut, which resulted in reduction in plant height and 1000 grain weight (Table 2). These findings are in conformity with those reported by Crowder (1954), Deo and Rai (1975), Desai and Deore (1982), Gardener and Wiggans (1960) and Gill *et al.* (1973).

Effect of Nitrogen

The differences in seed yield among 40, 80 and 120 kg N/ha were not significant during all the individual years as well as on pooled basis. However, application of 80 kg N/ha produced the highest grain yield (Table 1). Kumar and Verma (1981) also reported that response to increase in nitrogen dose beyond 40 kg N/ha was not appreciable for grain production in oats. Application of 120 kg N/ha produced significantly higher dry matter yield than 40 kg N/ha during 1989 and 1990 and on pooled basis, however it was at par with 80 kg N/ha. Application of 80 kg N/ha oats crop gave the maximum value of CBR (2.01). An increase in nitrogen application from 40 to 80 and 120 kg N/ha increase the green forage and crude protein yields during all the three years and also increased crude protein content on an average of three years. Ghosh (1985) reported that application of 80 kg N/ha recorded maximum grain, straw and green forage yields

of oats and the highest dry matter yield in lateritic acid soils. The results revealed that for obtaining maximum seed yield and dry matter production, oats var. Kent should be harvested for seed production only. However, early cutting at 50-55 days marginally reduced seed

yield by 12.9 % but gave an additional green forage yield of 244 q/ha and it also showed the highest value of CBR and net realization. Among nitrogen levels, 80 kg N/ha was found economical dose for oats crop sown for seed production.

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Hydraulics and Surface Horizontal Movement Under Microtube Drip System

P. K. Srivastava*, N. G. Savani, M. M. Parikh and S. Raman

Soil Water Management Project, Gujarat Agricultural University, Navsari Campus, Navsari

ABSTRACT

The pressure discharge relationship of different diameter microtubes is expressed in power form equation. The value of an exponent of the equation has little variation compared to multiplying constant for various length and diameter microtubes. A common power form equation is developed showing relationship among discharge rate, tube diameter, tube length and pressure head. The surface horizontal movement of the water is also expressed in power form, as a function of system parameters and time of application. The surface horizontal movement of water front under microtube drip system increased with increase in diameter and application time, for a given pressure head and decreased with increase in tube length.

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INTRODUCTION

Among the various drip systems, micro-tube system is thought to be more economical. The hydraulic characteristics of micro-tube drip system differs from other systems owing to its diameter and length. For a given tube length and diameter, the discharge rate is a function of the pressure head. However to get uniform water application either different lengths or diameter of microtubes can be adopted such that the discharge rates are more uniform within the allowable pressure variations along the main and lateral lines of the system. Therefore it is necessary to know the pressure discharge relationship for various available microtubes to

decide upon what length and diameter tube should be chosen for drip system. After selection of the system parameters, it is necessary to know the water distribution patterns for a given set of soil, hydraulic and system parameters and the time of application of irrigation water. Proper combination of these parameters provides uniform application as well as necessary moisture to the crop. This paper is an attempt to study (i) pressure discharge relationship for various sizes of microtubes, (ii) relationship among system and hydraulic parameters and (iii) the relationship among time of application, horizontal water front movement at surface, system parameters and hydraulic parameters.

*Present address : Assitant Research Scientist, Soil & Water Management Project, Gujarat Agricultural University, Navsari Campus, Navsari.

MATERIALS AND METHODS

Microtube Hydraulics

For a given length and diameter microtube, the flow function described by Bralts *et al.* (1981) and Pitts *et al.* (1986) for drip emitters can be used.

$$q = KH^X \quad (1)$$

where, q = emitter flow rate, L/h

K = proportionality constant

H = pressure head, m

X = discharge exponent

The magnitude of x and k are measure of flow variations due to sensitivity and manufacturing variations. However, these constants are differing in their values with change in tube length and diameter. An equation showing relationship among system parameters (length, diameter) and hydraulic parameters (discharge, pressure) may be of the following form :

$$q = ad^b (H/L)^c \quad (2)$$

where d = inner diameter of tube, mm

L = Length of tube, m

a, b, c = constants

Other parameters are as explained in Eq.1. The values of constants a, b, c for laminar flow conditions are given as 1.272, 2.70 and 0.80 and for turbulent flow these are 1.776, 2.73 and 0.56 respectively (Nakayma and Bucks 1986). However these constants are different for different flow conditions.

Horizontal Advance

The moisture movement pattern depends on the type of soil, initial moisture content, discharge rate and time of application. The horizontal advance front under point source is studied by various workers. It is expressed as a function of time for a particular discharge rate (Sivanappan & Padmakumari (1980); Gupta *et al.* 1990; Kaul and Michael 1982; Ramadevi 1983). The wetted diameter is explained as a function of discharge rate (Gupta and Tyagi; 1987) and total water applied (Sivanappan and Padmakumari 1980). Instead of considering one or two parameters, the horizontal advance as function of tube dia and length, operating pressure and time of application may be expressed in power form as given below :

$$A_H = \alpha d^B (H/L)^\eta t^\phi \quad (3)$$

where A_H = horizontal advance, cm

t = time of application, minutes

α, B, η, ϕ = constants

The microtubes having diameter of 0.645, 0.995, 1.312, 1.313 and 1.604 mm were used to study the pressure discharge relationship. A constant pressure was maintained by regulating a control valve fitted near the pressure gauge on the screen filter. The discharge volumes from each microtube were collected pressure of 2, 4, 6, 8, 10, 15 and 20 m. The length of microtubes was 2.0 m for all sizes except 0.645 mm diameter tube whose length was 0.5 m. The testing was carried out with 10 microtubes of the same length and diameter size and replicated two times for each pressure.

For horizontal advance study the same set was used and the horizontal movement at surface was measured for 15, 30, 45, 60, 90

and 120 minutes of operation. The data are collected for 4 m and 8 m pressure. The soil characteristics are given in Table-1.

TABLE 1

Soil physical and chemical properties.

Sr. No.	Soil properties	
1.	Soil texture	Clayey
2.	Sand	8.83%
3.	Silt	26.16%
4.	Clay	62.86%
5.	Soil depth	100 cm
6.	Field capacity	32%
7.	Permanant Wilting Point	17.5%
8.	Basic Infiltration Rate	0.3 cm/hr
9.	Bulk density	1.43 gm/cc
10.	pH	8.4
11.	Electric conductivity	0.2 mmhos/cm
12.	Organic carbon	0.25%
13.	Nitrogen	0.05%
14.	P ₂ O ₅	20.5 kg/ha
15.	K ₂ O	580.0 kg/ha

RESULTS AND DISCUSSION

Microtube Hydraulics

The data collected for individual microtube are fitted to power Eq. 1. The results of the analysis of the microtube flow data are presented in the table 2. From this study it is revealed that the value of the exponent, x varied from 0.47 to 0.53 for microtubes considered for this study. The values of x are lower for higher diameter and higher for lower

diameter. However the range of variation is very narrow, which suggests that all tubes under study are functioning almost like turbulent emitters. The values of proportionality constant, K , varied from 0.83 to 5.37 and are higher for higher diameter tubes. It shows that the discharge rate is more dependent on the system parameters than hydraulic parameters.

However for knowing the combined effect of all parameters, the data were fitted using Eq.2. The constant a , b and c for Eq.2 for microtubes under study were worked out to be

TABLE 2

Hydraulic characteristics of microtubes.

Microtube No.	Microtube dnu. (mm)	Microtube length (mm)	Constant K	Exponent x	Correlation r
M ₁	0.645	0.5	0.8318	0.530	0.9955
M ₂	0.995	2.0	1.3032	0.523	0.9961
M ₃	1.312	2.0	2.7542	0.520	0.9971
M ₄	1.313	2.0	2.4378	0.517	0.9973
M ₅	1.604	2.0	5.3703	0.470	0.9972

TABLE 3

Life table of *Tetranychus macfarlanei* on okra.

Pivotal age	<i>l_x</i>	<i>M_x</i>	<i>l_{xm_x}</i>	<i>x l_{xm_x}</i>
1	2	3	4	5
5.	0.6875	—	—	Immature stages
6.	0.6875	2.18	1.499	08.993
7.	0.6875	6.18	4.249	29.74
8.	0.6875	4.727	3.2498	25.999
9.	0.6875	4.818	3.3125	29.813
10.	0.6875	4.273	2.938	29.379
11.	0.6875	3.364	2.313	25.438
12.	0.6875	3.364	2.313	25.438
13.	0.6875	1.818	1.25	16.25
14.	0.6875	0.636	0.0625	0.875
15.	0.6875	0.273	0.1875	2.8125
16.	0.5625	3.111	1.75	28.00
17.	0.5625	2.445	1.375	23.375
18.	0.5625	4.222	2.375	42.75
19.	0.4375	1.429	0.625	11.875
20.	0.4375	0.429	0.1875	03.75

1.	2.	3.	4.	5.
21.	0.3125	1.20	0.375	07.875
22.	0.2500	4.25	1.0625	23.375
23.	0.1875	3.00	0.5625	12.938
24.	0.1875	2.00	0.375	09.000
25.	0.1875	1.00	0.1875	04.688
26.	0.1875	0.667	0.1251	03.252
27.	0.1875	0.00	0.00	00.00
28.	0.00	0.00	0.00	00.00
$\Sigma \quad 1 \times m_x = 30.3744 \quad 6 \times 1 \times m_x = 365.6155$				
Net reproduction rate (RO)	=	30.3744		
Mean duration of a generation (T)	=	$\frac{\Sigma x_1 \times m_x}{RO}$		
	=	12.037 days		
Approximate value of r_m	=	$\frac{\log_e RO}{T}$		
	=	00.2836		
Finite rate of increase	=	Antilog r_m		
	=	01.328 per head per day.		

2.176, 2.545 and 0.481 respectively. The equation has correlated the observed values with a correlation coefficient of 0.9962. These values suggests that 10 per cent increase in value of diameter or pressure head or length of tube the change in flow rate will be +27.46%, + 4.68% and -4.49% respectively. Therefore the influence of tube diameter on discharge rate is very prominent in comparison to change in length or operating pressure. This implies that for a unit change in discharge rate it will be more convenient to choose the diameter or length of tube instead of changing the operating pressure. As higher pressure requires capacity pump unit which costs more.

Horizontal Advance

The movement of water mainly depends on soil texture, soil infiltration rate, soil hydraulic conductivity, initial soil moisture status, application rate, total water applied and soil and water temperature. The horizontal movement of wetting at surface at different time intervals were observed for different microtubes under 4 and 8 m operating pressures as depicted in Fig. 1. It is clear that the horizontal advance increases with increase in time of application for a given set of tube diameter length and operating pressure. Higher diameter tube increases advance due to higher flow rates. Similarly higher pressure has resulted in higher horizontal advance.

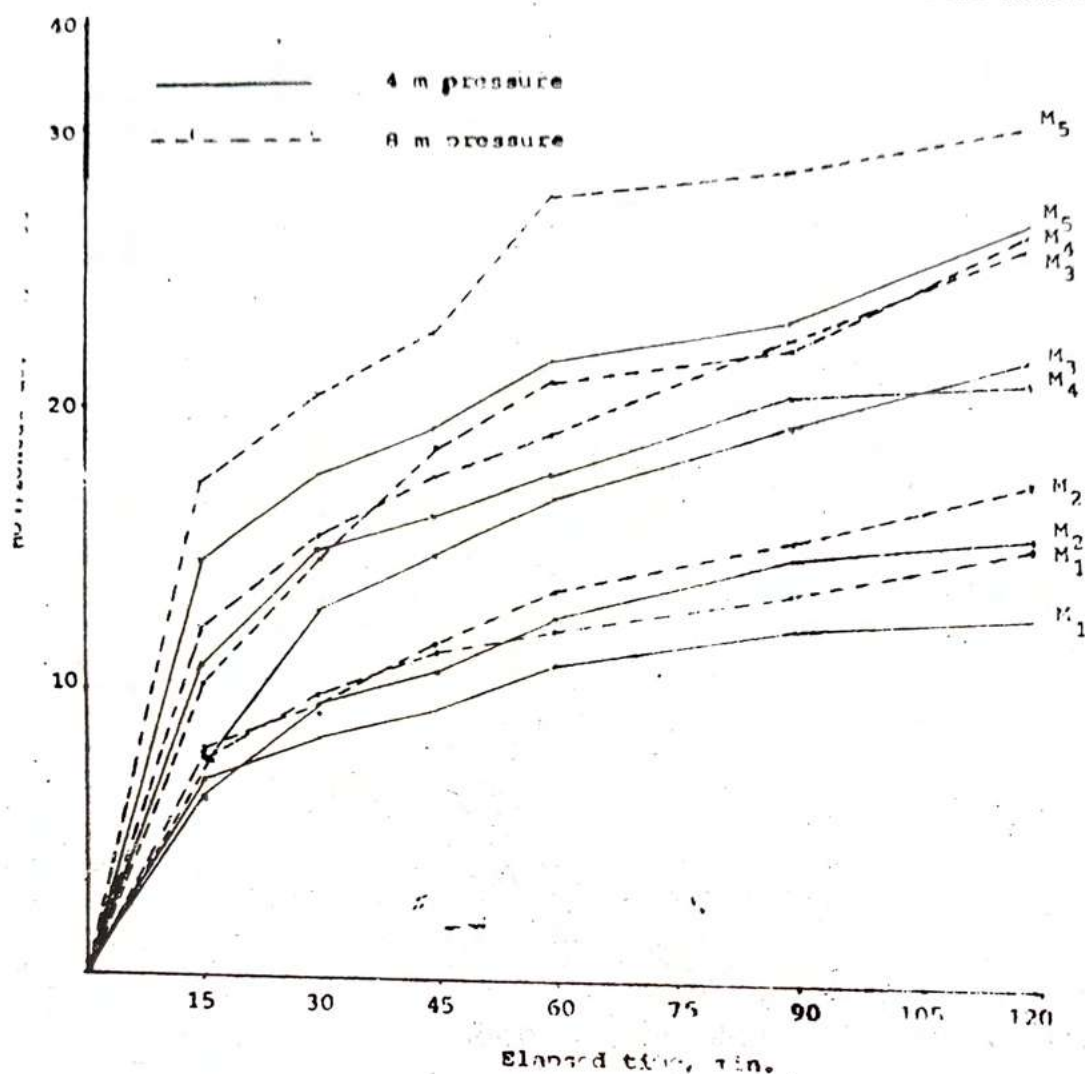


Fig. 1 Horizontal advance V/S elapsed time

An equation was derived to predict horizontal advance at surface considering microtube length, microtube diameter, operating pressure and time of application in power form as given in Eq. 3. The values of constants α , β , η and ϕ found to be 1.7285, 1.042, 0.250 and 0.4389 respectively. The correlation coefficient was observed to be 0.996.

It was observed that the horizontal advance at surface increased with increase in diameter, operating pressure but decreased with increase in length for a particular time of operation. For a given set of diameter, length and operating pressure, the horizontal advance at surface increased with increase in time of application (Fig. 2). Similarly higher horizontal

advance at higher application rate (Fig. 3) was also observed.

From the study following conclusions can be made. The pressure discharge relationship may be approximately by power form equation.

The power form equation can be developed for surface horizontal movement.

For a particular pressure, the horizontal movement of water increased with increase in microtube diameter and time of application and decreased with increase in tube length. For getting higher water distribution uniformity in microtube drip system, selection of appropriate combination of tube diameter and length will be more suitable than pressure changes.

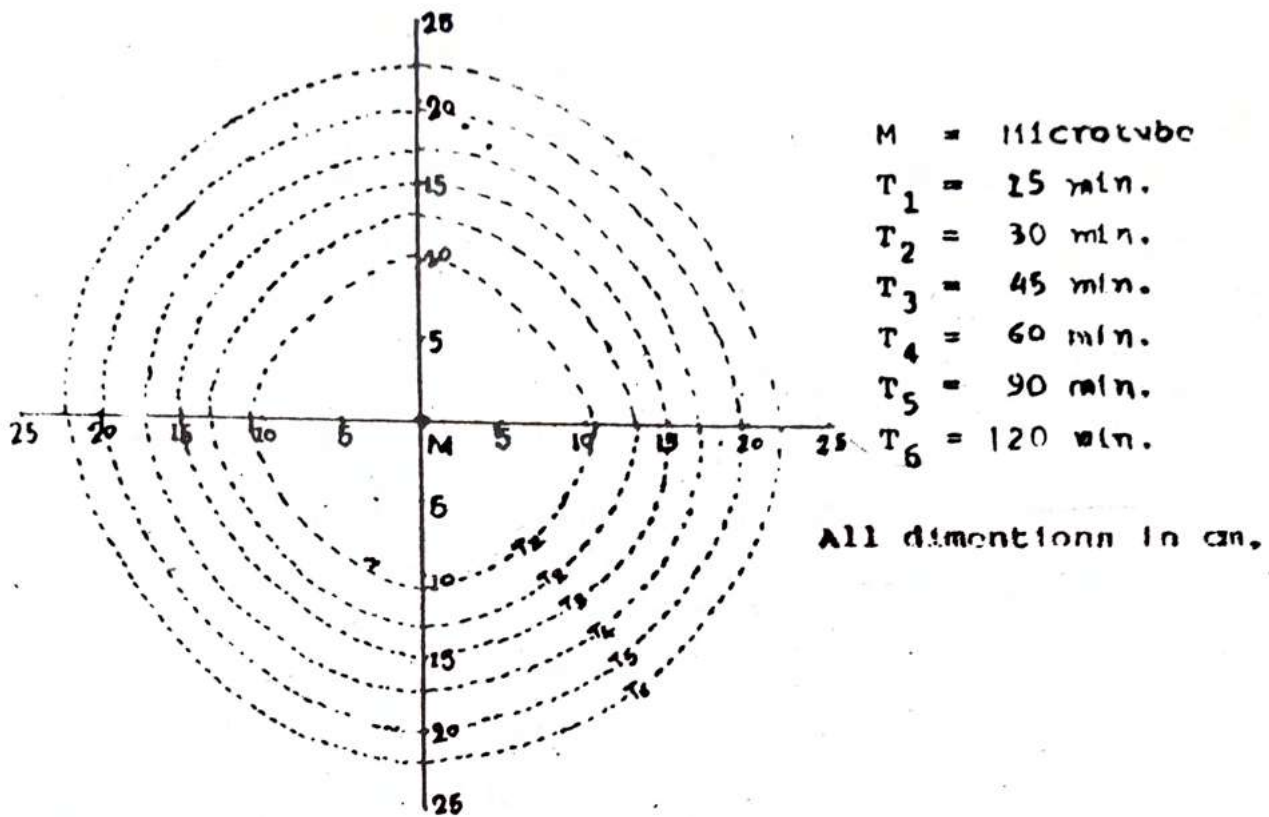


Fig. 2 : Effect of time of application on horizontal advance at surface (microtube M_3 , operating pressure-4m).

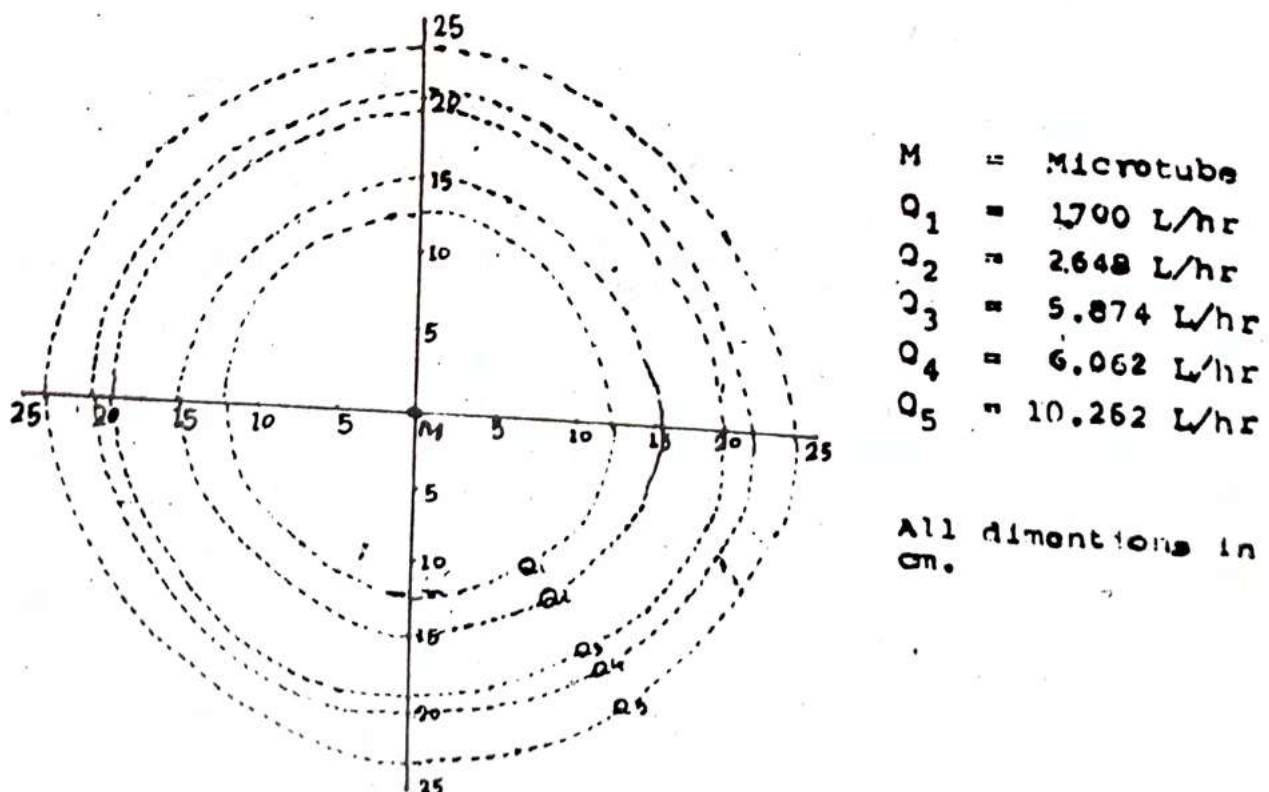


Fig. 3 : Effect of rate of discharge on horizontal advance at surface (Pressure - 4m, Application time-90 min.)

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Heterosis and Inbreeding Depression for Seed Cotton Yield in Upland Cotton *G. hirsutum* L.

U. G. Patel*, A. D. Patel, N. P. Mehta and J. C. Patel

Regional Cotton Research Station, Gujarat Agricultural University, Maktampur, Bharuch

ABSTRACT

Eight parents of *G. hirsutum* L. and their 28 crosses were studied for heterosis and inbreeding depression. The cross, LH 299 x 13426 showed maximum heterobeltiosis followed by LH 299 x G. Cot.10 and DS-4 x B. N. The relative ranking on the basis of *per se* performance and heterosis differed, which depicted poor yielding ability of the parents. The hybrids which showed maximum heterosis in F_1 also showed maximum inbreeding depression in F_2 generation.

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INTRODUCTION

Among the four cultivated species of cotton, *G. hirsutum* L. is the predominantly cultivated species, grown in all the cotton growing tracts. Though, genetic variability is fairly wide in this species, there is further scope for broadening the genetic base to obtain suitable hybrids/varieties with high yield for the various agroclimatic conditions. Study of heterosis and inbreeding depression will have a direct bearing on the breeding methodology to be employed for varietal improvement. Hence, the present investigation was undertaken to study the magnitude of heterosis and inbreeding depression for seed cotton yield.

MATERIALS AND METHODS

Eight parents viz., LH-299, DS-4, DS-56, 13426, B.N. 1412, H-655-C and G.Cot.10 were crossed in all possible combinations using dial-

lel mating design (excluding reciprocals). Eight parents and their 28 F_1 and 28 F_2 's were grown in R.B.D. with three replications at Regional Cotton Research Station, GAU, Maktampur (Bharuch) during 1987-88. A single replication had one row each of parents and F_1 's and F_2 's had four rows. There were 15 dibbles in a row spaced at 120 cm between rows and 45 cm between plants. Observation on seed cotton yield per plant were recorded on 10 randomly selected plants from parents and F_1 and 20 plants from F_2 generation. The magnitude of heterosis and inbreeding depression from F_1 to F_2 were calculated using standard procedures.

RESULTS AND DISCUSSION

Heterosis and inbreeding depression are two different facets of expression of the same phenomenon (Kheradnam *et al.* 1975).

*Present Address : Research Scientist (Cotton), Main Cotton Research Station, Gujarat Agricultural University, Surat-395 007.

Performance of parents, F_1 hybrids as compared to the midparent and better parent and

depression from F_1 to F_2 for seed cotton yield are presented in Table-1.

TABLE 1

Heterosis over better parent (BP), mid parent (MP) and inbreeding depression (ID) for the promising combination.

Cross	Mean performance of				Heterosis over		Inbreeding depression (ID)
	Male	Female	F_1	F_2	MP	BP	
LH-299 x DS 4	36.0	53.6	67.3	37.7	50.1*	25.4	20.2
LH-299 x 13426	36.0	46.0	75.3	33.3	87.7**	67.3*	60.1*
LH-299 x G.Cot.10	36.0	35.0	57.3	53.7	61.5*	59.2*	41.8*
DS-4 x DS-56	53.6	45.0	53.0	31.3	07.4	-1.2	59.7**
DS-4 x 13426	53.6	46.0	67.7	26.3	35.7	27.0	51.7**
DS-4 x B.N.	53.6	49.3	78.0	38.3	51.4*	45.3*	52.9**
DS-4 x 1412	53.6	32.0	55.7	36.7	29.9	03.7	52.6**
DS-56 x 1412	45.0	32.0	63.0	78.7	63.6*	40.0	-24.8
B.N. x 1412	49.3	32.0	68.7	36.0	68.8**	39.1	58.7**

*and** Significant at 0.05 and 0.01 level respectively.

Six crosses showed significant and positive heterosis over mid parental value for seed cotton yield, though only three crosses viz. LH-299 x 13426, LH 299 x G. Cot.10 and DS-4 x B.N exhibited significant and positive heterosis over better parent. Meredith and Bridge (1972) and Kumar *et al.* (1974) also observed high degree of heterosis in intra hirsutum crosses. Interestingly, the cross, LH 299 x 13426 though recorded highest mid-parent and better parent heterosis, ranked second in *per se* performance for seed cotton yield. Conversely, the cross DS-4 x B.N. showed highest mean performance but ranked fifth on the basis of average heterosis. Thus, relative ranking on the basis of *per se* performance and heterosis dif-

fered. This is attributed to the poor yielding ability of the parents. In such cases, average and better parent heterosis do not offer any economic promise.

It was pertinent to note that the crosses of low x low yielding parents showed maximum value of seed cotton yield and better parent heterosis, though their mean yields were lower as compared to high x high and high x low crosses. On the contrary, the crosses involving high x high yielding parents exhibited lower heterosis but their *per se* values were high. It would therefore, be desirable to select the hybrid based on mean values rather than extent of heterosis.

The loss in yield in advance generation was due to inbreeding depression. Inbreeding depression is caused by a decrease in heterozygosity which conditions strong dominance or over dominance (William and Meredith, 1979). The prevalence of dominant gene action in cotton suggest that inbreeding depression is a major complicating factor in early generation yield evaluation. In the present investigation, of the six heterotic crosses, four crosses showed significant inbreeding depression. Thus, high inbreeding depression was associated with high heterotic effect. This suggest the importance of non-additive gene action in cotton. Presence of such non-additive gene action which enhance the vigour for seed cotton yield in F_1 can be attributed to epistatic geneaction. However, two crosses LH 299 x DS4 and DS5 x 1412 were exceptions where high heterosis was associated with low

inbreeding depression, suggesting that the transgressive segregation might have occurred in F_2 generation. However, an examination of data on inbreeding depression for seed cotton yield/plant indicated that, in general, the mean expression of F_2 was lower than that of F_1 , but in some cases comparable or even higher expression of F_2 than that of F_1 were also found as in case of DS 56 x 1412. This is in agreement with some of the earlier reports indicating superiority of F_2 over F_1 . Yadav and Murthy (1976) and Gunasselan and Krishnaswami (1988).

Thus, it is quite clear that the biparental matings be made from such crosses and evaluated subsequently in systematic manner to get segregates superior to the better parent/standard variety which may be handled through pedigree method of breeding.

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On the Biological Aspects of *Tetranychus macfarlanei* (Acari : Tetranychidae) Infesting Okra (*Abelmoschus esculentus*) in South Gujarat

A. S. Sejalina, A. B. Rai, C. B. Patel* and G. G. Radadia

Department of Entomology, N. M. College of Agriculture, Gujarat Agricultural University, Navsari Campus, Navsari

ABSTRACT

The life cycle of *Tetranychus macfarlanei* Baker and Pritchard was studied in laboratory, Department of Entomology, Gujarat Agricultural University, Navsari during March-April, 1989 (Av. 27.67°C & 60.45% RH) and July-August (Av. 29.67°C and 87.30% RH). The span of the various stages varied during different seasons. The low temperature and relative humidity during March-April prolonged the developmental period, whereas relatively high temperature and relative humidity had shorten the duration. Increased fecundity and rate of egg laying were observed after the mating despite the fact that unmated female oviposited for a longer time. While studing the life table of the mite at 29.67°C & 87.30% RH, the net reproductive rate (R_0), the mean generation time (T), the innate capacity for increase in number (r_m) and the finite rate of increase (λ) were worked out : 30.3744 times, 12.037 days, 0.2836 and 1.328 per day, respectively.

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INTRODUCTION

Tetranychus macfarlanei Baker and Pritchard has recently been recorded on cotton, vegetable crops and several weed plants in South and Central Gujarat (Jose and Shah, 1989), it was observed abundant on okra during summer 1989. It generally prefers the lower side of the leaf. Feeding leads to the appearance of chlorotic spots which mearge to form bigger patches. Biology of some species of *Tetranychus* have been reported in the past (Boudreaux, 1963; Laing, 1969 and Puttaswamy and Channabasavanne, 1979). Very little information is available on bionomics of *T. macfarlanei*, therefore, studies were undertaken on biology and life table of this pest.

MATERIALS AND METHODS

Initially, *T. macfarlanei* was collected from okra plant of Research Farm, Gujarat Agricultural University, Navsari and reared continuously in laboratory on okra leaves to have pure mass culture and constant supply of materials for different studies. The life cycle was studied in laboratory at room temperature and humidity conditions (an average of 27.53°C and 60.45% RH during March-April and an average of 29.67°C and 87.30% RH during July-August). First of all, thirty adult females taken from stock culture were released on okra leaves in the morning in order to collect eggs for the study. Next day morning, the number of eggs laid by these mites were counted and marked

*Present address : Professor & Head, Department of Entomology, N. M. College of Agriculture, GAU, Navsari.

for subsequent development and adults were removed from the leaf. Beginning with these eggs, the detail studies on biology of this mite were carried out on excised bit of okra leaf (size - 1.5 x 1.5 cm) kept on water soaked filter paper (7 x 5 cm) overlying a little mass of wet cotton (size 8 x 6 x 0.4 cm) in Petri dish (15 cm. diameter and 1 cm. height). The method of retaining individual mite on okra leaf bit was adopted throughout the life span. Water was added periodically so as to keep cotton saturated and maintain leaf bits in turgid condition. The leaf bits were replaced every alternate day to avoid leaf deterioration and consequent poor nutrition. After egg hatching, the newly emerged hexopod larvae were lifted carefully with the help of zero number fine camel hair brush and kept on leaf bits at the rate of one larva per leaf bit. Observation were made twice a day for developmental stages, and once, when adults were present. In rare occasions, some mites drowned in water and died before completing their life cycle, such sets were dis-

carded under the study from that stage. The fecundity was worked out by noting total number of eggs laid by an individual adult female mite during her life span. During oviposition, eggs laid were crushed to avoid recounting. Duration and behaviour of various stages, sex ratio and parthenogenesis were also studied. A standardized ocular micrometre fitted to a stereoscopic microscope was used for measuring various stages.

To determine the effect of mating and influence of female age on egg laying, the same method of retaining individual mite kept on leaf bits overlying a wad of cotton in petri dish was employed. Leaf bits were replaced every alternate day. For the purpose, a teleochrysalis female (quiescent female deutonymph) was placed singly on leaf bit and no males were provided. In another case, two males were provided to fertilize the female since their emergence as an adult. Twelve sets each for female

TABLE 1

Morphometric differences of various stages of *Tetranychus macfarlanei**

Stage	Length (mm)			Width (mm)		
	Max.	Min.	Av. $\pm$ S. D.	Max.	Min.	Av. $\pm$ S. D.
I ^c	2.	3.	4.	5.	6.	7.
Egg**	0.13	0.12	0.127 $\pm$ 0.005			
Larva	0.18	0.16	0.175 $\pm$ 0.0071	0.13	0.12	0.129 $\pm$ 0.0032
Prtonymph	0.26	0.23	0.25 $\pm$ 0.0105	0.16	0.15	0.156 $\pm$ 0.0052
Deutonymph	0.38	0.33	0.364 $\pm$ 0.0217	0.21	0.19	0.203 $\pm$ 0.0082
Adult						
Male	0.38	0.35	0.362 $\pm$ 0.0132	0.21	0.20	0.206 $\pm$ 0.0052
Female	0.42	0.40	0.411 $\pm$ 0.0086	0.25	0.23	0.243 $\pm$ 0.0095

* Average of 25 observations.

** Measurement in diameter.

without male (unmated) and female with male (mated) were prepared. The number of eggs laid by each virgin female (unmated) and mated female was recorded daily. In the later group of mites, the progeny contained female indicating that mating was followed by fertilization as unmated female invariably gave rise to male progeny. Male emerges a bit earlier as an adult than female.

A life table was worked out in laboratory during July-August (av. 29.67°C and 87.30% R.H.). Initially, sixty adult females were released on okra leaves. Next morning, mites were removed and eggs counted. Subsequent observations on their hatching and on the emergence of larva, nymph and adult and their survival at each age interval were made. To determine the age specific fecundity (mx), females (50) emerged on the same day were transferred to new okra leaves and reared singly. Eggs laid on subsequent days were recorded. Studies continued till all female died. The data were analysed according to the formula given by Atwal and Bains (1974).

RESULTS AND DISCUSSION

Developmental stage

Both sexes of *T. macfarlanei* consisted of egg, larva, protonymph, deutonymph and adult. At the end of the larval and each nymphal instar, there was a short quiescent phase in which mites anchored and moulted to the succeeding stage. Usually this behaviour is normal and common to all tetranychids. Eggs were laid singly generally on the lower side of the leaf along with midrib. They were spherical, translucent white when freshly laid, later changing to light yellow and finally to brackish brown. Hatching varied from 91.43 to 97.26 per cent. Larvae were less active than protonymphs

which in turn were less active than deutonymph.

Developmental period

The span of various stages varied during different seasons. The key factor affecting the life span seemed to be the variation in temperature and humidity. In March-April, incubation period for male & female was 4.31 ± 0.46 days, while it was 3.06 ± 0.23 days during July-August when relatively higher temperature and humidity prevailed. Similarly, the duration of various developmental stages was prolonged during March-April as compared to July-August. Combined larval-nymphal period was 5.69 ± 1.55 days for male and 6.13 ± 0.41 days for female during March-April, while it was 4.30 ± 0.39 days and 5.07 ± 0.23 days, for respective sexes, during July-August. Hence, the males emerged earlier than the females and were found near the teleochrysalis female. This behaviour increases the probability of mating and might enhance the reproductive potential under natural conditions. Similar impact of low temperature in extending the developmental period and the duration of various stages has also been reported among tetranychids (Shih and Sheih, 1978; Puttaswamy and Channabasavanna, 1979 and Jose and Shah, 1989).

Adult stage

The male was slightly pinkish and smaller than the female. The body was narrow with a pointed abdomen. It lived longer during July-August (11.2 ± 3.71 days) than during March-April (4.31 ± 0.88 days). The female was bright red having dark patches on the dorsum, and survived for 15.27 ± 4.00 and 11.36 ± 3.62 days during respective seasons.

TABLE 2

Duration of various developmental stages, adult period and ovipositional period of okra mite, *Tetranychus macfarlanei*.

Stage		March-April		July-August	
		No. observed	Av. $\pm$ S.D.	No. observed	Av. $\pm$ S.D.
1.		2.	3.	4.	5.
Incubation period	Male				
	Female	145	4.31 $\pm$ 0.46	75	3.06 $\pm$ 0.23
Larval period	Male	17	2.27 $\pm$ 0.24	20	0.98 $\pm$ 0.42
	Female	42	2.36 $\pm$ 0.35	34	1.13 $\pm$ 0.34
Nymphochrysalis	Male	17	0.54 $\pm$ 0.25	20	0.65 $\pm$ 0.21
	Female	42	0.66 $\pm$ 0.25	32	0.70 $\pm$ 0.81
Protonymphal period	Male	17	1.16 $\pm$ 0.32	20	0.86 $\pm$ 0.24
	Female	36	1.18 $\pm$ 0.31	26	0.96 $\pm$ 0.14
Deutochrysalis period	Male	17	0.43 $\pm$ 0.25	20	0.35 $\pm$ 0.21
	Female	36	0.65 $\pm$ 0.23	26	0.39 $\pm$ 0.26
Deutonymphal period	Male	17	0.06 $\pm$ 0.27	20	0.75 $\pm$ 0.20
	Female	36	0.69 $\pm$ 0.52	22	1.27 $\pm$ 0.38
Teleochrysalis period	Male	17	0.56 $\pm$ 0.27	20	0.66 $\pm$ 0.39
	Female	36	0.67 $\pm$ 0.28	22	0.50 $\pm$ 0.33
Combined larval-nymphal period	Male	17	5.69 $\pm$ 1.55	20	4.30 $\pm$ 0.39
	Female	36	6.13 $\pm$ 0.41	22	5.07 $\pm$ 0.23
Adult period	Male	17	4.31 $\pm$ 0.88	20	11.20 $\pm$ 3.71
	Female	22	11.30 $\pm$ 3.62	22	15.27 $\pm$ 4.00
Pre-oviposition period	Unmated	28	1.24 $\pm$ 0.39	22	0.71 $\pm$ 0.15
	Mated	—	—	12	1.83 $\pm$ 0.75
Oviposition period	Unmated	23	6.04 $\pm$ 3.13	22	13.09 $\pm$ 4.61
	Mated	—	—	12	12.67 $\pm$ 2.52
Post-oviposition period	Unmated	22	3.91 $\pm$ 0.92	22	2.73 $\pm$ 1.19
	Mated	—	—	12	2.33 $\pm$ 0.68
Rate of egg laying/ female/ day	Unmated	22	4.62 $\pm$ 1.18	22	5.28 $\pm$ 0.27
	Mated	—	—	12	5.96 $\pm$ 4.05
Fecundity	Unmated	23	25.78 $\pm$ 10.63	22	44.64 $\pm$ 18.77
	Mated	—	—	12	69.00 $\pm$ 27.88
Egg to egg generation period		26	10.69 $\pm$ 0.68	22	8.77 $\pm$ 0.08
Mean temperature (°)		—	27.53	—	29.67
Mean relative humidity (%)		—	60.45	—	80.30

Mating

Mating was observed soon after the emergence. The male slipped underneath the female and arched its opisthosomal region upward to bring aedeagus in contact with female genital opening. The mating lasted 1-2 minutes. Similar mating behaviour was observed in *T. ludeni* (Puttaswamy and Channabasavanna, 1979).

Oviposition period and fecundity

Oviposition period, fecundity and the rate of egg-laying for mated female was recorded only during July-August. Fecundity and the rate of egg laying following mating increased despite the fact that the unmated female oviposited for longer period. Comparatively lower fecundity (25.78 ± 10.63 eggs) and fecundity rate (4.62 ± 1.18 eggs/days) and

longer preoviposition period (1.24 ± 0.39 days) were recorded for unmated female during March-April (at low temperature and humidity). The generation period (egg to egg) was 10.69 ± 0.68 days during March-April, while it was 8.77 ± 0.08 days during July-August. Jose and Shah (1989) recorded increased fecundity following the decrease of temperature which is in contrast to the present findings. Some of the comparable reports on oviposition and fecundity are reported in case of *T. cinnabarinus* (Shih and Sheih, 1978) and *T. ludeni* (Puttaswamy and Channabasavanna, 1979).

Sex ratio

Male to female sex ratio was 1:6.5 parthenogenetically reproduced population gave 100 per cent males. Effect of mating and

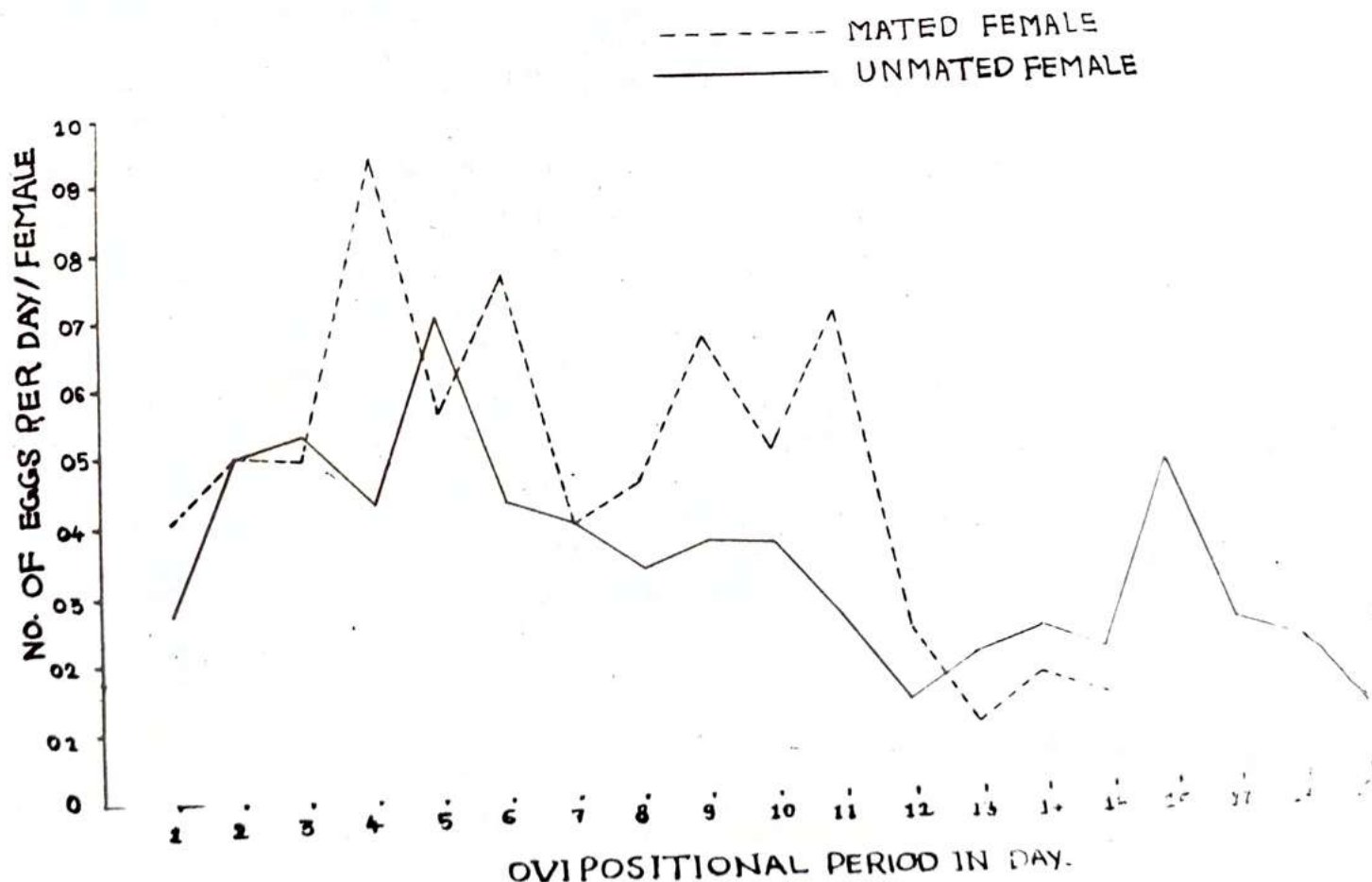


Fig. 1: Influence of mating on oviposition in *Tetranychus macfarlanei*

influence of female age on egg laying : An almost similar pattern of egg laying recorded in case of *T. macfarlanei* was reported for other tetranychids (Boudreaux, 1963); with advancing age, the rate of egg laying increased for few days in case of both mated and unmated females. Thereafter, it declined, though not smoothly (Fig. 1). The fecundity rate after mating reached its peak on 4th day of adult life (9.33 eggs) and on 5th day (7.00 eggs) in case of unmated females. The total fecundity and rate of egg laying by mated females was higher than by unmated females. The later ones oviposited for a longer period. Similar observations are reported for many species of tetranychids (Banu and Channabasavanna, 1972 and Lakshamanlal and Mukharjee, 1978).

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Life table

A life table of *T. macfarlanei* on okra was constructed from the data obtained in laboratory (Table 3). The net reproductive rate (R_0), mean generation time (T), innate capacity for increase (rm) and finite rate of increase (λ) were worked out to be 30.3744 times, 12.037 days, 0.2836 progeny/female/day and 1.328 per head/day at 29.67°C and 37.30% R.H. Laing (1969) recorded on almost similar value of R_0 as 30.93 for *T. urticae* from 15 to 28°C, but he found lower rm value (0.143) which might have been due to a higher mean generation time (24.0 days). rm was reported as 0.336 at 27°C and 95% R.H. for *T. urticae* (Shah et al., 1976) and 0.318 at 27 ± 2°C and 65.5% R. H. for *T. Cinnabarinus* (Shih and Shieh, 1978).

Population Dynamics of Chickoo Moth, *Nephoteryx eugraphella* (Ragonot). (Pyralidae : Lepidoptera) in Relation to Weather Parameters

B. S. Patel, R. C. Jhala and C. B. Patel*

Department of Entomology, N. M. College of Agriculture, Gujarat Agricultural University, Navsari-396 450

ABSTRACT

The studies were carried out during 1989-90 on population dynamics of *Nephoteryx eugraphella* (Ragonot) infesting sapota trees, *Manilkara echras* (Mill). The infestation was found to remain higher in late monsoon to early winter period (September to January). There were two peaks of infestation on bud, first in second fortnight of September and second in first fortnight of November. The infestation on leaves remained below 5 per cent throughout the year with peak activity in the first fortnight of January. Per cent infestation on buds was significantly positively correlated with minimum (X_2) and average (X_3) temperature, evening relative humidity (X_5) and rainy days (X_9) while significantly negatively correlated with sunshine hours (X_7). The correlation with maximum temperature (X_1), morning (X_4) and average (X_6) relative humidity and rainfall (X_8) was not significant. The per cent infestation on leaves was significantly negatively correlated with X_2 , X_3 , X_5 and X_6 while it was not-significant with other meteorological factors. The multiple linear regression equation was : $Y = 5.387 + 360 (X_2) - 0.035 (X_3) - 0.097 (X_5) - 0.438 (X_7) - 0.002 (X_9)$ for the infestation on bud while it was : $Y = 3.779 - 0.042 (X_2) - 0.033 (X_3) + 0.011 (X_5) + 0.003 (X_6)$ for the infestation on leaves. Only 47.10 and 22.8 per cent variation was explained by various weather parameters in the per cent infestation on buds and leaves, respectively.

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INTRODUCTION

Among the various factors affecting the yield of fruit crops, damage caused by insect pests is very important. More than 25 insect pests are reported attacking sapota tree (*Manilkara achras* (Mill.) Fosbarg), (Butani, 1979). Amongst, Chickoo moth (*Nephoteryx eugraphella*) is one of the major insect-pest in South Gujarat damaging leaves and bud of sapota. The pest causes considerable damage to young terminals affecting the buds and fresh

leaves and reported that the damage caused by this pest is alarming one as flowering parts of sapota are badly affected and considered as potential insect pest of sapota in South Gujarat (Jhala *et al.*, 1986).

Before developing Insect Pest Management Programme for specific agro ecosystem, it is necessary to have the basic information on abundance and distribution of pest in relation to weather parameters which help in determining appropriate time of action

*Address for communication : Professor of Entomology, N. M. College of Agriculture, GAU, Navsari-396 450.

and suitable effective method of control. Published information on population dynamics of this pest is very limited and this pest has also remained unattended from the view point of effect of weather parameters on its population fluctuation. Therefore, the present investigation was carried out with a view to study the effect of different weather parameters on the population fluctuation of the pest throughout the year.

MATERIALS AND METHODS

On order to study the population dynamics of this insect-pest, sapota trees were selected randomly in the orchard at two locations *e.i.*, College Farm, N. M. College of Agriculture, Navsari and farmer's orchard (Dr. Vasadia's farm) near college farm. Ten trees in each orchard were observed at 15 days interval starting from July 1989 and continued upto June, 1990. Randomly selected ten terminal shoots with flower buds and leaves were observed critically in each tree and damaged and healthy flower buds and leaves were counted. Thus in all 100 shoots were observed in each orchard at each observation. Based on this data, per cent buds and leaves damaged by various pest were worked out.

In order to study the instantaneous effect of weather parameters *viz.*, maximum temperature, minimum temperature, average temperature, morning relative humidity, evening relative humidity, average relative humidity, sunshine hours, rainfall and rainy days on population of the pest, correlation coefficient and multiple/simple regression were worked out by taking average infestation of both the locations. Weekly meteorological data as recorded at meteorological observatory in college

farm, N. M. College of Agriculture, Navsari for the period during July 1989 to June 1990 were used. The weekly meteorological data were transferred into fortnightly average and utilized for present study.

RESULTS AND DISCUSSION

It can be seen from the data presented in Table 1 and depicted in figure 1 that the infestation of this pest on buds was more or less throughout the year. The infestation was higher in late monsoon to early winter period i. e., September to January. There were two peaks of infestation on bud, first in second fortnight of September (7.07%) and second in first fortnight of November (6.36%) recording more than 5 per cent infestation on buds. Thus higher activity period was found in the month of September and November, while lower activity was found during December to August (Below 5%).

In Gujarat, the higher infestation by *N. eugraphella* on buds has been reported in September during 1985-86 (Anonymous, 1986 a), 1986-87 (Anonymous, 1987) and 1989-90 (Anonymous, 1990), while in November during 1979-81 (Patel, 1981). These reports are in close agreement with present findings. However, higher activity of this pest has been also reported in October during 1981-83 (Jhala *et al.*, 1986; Anonymous, 1989 b), in August during 1984-85 (Anonymous, 1985) and 1985-86 (Anonymous, 1986 b) and in June during 1987-88 (Anonymous, 1989 a). The present finding differed from above reports. The minimum activity of this pest on buds has been observed in May-June during 1979-81 (Patel, 1981), in March-April during 1981-83 (Jhala *et al.* 1986), in January during 1984-85, (Anonymous, 1985) in March during 1985-86, (Anonymous, 1986a), in March and May to July

TABLE 1

Per cent infestation by chickoo moth *N. eugraphella* on sapota (1989-90).

Sr. No.	Month and Fortnight	Per cent infested buds			Per cent infested leaves		
		At College orchard	At Farmer's orchard	Average	At College orchard	At Farmer's orchard	Average
1.	2.	3.	4.	5.	6.	7.	8.
1.	July 1989	I 3.35	4.61	3.98	0.97	1.20	1.09
2.		II 5.01	4.34	4.68	2.27	1.85	2.06
3.	August	I 3.46	3.80	3.63	2.04	1.57	1.81
4.		II 4.38	5.30	4.84	0.76	0.93	0.85
5.	September	I 4.48	5.21	4.85	2.50	1.02	1.76
6.		II 7.96	6.18	7.07	1.47	0.36	0.92
7.	October	I 3.85	2.92	3.39	3.77	2.07	2.92
8.		II 2.41	2.85	2.63	1.68	2.37	2.03
9.	November	I 7.94	4.78	6.36	2.87	2.53	2.70
10.		II 3.29	4.59	3.94	2.96	4.04	3.50
11.	December	I 2.38	3.20	2.79	2.38	1.91	2.15
12.		II 2.29	1.34	1.82	2.05	1.58	1.82
13.	January, 1990	I 2.31	1.07	1.69	4.20	4.40	4.30
14.		II 1.94	0.84	1.39	3.68	0.62	2.15
15.	February	I 1.76	1.00	1.38	1.94	1.29	1.62
16.		II 1.71	1.08	1.40	2.11	1.09	1.60
17.	March	I 2.54	1.16	1.85	1.50	0.78	1.14
18.		II 1.47	1.78	1.63	1.05	0.44	0.75
19.	April	I 2.09	1.68	1.89	0.95	0.73	0.84
20.		II 1.96	1.95	1.96	1.04	0.90	0.97
21.	May	I 1.88	1.32	1.60	0.98	1.00	0.99
22.		II 2.10	2.08	2.09	1.14	0.99	1.07
23.	June	I 2.96	3.31	3.14	1.24	0.87	1.06
24.		II 3.79	2.43	3.11	1.78	1.09	1.44



—x— Per cent infested leaves
 -o- Min Temp.
 -□- Av. Temp.
 -●- Av. Relative humidity
 -■- Evening relative humidity

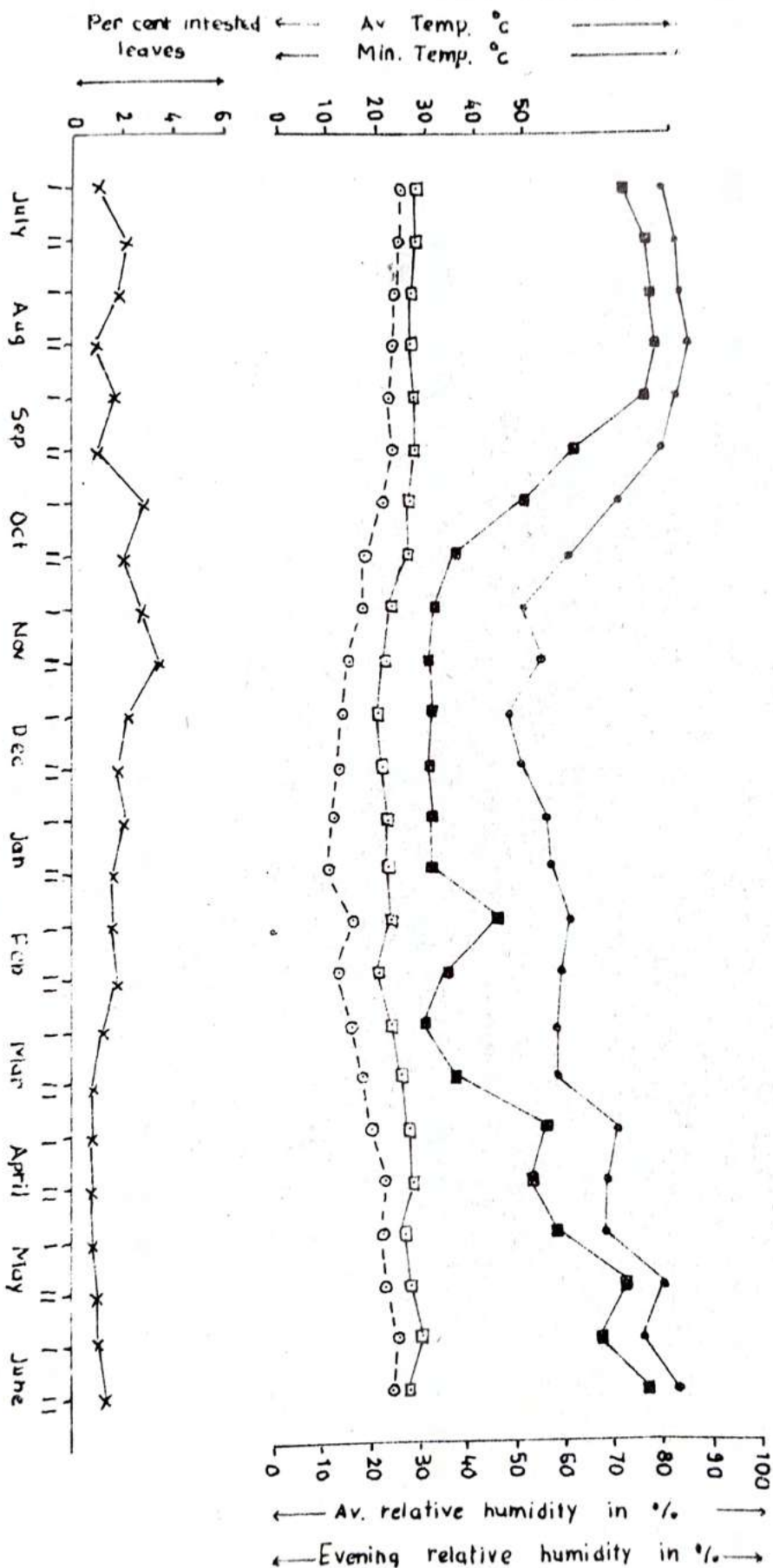
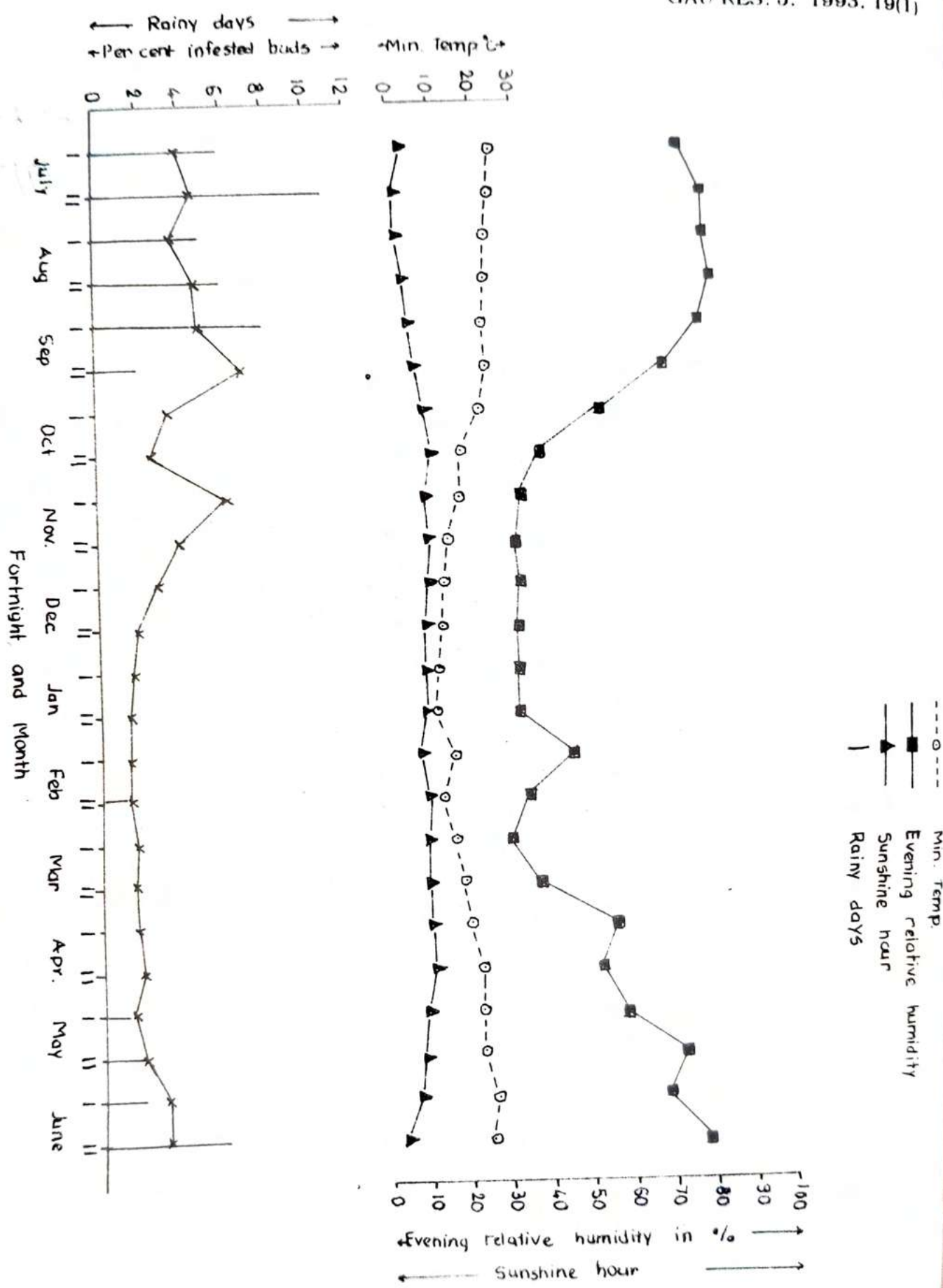


Figure 2 Level of infestation by *N. eugraphella* on Supata leaves in relation to weather parameters during different months of the year 1983-84.

Figure 2 : Level of infestation by *N. guayanaensis* on sapota buds in relation to weather parameters during different months of the year 1989-90.



during 1985-86 (Anonymous, 1986b), in December and February during 1986-87 (Anonymous, 1987), in April during 1987-88 (Anonymous, 1989a) and 1989-90 (Anonymous, 1990) and in February during 1988-89 (Anonymous, 1989b). The present finding of lower activity of the pest on buds observed during December to August mostly tally with above reports. Further, the higher infestation of this pest on buds during late monsoon to early winter in the present study is in confirmation to earlier report made by Patel (1981) and Jhala *et al.*, (1986). However, the variation reported in higher activity of this pest on buds during different period of study might have been due to effect of weather parameters and other ecological factors.

As regard the infestation if *N. eugraphella* on leaves, it can be seen from the data presented in Table 1 and depicted in figure 2 that the infestation remained throughout the year below 5 per cent. However, it was comparatively higher during November and January. Maximum infestation (4.30%) was in the first fortnight of January, while minimum (0.75%) was in second fortnight of March. Further most of the peak infestation period on leaves coincided with that of infestation on buds as can be seen from figure 1 and 2. In Gujarat, higher activity of *N. eugraphella* on leaves has been reported in October during 1985-86 to 1987-88 (Anonymous, 1986 a, 1987, 1989a), in August during 1988-89 (Anonymous, 1989b) and in November during 1989-90 (Anonymous, 1990). These reports differed from present finding, might be due to different effect of weather parameters and ecological condition at various location in different years.

Analytical data presented in Table-2 indicated that the correlation between dependent

variable viz., chickoo moth infestation on buds (Y_1) and minimum temperature (X_2), average temperature (X_3), evening relative humidity (X_5) and rainy days (X_9) was positive and significant at 5% level of significance. This revealed that as the above variable increased, the infestation was also increased significantly and vice versa. Highly significant negative correlation was observed between sunshine hours (X_7) and chickoo moth infestation on buds (Y_1) indicating that as sunshine hours increased, the infestation of the pest decreased (Figure 1). The multiple linear regression equation fitted to the data taking chickoo moth infestation on bud (Y_1) as a dependent variable and meteorological factors having significant coefficient as independent variable was $Y_1 = 5.387 + 0.360 (X_2) - 0.035 (X_3) - 0.097 (X_5) + 0.438 (X_7) - 0.002 (X_9)$ (Table 3). The coefficient of determination (R^2) was 0.471 showing thereby that only 47.10 per cent variation in the dependent variable was explained by various independent variable. However, it was statistically not significant indicating that the factors other than climatic ones were also responsible for contributing to pest infestation on buds.

As regard the correlation between dependent variables, chickoo moth infestation on leaves (Y_2) and climatic factors, it can be seen from Table 2 that with minimum temperature (X_2), average temperature (X_3), evening relative humidity (X_5) and average relative humidity (X_6), there was a significant negative correlation. This indicated that as the above variable increased, the chickoo moth infestation decreased and vice versa (Figure 2). The correlation between maximum temperature (X_1), morning relative humidity (X_4), sunshine hour (X_7), rainfall (X_8) and rainy days (X_9) was non-significant indicating that there was no correlation between above factors and chickoo

TABLE 2

Correlation coefficient values of chickoo moth (*N. eugraphella*) infestation on chickoo with respect to weather parameters.

X	Maximum temperature (°C) X_1	Minimum temperature (°C) X_2	Average temperature (°C) X_3	Morning relative humidity (%) X_4	Evening relative humidity (%) X_5	Average relative humidity (%) X_6	Sun shine hours X_7	Rainfall (mm) X_8	Rainy days X_9
Y	2.	3.	4.	5.	6.	7.	8.	9.	10.
Chickoo moth on buds (Y_1)	-0.170	0.502*	0.413*	0.262	0.408*	0.394	-0.535*	0.348	0.483*
Chickoo moth on leaves (Y_2)	0.007	-0.478*	-0.429*	-0.306	-0.450*	-0.440*	0.142	-0.006	-0.176

* Significant at 5 per cent level of significance.

** Significant at 1 per cent level of significance.

TABLE 3

Multiple/simple regression equations to predict incidence of pest(*N. augraphella*) on the basis of weather parameters having significant correlation.

Sr. No.	Insect pests	A Value	Maximum temperature (°C) X_1	Minimum temperature (°C) X_2	Average temperature (°C) X_3	Morning relative humidity (%) X_4	Evening relative humidity (%) X_5	Average relative humidity (%) X_6	Sun shine hours X_7	Rainfall (mm) X_8	Rainy days X_9	R
1	Chickoo moth on buds (Y_1)	5.387	-	0.360	-0.035	-	-0.097	-	-0.438	-	-0.002	0.471
2	Chickoo moth on buds (Y_2)	3.779	-	-0.042	-0.033	-	0.011	0.003	-	-	-	0.228

moth infestation on leaves (Y_2). The multiple linear regression equation fitted taking chickoo moth infestation on leaves (Y_2) as dependent factor and meteorological factors having significant regression coefficient as independent variable was $Y_2 = 3.779 - 0.042 (X_2) - 0.033 (X_3) + 0.011 (X_5) + 0.003 (X_6)$ (Table 3). The coefficient of determination

(R^2) was 0.228 showing thereby that only 22.8 per cent variation in the dependent variable was explained by various independent variables. However it was statistically non-significant signifying that the factors other than climatic ones were also responsible for contributing to pest infestation on leaves.

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Seasonal Development of *Goniozus* (= *Parasierola*) *Nephantidis* Muesebeck and its Effectiveness Against *Opisina arenosella* Walker

M. N. Kapadia* and V. P. Mittal

Department of Entomology, Gujarat Agricultural University, Junagadh-362 001

ABSTRACT

The studies on the development of *Goniozus nephantidis* Muesebeck on the larvae of *Corcyra cephalonica* (Stainton) in different months of the year, and its effectiveness against *Opisina arenosella* Walker, were done under Mahuva (Gujarat State) conditions during 1983-86. The egg to larval (4.00 days), pupal (6.37 days) and oviposition (2.70 days) periods were shorter in the months of June - July, March and January - February, respectively, while they were longer in April (5.83 days), May - June (10.00 days) and April (12.00 days). The females survived longer (20.40 days) in November - December and males in April (7.40 days). November - December had provided the suitable conditions (28.78°C and 41.15% RH) for obtaining the higher yield of cocoons (74.76%) by good fecundity (21.00 eggs/female) of the parasitoid.

The field releases made for three years (1983-86) resulted the overall recovery to be 30.97 per cent parasitism of *O. arenosella*. November and February were found the most suitable months for obtaining the higher recovery.

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INTRODUCTION

The Oecophorid pest of coconut, *Opisina arenosella* Walker was found associated with total 23 natural enemies under Mahuva conditions of Gujarat State. Among the larval parasitoids, the bethylid, *Goniozus* (= *Parasierola*) *nephantidis* Muesebeck is the most important one. The life-history and habits of this parasitoid have been reported earlier (Rao et al: 1948; Kurian and Antony, 1961; Remadevi et al 1978 (its biology and natural incidence under Mahuva conditions have been studied) Kapadia and Mittal: 1986): Releasing of this parasitoid for the control of the pest was suggested (Selvasekaran and Chandrasekaran,

1984). Since no studies on its development in different seasons and effectiveness has previously been done in Gujarat; attempts were, therefore, made to know the seasonal development of the parasitoid and to evaluate its effectiveness against the pest.

MATERIALS AND METHODS

The development of *G. nephantidis* was studied under the laboratory conditions in different months of the years (1983-84), using the laboratory host, *Corcyra cephalonica* (Stainton). For this purpose, the culture used was from its mass rearing in the laboratory. Different developmental stages of the parasitoid were studied as per method described by Kapadia

*Present address : Associate Research Scientist (Entomology), Dry Farming Research Station, GAU, Targadia-360 003

and Mittal (1986). The mass rearing of the parasitoid was also done by adopting this method in which the mated parasitoid females were released individually into the glass tube (9 x 2.5 cm in diameter) bearing a single healthy *Corcyra* larva. Honey was provided as small droplets on a plastic piece as food for them. After a day, the parasitized larva was removed and replaced by another healthy host larva. These larvae were kept on paper for obtaining the parasitoid cocoons. The emerged adults were collected in glass tubes (10 x 3 cm in diameter) for their field releases.

Five day old female parasitoids were released in the selected coconut orchard of 200 palms, infested with the suitable stage of the pest. The number of parasitoid females released was in proportion of 20 per cent of population of full grown *Opisina* larvae. The field releases were made during three years (1983-86). The observations on the level of parasitism in the released and non-released coconut orchards were recorded after 15 days of the release. The control orchard was selected about 2 km away from the released orchard. Twenty five infested coconut palms were selected at random from the experimental orchard for determining the parasitism.

RESULTS AND DISCUSSION

The results obtained on the development of parasitoid in different months of the year and field recovery by the parasitoid are presented in Table 1 and 2.

1. Seasonal development

The data indicated that egg to larval period was less (4.00 days) in the months of June - July than in other months (5.15-5.83 days). The pupal period varied from 6.56 to 10.00 days. It was comparatively shorter (6.56

days) in months of January - February as compared to May-June (10.00 days). The oviposition period prolonged in the month of April (12.00 days), followed by November - December (9.50 days), and shortened in January - February (2.70 days). The fecundity was higher (30.10) in April, followed by November - December (21.00). The longevity of females and males was longer in November - December (20.40 days) and April (7.40 days), respectively. The percentage becoming cocoons from total eggs laid was higher (74.76%) in November - December, followed by March (72.72%), while the lowest percentage cocoons (30.56%) was obtained in April, followed by February (42.56%). No report regards the seasonal development of this parasitoid is available from the published literature. However, Rao *et al.* (1948) reported that the parasitoid was less active during the periods of monsoon.

2. Effectiveness

The field releases of the parasitoid were made in four selected coconut orchards in each year. The data summarized in Table 2 revealed that during the releasing year of 1983-94, the percentage parasitism over the control varied from 18.52 to 52.20 per cent parasitism. The maximum recovery (52.20%) was obtained in February. The released parasitoid caused an average 29.94 per cent parasitism over the control in the said year. The parasitism in the released orchards of 1984-85 was recorded in the range of 21.25 to 30.00 per cent over the control. The higher recovery (30.00%) was obtained in the February release, followed by January (28.27%). Whereas, the average recovery was 26.44 per cent in this releasing year. In releasing year of 1985-86, the levels of parasitism in the experimental orchards were recorded more in the range of 15.00 to 88.50

TABLE 1

Developmental stages, fecundity and percentage becoming cocoons of *Goniozus nephantidis* on *C. cephalonica* during the different months of the year, 1983-84.

Sr. No.	Particular	Average period (days)/month						
		April	May-June	June-July	November-December	January-February	February	March
1.	Egg to larval period	5.83	5.30	4.00	5.15	5.31	5.40	5.61
2.	Pupal period	9.03	10.00	6.65	9.76	6.56	8.70	6.37
3.	Pre-oviposition period	4.10	4.00	5.83	6.40	6.20	10.00	5.33
4.	Oviposition period	12.00	4.13	5.50	9.50	2.70	5.33	4.67
5.	Post-oviposition period	3.70	3.00	2.00	3.40	4.90	2.67	4.16
6.	Fecundity	30.10	13.26	11.67	21.00	5.00	12.20	9.16
7.	Egg laying day	5.30	1.93	2.50	3.80	1.33	2.75	2.33
8.	Longevity	19.00	9.45	8.61	20.40	14.20	18.60	9.80
	Female	7.40	4.05	2.86	4.70	3.60	4.25	4.00
9.	% becoming cocoons from eggs laid	30.56	67.27	70.29	74.76	62.22	42.62	72.72
	Average temp. (°C) :	25.71	32.41	31.86	28.78	26.44	26.80	34.02
	Average relative humidity (%) :	57.90	74.48	85.52	41.15	39.76	39.01	35.90

TABLE 2

Field releases and effectiveness of *Goniozus nephantidis* against *O. arenosella* during different years (1983-86).

Year of study	Experimental orchard No.	No. of parasitoid adults released*	Month of releasing	Parasitism (%) after 15 days of release		Parasitism (%) over the control
				Experimental orchard	Control orchard	
1983-84	1	285	January	18.52 (27)	0.00 (25)	18.52
	2	225	February	58.34 (72)	6.14 (65)	52.20
	3	250	February	43.60 (78)	18.75 (48)	24.85
	4	912	April	35.71 (28)	11.54 (26)	24.17
	4	1672	-	39.04 (205)	9.11 (164)	29.94
1984-85	1	167	September	40.00 (40)	18.75 (56)	21.25
	2	180	November	28.57 (42)	2.33 (58)	26.24
	3	1175	January	28.27 (49)	0.00 (43)	28.27
	4	1000	February	30.00 (40)	0.00 (30)	30.00
	4	2522	-	31.71 (171)	5.27 (187)	26.44
1985-86	1	2200	February	88.50 (32)	0.00 (40)	88.50
	2	400	April	15.00 (20)	0.00 (20)	15.00
	3	280	November	28.57 (70)	0.00 (200)	28.57
	4	580	December	20.00 (300)	6.00 (300)	14.00
	4	3460	-	38.02 (422)	1.50 (560)	36.52
Overall	12	7454	-	36.27	5.29	30.97

* Proportion of females to male was 4 : 1.
 Figures in parentheses indicate number of *opisina* larvae observed.

per cent as compared to the non-released orchard. The February release had gave the maximum recovery (88.50%). The average parasitism in this releasing year was 36.52 per cent.

The results of three years indicated that the overall recovery was 30.97 per cent. November and February were found the most suitable months for getting the higher recovery.

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Evaluation of Granular Insecticides Against Sugarcane Leaf Hopper, *Pyrilla perpusilla* Wlk. on Sugarcane*

D. R. Patel, M. B. Patel and C. B. Patel**

Department of Entomology, N. M. College of Agriculture, Gujarat Agril. University, Navsari Campus, Navsari-396 450

ABSTRACT

Field cum laboratory trial was conducted at the Department of Entomology, N. M. College of Agriculture, G.A.U., Navsari during the year 1990, to evaluate the different granular insecticides against pyrilla adults on sugarcane. The results indicated that carbofuran 3G, Cartap hydrochloride 4G, phorate 10G each @ 1 kg a.i./ha and sevidol 4.4 G @ 1.5 kg a.i./ha were found effective in reducing pyrilla population in sugarcane. The efficacy of all the granular insecticides increased fourteen days after insecticidal application while it was decreased 21 days after insecticidal application.

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INTRODUCTION

Amongst the sucking insects attacking sugarcane, the leaf hopper, *Pyrilla perpusilla* Wlk. is a serious pest found in almost all the sugarcane growing states and now becoming a regular menace to the sugarcane growers. In India, various pesticides have been tested against the pest. Shah *et al.* (1979) reported that endosulfan, monocrotophos and carbaryl were the most effective for the control of pyrilla. Joshi and Sharma (1975) recommended granular insecticides viz., thiodemeton, phorate and carbofuran in furrows in the month of August for the control of this pest. Gajare and Hapase (1981) reported treatments of endosulfan, fenitrothion and methyl demeton to be effective in controlling pyrilla on sugarcane in aerial spraying programme. Rajput *et al.*, (1985) studied the efficacy of granular insecticides viz.,

aldicarb 10G, carbofuran 3G, phorate 10G, dimethoate 2G and disulfoton 10G and reported that all the granular insecticides were found effective in reducing pyrilla population. Sajjan *et al.* (1985) found monocrotophos, carbaryl, enosulfan and trichlorphon as effective to control pyrilla. As reported by Om Prakash (1986), fenitrothion, phosalone, quinalphos and endosulfan were the effective for the control of pyrilla. Looking to these reports, very little information is available on chemical control of this pest through granular insecticide, therefore a laboratory cum field was conducted to evaluate some granular insecticides against pyrilla in sugarcane.

MATERIALS AND METHODS

Field cum laboratory experiment using randomized block design with seven treatments

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**Address for communication : Professor and Head, Department of Entomology, N. M. College of Agriculture, GAU, Navsari,-396 450.

TABLE 1

Effect of granular insecticides on adults of *Pyrilla perpusilla* Wik.

Sr. No.	Treatment	Per cent mortality days after insecticidal treatment								
		7			14			21		
		Feeding period (days)			Feeding period (days)			Feeding period (days)		
1	3	6	1	3	6	1	3	6		
1.	Quinalphos 5G 1.0 kg a.i./ha	00.00 (9.1)	6.67 (15.32)	40.00 (39.15)	30.00 (33.00)	50.00 (45.00)	73.33 (59.00)	0.00 (9.10)	10.00 (18.43)	33.33 (35.22)
2.	Phorate 10G 1.0 kg a.i./ha	20.00 (26.07)	36.67 (37.22)	73.33 (59.00)	36.67 (37.14)	73.33 (59.00)	80.00 (63.93)	6.67 (15.32)	20.00 (26.07)	46.67 (43.07)
3.	Cartap hydrochloride 1.0 kg a.i./ha.	23.33 (28.78)	40.00 (39.15)	90.00 (71.97)	66.67 (54.78)	86.67 (69.25)	93.33 (74.68)	6.67 (15.32)	23.33 (28.28)	43.44 (41.07)
4.	Sevidol 4.4 G 1.5 kg a.i./ha	20.00 (26.07)	43.33 (41.15)	83.33 (66.14)	60.00 (50.85)	83.33 (66.14)	86.67 (68.86)	3.33 (12.21)	16.67 (23.86)	36.67 (37.22)
5.	Carboturan 3G 1.0 kg a.i./ha	26.66 (30.99)	53.33 (46.92)	86.67 (68.86)	70.00 (57.00)	90.00 (71.96)	96.67 (77.79)	13.33 (21.14)	33.33 (35.22)	43.33 (41.15)
6.	Neemark 15 G 3.0 kg a.i./ha	16.67 (28.86)	36.67 (37.22)	76.77 (61.22)	20.00 (26.07)	30.00 (33.00)	60.00 (50.85)	10.00 (18.43)	33.00 (33.21)	46.67 (43.07)
7.	Control	00.00 (9.10)	3.33 (12.21)	16.67 (23.86)	13.33 (21.14)	20.00 (26.57)	26.67 (30.99)	0.00 (9.10)	10.00 (18.43)	23.33 (28.48)
	S. Em. $\pm$	(2.85)	(2.49)	(2.52)	(3.56)	(3.91)	(3.11)	(1.86)	(2.97)	(2.48)
	C. D. at 5%	(8.78)	(7.67)	(7.77)	(10.97)	(12.05)	(9.59)	(5.74)	(9.15)	(7.66)

Figures in parentheses are transformed values = $\text{Arc sin } \sqrt{\text{percentage}}$.

replicated three times was conducted at the Department of Entomology, N. M. College of Agriculture, G.A.U., Navsari during the year 1990. Different granular insecticides as shown in table 1 were applied in the soil to eight months old sugarcane crop grown in the field. Laboratory glass jar, having 15 cm. diameter and 20 cm height, was used for pyrilla rearing. The bottom of the jar was filled with 4 to 5 cm thick layer of sterilized moist sand. The leaves of treated plants were brought to the laboratory 7, 14 and 21 days after treatment. About 10 cm long leaf-cut, 6 to 7 per jar, were vertically thrust in the sand layer of the glass jar to keep them succulant and counted number (ten each) of field collected pyrilla adults were fed on the leaves. Mortality of the adults was recorded 1, 3 and 7 days after feeding in each case.

The data obtained on the percentage mortality of pyrilla were statistically analysed after $\arcsin (\sin^{-1} \sqrt{x})$ transformation.

RESULTS AND DISCUSSION

The data in terms of mortality when leaves of treated plants fed to the pyrilla 7, 14 and 21 days after insecticidal application are presented in Table 1.

When leaves fed 7 days after treatment, difference in percentage mortality of pyrilla adults one day and three days after feeding was significantly superior to control in all the treatments except quinalphos in which the difference was at par with control. Among the various treatments, carbofuran had given the highest percentage mortality 26.66% and 53.33% on one day and three days after feeding respectively. After six days feeding cartap hydrochloride gave the highest percentage mortality of pyrilla adults (90.0%) which was

significantly superior to other treatments except carbofuran 3G (86.67%) and sevidol 4.4 G (83.33%). The trend of performance of various treatments based on per cent mortality of pyrilla adults after six days feeding in descending order was : cartap hydrochloride 4G (90%) > carbofuran 3G (86.67%) > sevidol 4.4G (83.33%) > neemark 15G (76.67%) > phorate 10G (73.33%) > quinalphos 5G (40%) > control 16.67%).

When leaves fed fourteen days after insecticidal application, all the treatments except neemark had given significantly higher mortality of pyrilla adults as compared to control after one day and three days of feeding. Among the various treatments carbofuran had given the highest percentage of mortality of pyrilla but it was at par with cartap hydrochloride and sevidol after one day and three days of feeding. Similar trend was observed six days after feeding. The trend of performance of various treatments on the basis of per cent mortality six days after feeding in descending order was : carbofuran — 3G (96.67%) > cartap hydrochloride 4G (93.33%) > sevidol 4.4G (86.67%) > phorate 10G (80.0%) > quinalphos 5G (73.33%) > neemark 15G (60.0%) > control (26.67%). The mortality of pyrilla in all the insecticides except neemark was increased when leaves fed fourteen days after insecticidal application. This indicated that efficacy of insecticides increased fourteen days after application.

Twenty one days after insecticidal application, all the treatments were significantly superior to control except quinalphos 5G and sevidol 4.4G after one day and three days of feeding. Maximum per cent mortality was recorded in the treatments of carbofuran 3G one day and three days after feeding. The trend of performance of various treatments on the

basis of per cent mortality six days after feeding in descending order was : phorate 10G (46.67%) > neemark 15G (46.67%) > carbofuran 3G (43.33%) > cartap hydrochloride 4G (43.33%) > sevidol 4.4G (36.67%) > quinalphos 5G (33.33%) > control (23.33%). Efficacy of all the granular insecticides viz., quinalphos, phorate, cartap hydrochloride, sevidol, carbofuran and neemark was decreased twenty one days after insecticidal application as compared to that seven and fourteen days after insecticidal application as they gave lower percentage

mortality of pyrilla adults. Rajput *et al.*, (1985) reported that aldicarb 10%, carbofuran 3%, phorate 10%, dimethoate 2% and disulfoton 10% each @ 2 kg a.i./ acre gave 100%, 92%, 84%, 84% and 64% mortality of pyrilla nymphs, respectively. Similarly Marwat and Khan (1987) reported that the disulfoton and carbofuran gave best control of *Pyrilla perpusilla* Wlk. The present investigation is also in close agreement with the above reports if compared with the efficacy fourteen days after insecticidal application.

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Population Dynamics of Sugarcane Leaf Hopper (*Pyrilla perpusilla* Wlk.) and its Ectoparasite (*Epiricania melanoleuca* F.) in Relation to Climate*

D. R. Patel, M. B. Patel and C. B. Patel**

Department of Entomology, N. M. College of Agriculture, Gujarat Agricultural University, Navsari-396 450

ABSTRACT

The present investigation was carried out at farmers field to study the population dynamics of sugarcane leaf hopper and its ectoparasite on sugarcane in relation to weather parameters. Egg laying of leaf hopper was observed from second week of May to third week of September with maximum in the month of August. The leaf hopper population started appearing from fourth week of May and continued till third week of October. Egg masses of *Epiricania* were noticed in first week of August to fourth week of October and maximum in the second week of October. Highest per cent parasitism was recorded in second week of September while maximum number of cocoons were observed in the first week of October. The influence of weather parameters on population of leaf hopper and different stages of ectoparasite was studied by working out correlation coefficient and multiple/simple regression.

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INTRODUCTION

Sugarcane leaf hopper, *Pyrilla perpusilla* Wlk. is a serious pest of sugarcane, causing enormous damage to the crop by sucking cell sap from the leaves. Heavy attack of this pest reduces sugar recovery to an extent of 0.2 to 5.0 units (Gupta, 1948) and when affected canes are used as seed material they give poor germination, low yield and finally, sugar or jaggary produced is of poor quality. (Khan and Kanhaya, 1987). Population fluctuation of leaf hopper at a place is affected by various biotic and abiotic factors. In South Gujarat, sugarcane crop is sown from September to March. Continuous availability of the crop in

overlapping seasons favours the pests to multiply enormously and to spread to other areas. It was therefore felt to study population dynamics of this pest as well as its parasite on sugarcane crops sown in different months of the year and effects of climatic condition on the pest and the parasite population.

MATERIALS AND METHODS

The present investigation was conducted at farmers field at village Eru, Ta. Navsari to study the population dynamics of sugarcane leaf hopper and its parasite on sugarcane in relation to weather parameters during the period from February '90 to February '91. From the selected field three spots were located. At

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**Present address : Professor and Head, Dept. of Entomology, N. M. College of Agriculture, G.A.U., Navsari.

each spot ten plants were selected at random to record observations. To determine the population of sugarcane leaf hopper, observations on number of eggs nymphs and adults were recorded weekly on three leaves each from top, middle and lower part of the selected cane plants. Number of different stages viz, egg masses, larvae and cocoons of parasite was also recorded. Per cent parasitism was calculated from the observations on number of parasitized individuals (Nymphs and adults) of leaf hopper out of total number of individuals observed. In order to study the effect of weather parameters on population of leaf hopper and its ectoparasite, correlation, coefficient and multiple/simple regression were worked out. Weekly meteorological observations recorded for the period from February '90 to February '91 were used for this purpose.

RESULTS AND DISCUSSION

The egg laying of leaf hopper was found from second week of May to third week of September. There was no egg laying in the months from February to April and October '90 to February '91. Maximum egg laying was recorded in the month of August (Table 1). According to Brar and Bains (1980) egg masses were found on sugarcane plant from April to November. The adults/nymphs appeared from fourth week of May and remained continued till the third week of October, ranging between 0.33 to 21.33 per ten plants. Two higher peaks of leaf hopper population were observed, one in second week of July (21.33/ten plants) and second in fourth week of July (16.67/ten plants). Rehman (1942) reported that nymph and adult stages were present in

TABLE 1

Average number of *Pyrilla* and different stages of *E. melanoleuca* F. per 10 plants on sugarcane at farmer's field, village Eru, Ta. Navsari (1990-91).

Month	Week	Std. met. week	No. of <i>Pyrilla</i> eggs	No. of <i>Pyrilla</i> nymphs & adults	Per cent parasitism by <i>E. melanoleuca</i>	<i>E. melanoleuca</i>	
						No. of egg mass	No. of cocoon
1.	2.	3.	4.	5.	6.	7.	8.
1990	III	08	00.00	00.00	00.00	0.00	0.00
February	IV	09	00.00	00.00	00.00	0.00	0.00
March	I	10	00.00	00.00	00.00	0.00	0.00
	II	11	00.00	00.00	00.00	0.00	0.00
	III	12	00.00	00.00	00.00	0.00	0.00
	IV	13	00.00	00.00	00.00	0.00	0.00
April	I	14	00.00	00.00	00.00	0.00	0.00
	II	15	00.00	00.00	00.00	0.00	0.00
	III	16	00.00	00.00	00.00	0.00	0.00
	IV	17	00.00	00.00	00.00	0.00	0.00
	V	18	00.00	00.00	00.00	0.00	0.00

1.	2.	3.	4.	5.	6.	7.	8.
May	I	19	00.00	00.00	00.00	0.00	0.00
	II	20	10.67	00.00	00.00	0.00	0.00
	III	21	20.33	00.00	00.00	0.00	0.00
	IV	22	10.00	00.67	00.00	0.00	0.00
June	I	23	11.33	01.67	00.00	0.00	0.00
	II	24	21.33	00.33	00.00	0.00	0.00
	III	25	31.33	02.67	00.00	0.00	0.00
	IV	26	32.33	01.67	00.00	0.00	0.00
July	I	27	40.67	10.67	00.00	0.00	0.00
	II	28	10.67	21.33	00.00	0.00	0.00
	III	29	46.00	15.33	00.00	0.00	1.67
	IV	30	32.00	16.67	08.00	0.00	3.67
	V	31	12.67	14.33	09.30	0.00	4.00
August	I	32	30.67	10.33	09.67	2.33	4.67
	II	33	61.67	11.00	06.06	3.37	3.33
	III	34	58.33	10.66	15.63	3.67	3.33
	IV	35	18.67	14.33	23.26	3.37	3.67
September	I	36	23.00	07.33	40.91	1.33	2.33
	II	37	22.33	07.00	42.85	2.00	3.33
	III	38	12.67	07.33	36.37	2.33	4.00
	IV	39	00.00	03.33	40.00	3.37	3.67
October	I	40	00.00	07.67	23.73	3.67	6.33
	II	41	00.00	07.33	27.27	5.33	4.33
	III	42	00.00	02.33	14.29	1.00	3.33
	IV	43	00.00	00.00	00.00	1.33	2.00
	V	44	00.00	00.00	00.00	0.00	0.00
November	I	45	00.00	00.00	00.00	0.00	0.00
	II	46	00.00	00.00	00.00	0.00	0.00
	III	47	00.00	00.00	00.00	0.00	0.00
	IV	48	00.00	00.00	00.00	0.00	0.00
December	I	49	00.00	00.00	00.00	0.00	0.00
	II	50	00.00	00.00	00.00	0.00	0.00
	III	51	00.00	00.00	00.00	0.00	0.00
	IV	52	00.00	00.00	00.00	0.00	0.00
1991	I	1	00.00	00.00	00.00	0.00	0.00
January	II	2	00.00	00.00	00.00	0.00	0.00
	III	3	00.00	00.00	00.00	0.00	0.00
	IV	4	00.00	00.00	00.00	0.00	0.00
	V	5	00.00	00.00	00.00	0.00	0.00
February	I	6	00.00	00.00	00.00	0.00	0.00
	II	7	00.00	00.00	00.00	0.00	0.00

field from May to December. As per Khan and Khan (1986) adult appeared in early April, late June or early July, August-September and late October or November. According to Gupta *et al.*, (1977) large population of *Pyrilla* was infesting sugarcane in August and September. Mathur (1978) recorded 15-55 nymphs and adults per leaf during August-October. Similarly Chaudhary and Sharma (1990) reported that leaf hopper was abundant in sugarcane field during July - August.

The egg masses of *E. melanoleuca* were recorded nil during the period from February 1990 to July 1990 and November 1990 to February 1991. The egg laying was first time observed in the first week of August and continued till fourth week of October, ranging between 1.00 to 5.33 egg masses per ten plants. Maximum number of egg masses were found in second week of October (5.33). Two higher peaks of number of egg masses were recorded i.e. one in third week of August (3.67) and second in second week of October (5.33). The per cent parasitism of leaf hopper by *E. melanoleuca* ranged between 6.06 to 42.85 from July to October with highest per cent parasitism in second week of September (42.85). The cocoons were found from July to October. The number of cocoons ranged between 1.67 to 6.33 per ten plants with highest number in the first week of October (6.33). No cocoon was found, during the period from February '90 to June '90 and November '90 to February '91 (Table 1). Mukerjee and Venkatraman (1946) and Khanna and Butani (1958) reported that the parasite *E. melanoleuca* was active from April to November at Delhi and Bihar respectively. According to Dhaliwal and Bains (1985) *E. melanoleuca* found to be parasitising nymph and adult to an extent of 60 to 80 per cent during August to

October in Punjab. The variation in present finding may be due to effect of ecological condition prevailing in the area and population density of sugarcane leaf hopper in the locality.

From the table 1 it is seen that *Pyrilla* population appeared in the last week of May. The population of *E. melanoleuca* appeared little late i.e. in the month of July and then simultaneously increased with host population. Population of *Pyrilla* and its parasite recorded nil in the month of February '90 to April '90 and November '90 to April '90 and November '90 to February '91 (Fig.-1).

The leaf hopper population (Y_1) had significant and negative correlation with maximum temperature (X_1) and sunshine hour (X_7). During the study when maximum temperature level was 28.8°C (3rd week of August) the *Pyrilla* population was 10.66, where as with maximum level 34.9°C (3rd week of October) it was 2.33. The correlation with the rest of the weather parameters was non significant. The correlation between egg masses of parasite (Y_2) and average temperature (X_3) was negative and significant, while no correlation was observed between egg masses of parasite and other weather parameters. The per cent parasitism by *E. melanoleuca* had significant negative correlation with average temperature (X_3) and significant positive correlation with morning relative humidity (X_4). The correlation between cocoon of parasite (Y_4) and minimum temperature (X_2) and average temperature (X_3) were negative and significant, while it was non significant with rest of the weather parameters (Table 2).

The multiple linear regression equation fitted for leaf hopper (nymph and adult) Y_1 was

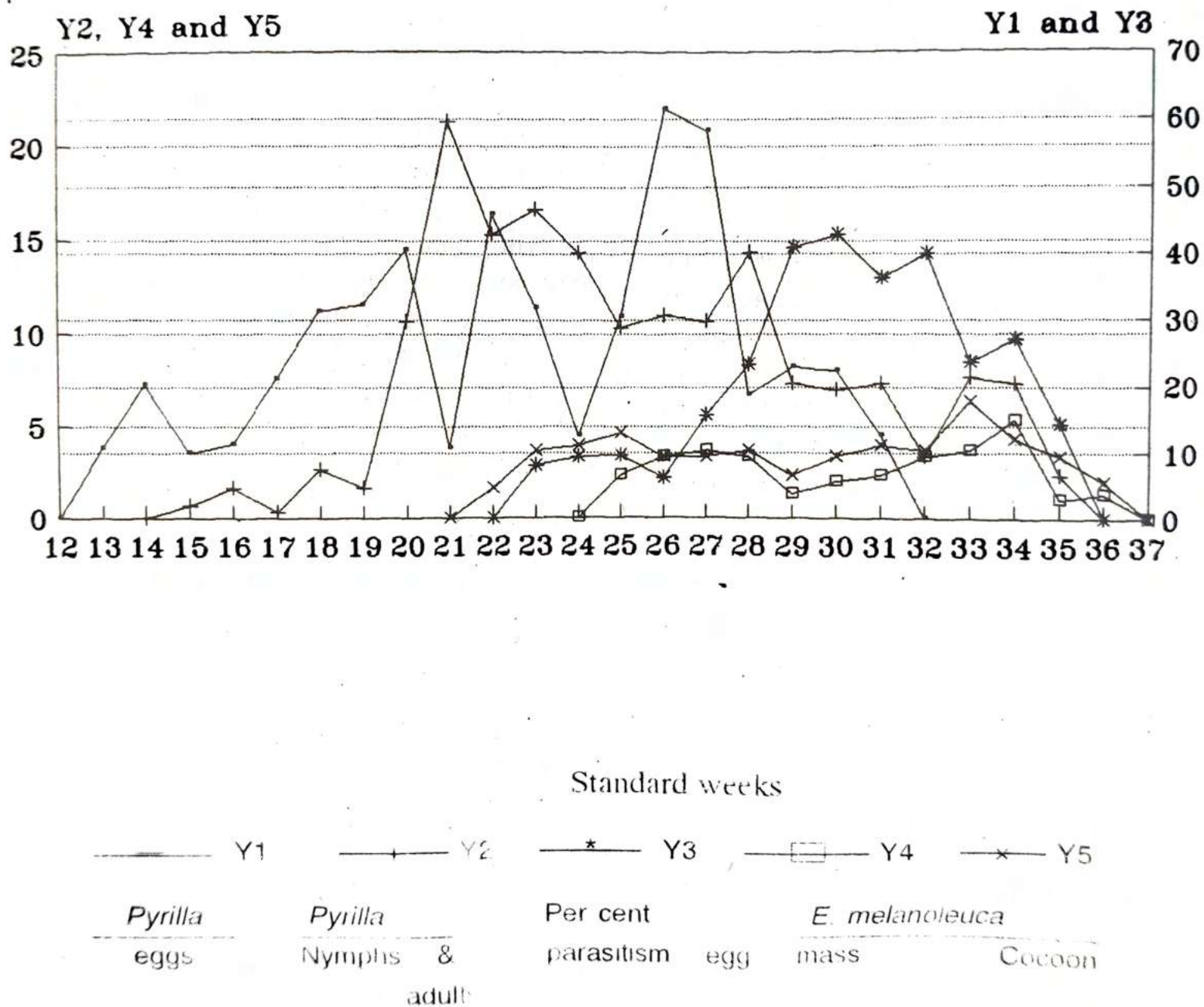


Fig. 1 : Number of *Pyrilla* and different stages of *E. melanoleuca* F. on sugarcane (1990-91)

TABLE 2

Correlation coefficient values of *Pyrilla* and its ectoparasite *E. melanoleuca* on sugarcane with respect to weather parameters. (Village Eru, Ta. Navsari).

Correlation Co-efficient values										
Values		Maximum temperature	Minimum temperature	Average temperature	Morning relative humidity	Evening relative humidity	Average relative humidity	Sun shine hours	Rainfall (mm)	Rainy days
Y	X	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉
<i>Pyrilla</i> (nymph and adult) (Y ₁)		-0.553**	0.355	-0.150	0.011	0.378	0.350	-0.510*	-0.155	0.189
No. of egg masses of parasite (Y ₂)		-0.208	-0.414	-0.534*	0.403	-0.093	0.040	0.018	0.165	0.328
Per cent parasitism (Y ₃)		-0.330	-0.390	-0.615**	0.496*	-0.021	0.123	0.085	0.258	0.312
Cocoon of parasite (Y ₄)		-0.275	-0.448*	-0.620**	0.296	-0.150	-0.032	-0.077	0.053	0.253

** Significant at 1%

* Significant at 5%

TABLE 3

Multiple/simple regression equations to predict *Pyrilla* and *E. melanoleuca* on the basis of weather parameters having significant correlation (Village Eru, Ta. Navsari).

A value	Temperature °C			Relative humidity%			Sunshine hours	Rainfall (mm)	Rainy days	R ²
	Maxi num X ₁	Mini num X ₂	Average X ₃	Morn- ing X ₄	Evening X ₅	Average X ₆				
<i>Pyrilla</i> (nymph and adult) (Y ₁)	52.6992	-1.3640	—	—	—	—	-0.4406	—	—	0.3264*
No. of egg masses of parasite (Y ₂)	25.50822	—	-0.8650*	—	—	—	—	—	—	0.2853*
Per cent parasitism (nymph and adult) (Y ₃)	174.6278	—	-7.6510*	0.5655	—	—	—	—	—	0.3900**
Cocoon of parasite (Y ₄)	33.9810	—	-0.1167	-1.0338*	—	—	—	—	—	0.3911**

** Significant at 1%

* Significant at 5%

$Y_1 = 52.6992 - 1.3640 (X_1) - 0.4406 (X_7)$. The multiple regression coefficient ($R^2 = 0.3264$) was statistically significant explaining 32.64 per cent variation in the dependent variable by different independent variables. The multiple linear regression equation fitted for egg masses of *E. melanoleuca* (Y_2) was $Y_2 = 25.5082 - 0.08650 (X_3)$. The multiple regression coefficient ($R^2 = 0.2853$) was statistically significant showing 28.53 per cent variations in dependent variable by different

independent variables. The multiple linear regression equation for per cent parasitism by *E. melanoleuca* F. (Y_3) was $Y_3 = 174.6278 - 7.6510 (X_3) + 0.5655 (X_4)$. The multiple regression coefficient ($R^2 = 0.3900$) was statistically — significant. The multiple linear regression equation for cocoons of parasite (Y_4) was $Y_4 = 33.9810 - 0.1167 (X_2) - 1.0338 (X_3)$. The multiple regression coefficient ($R^2 = 0.3911$) was statistically significant (Table 3).

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Selection Criteria in Summer Mungbean (*Vigna radiata* (L.) Wilczek)

H. C. Pathak* and M. S. Patel

NARP, Sub Station, Gujarat Agricultural University, Derol, Panchmahals

ABSTRACT

Forty four (44) diverse genotypes of mungbean were evaluated in a randomized block design with four replications during summer, 1986. Wide range of variability was noticed for all characters as evidenced by range. Higher magnitude of GCV and PCV was also observed for seed yield, branches per plant, pods per plant, pod length, bunches per plant and pods per bunch. Pod length followed by days to flowering, pods per plant and days to maturity showed highest heritability whereas pods per plant, pod length, pods per bunch and bunches per plant exhibited very high magnitude of genetic advance as percentage of mean. Seed yield was positively correlated with pods per plant, bunches per plant and pods per bunch. Path coefficient analysis indicated that the bunches per plant, pod length and pods per bunch are the important yield components in mungbean during summer.

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INTRODUCTION

The mungbean (*Vigna radiata* (L.) Wilczek var. *radiata* (Verdc.) is an important pulse crop having good potential to meet the rising demand of pulses. It contains very high protein content and gives better yield during summer. To develop high yielding varieties specifically suited to summer, it was considered worth-while to collect information on genetic variability and character associations which are of vital importance for initiating crop improvement programme and are very rare especially under summer conditions.

MATERIALS AND METHODS

The materials for the present investigation consisting of 44 diverse genotypes of

mungbean was raised in a randomized block design with four replications during summer 1986 at Gujarat Agricultural University, Derol. The plot size consisted of single row of 5 m length following the spacings of 30 cm and 10 cm between rows and plants, respectively. The cultivation practices in vogue were followed for raising the crop. Five plants were randomly chosen in each replication and observations were recorded on seed yield (g/plant), days to flowering and maturity, plant height (cm), branches per plant (no.), pods per plant (no.), pod length (cm), seeds per pod (no.), bunches per plant (no.) and pods per bunch (no.). Mean data were utilized for statistical analysis of heritability in broad sense (Johnson *et al.* 1995a), genetic advance (Lush, 1948), phenotypic and genotypic correlations (Johnson *et al.* 1955b), and path coefficient analysis (Dewey and Lu, 1959).

*Present address : Geneticist (Tobacco), B.T.R.S., Gujarat Agricultural University, Anand-388 110.

RESULTS AND DISCUSSION

The results obtained under the investigation are presented in Table 1 to 3.

The data on genetic variability (Table 1) indicated the higher range of variation for pods

per plant and plant height. Besides, other characters also exhibited high degree of variability in the material. The high genotypic and phenotypic coefficient of variation was observed for pods per plant followed by pod length, pods per bunch, bunches per plant, branches per plant and seed yield. Pod length

TABLE 1

Genetic variability, heritability and genetic advance for 10 characters in mungbean.

Character	Range	General Mean	GCV (%)	PCV (%)	h^2 (%)	G.A. as% of mean
Seed yield/plant	2.10 — 8.63	5.17	17.17	36.95	21.60	16.44
Days to flowering	50.0 — 61.50	54.22	4.33	4.99	75.35	7.75
Days to maturity	71.0 — 80.0	75.11	2.24	2.72	67.53	3.78
Plant height	33.0 — 70.0	51.79	11.68	18.00	42.06	15.60
Branches/plant	1.50 — 4.50	2.18	18.18	29.77	37.27	22.86
Pods/plant	9.5 — 40.6	21.59	33.61	40.43	69.12	57.57
Pod length	6.17 — 13.00	8.21	24.69	25.14	96.48	49.93
Seeds/pod	8.8 — 14.0	10.71	9.92	13.22	56.25	15.31
Bunches/plant	4.5 — 12.2	7.20	20.29	29.22	48.22	29.03
Pods/bunch	1.55 — 4.80	3.26	23.80	31.84	55.85	36.50

had the highest heritability followed by days to flowering, pods per plant and days to maturity. Other characters viz. seeds per pod and pods per bunch also exhibited moderately high heritability. The data further revealed that pods per plant followed by pod length, pods per bunch and bunches per plant showed high genetic advance as percentage of mean. Branches per plant, seed yield, plant height and seeds per pod also exhibited substantial genetic advance as percentage of mean. High to medium extent of heritability and genetic advance were also reported by Ali and Saikh (1987), Pandey *et al.* (1988) and Pundir *et al.* (1992) in mungbean. Thus, the trait pod length

followed by pods per plant, pods per bunch and bunches per plant showed high heritability followed by high genetic advance, a condition most effective for selection. This condition appears due to additive gene action while days to flowering and days to maturity, possessed high heritability but low genetic advance resulting due to non additive gene action (Liang and Walter, 1968).

The results on correlation studies (Table 2) indicated that the genotypic and phenotypic correlations followed the same trend and that the genotypic correlations were, in general, higher than the phenotypic correlations. The seed yield was strongly

TABLE 2

Genotypic (upper diagonal) and phenotypic (lower diagonal) correlation coefficients between different characters in mungbean.

Character	Seed yield	Days to flowering	Days to maturity	Plant height	Branches/plant	Pods/plant	Pod length	Seeds/pod	Bunches/plant	Pods/bunch
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Seed yield	—	-0.510**	-0.167	-0.668**	-0.212	0.850**	-0.544**	-0.321	0.870**	0.394**
Days to flowering	-0.345*	—	0.499**	1.253**	0.105	-0.640**	0.689**	0.525**	-0.326*	-0.814**
Days to maturity	-0.082	0.420**	—	0.689**	0.217	-0.186	0.434**	0.293*	0.161	-0.369*
Plant height	0.033	0.488**	0.237	—	0.290*	-0.649**	0.778**	0.324*	-0.287	-0.959**
Branches/plant	0.142	0.056	0.056	-0.036	—	0.249	0.241	0.457**	0.590**	-0.140
Pods/plant	0.493**	-0.529**	-0.152	-0.203	0.251	—	-0.722**	-0.233	0.812**	0.877**
Pod length	-0.219	0.572**	0.357*	0.531**	0.153	-0.587**	—	0.593**	-0.403**	-1.032**
Seeds/pod	0.039	0.233	0.219	0.241	0.182	-0.140	0.499**	—	0.102	-0.646**
Bunches/plant	0.499**	-0.282	0.088	0.062	0.419**	0.781**	-0.268	-0.002	—	0.509**
Pods/bunch	0.413**	-0.504**	-0.151	-0.355*	-0.088	0.632**	-0.741**	-0.295	0.376*	—

* P = 0.05 ; ** P = 0.01

TABLE 3

Path co-efficient analysis showing direct and indirect effects of g characters on seed yield in mung.

Character	Days to flowering	Days to maturity	Plant height	Branch/ plant	Pods/ plant	Pod length	Seeds/ pod	Bunches/ plant	Pods/ bunch	rg with seed yield
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Days to flowering	0.5570	-0.573	-0.009	-0.224	0.146	2.001	-0.300	-1.061	-1.044	-0.510
Days to maturity	0.278	-1.148	-0.005	-0.463	0.031	1.258	-0.167	0.523	-0.473	-0.167
Plant height	0.679	-0.791	-0.007	-0.620	0.148	2.257	-0.185	-0.934	-1.230	-0.668
Branch/plant	0.058	-0.249	-0.002	-2.139	0.056	0.699	-0.262	1.919	-0.180	-0.212
Pods/plant	-0.356	0.156	0.005	-0.531	-0.229	-2.095	0.133	2.643	1.124	0.850
Pod length	0.384	-0.498	-0.006	-0.515	0.165	2.902	-0.339	-1.312	-1.323	-0.544
Seeds/pod	0.292	-0.336	-0.002	-0.977	0.053	1.721	-0.573	0.331	-0.829	-0.321
Bunches/plant	-0.181	-0.184	0.002	-1.260	-0.185	-1.170	-0.058	3.256	0.653	0.870
Pods/bunch	0.453	0.423	0.007	0.300	-0.200	-2.995	0.370	1.658	1.283	0.394

* The darkened figures denote the direct effects.

* The residual effect = 0.454

and positively correlated with pods per plant, bunches per plant and pods per bunch both at genotypic and phenotypic levels. Mishra and Sahu (1985), Roshnaiah *et al.* (1987), Sandhu *et al.* (1988) and Naidu *et al.* (1991) also observed significant and positive association of grain yield with cluster and pods per plant in greengram. Sandhu *et al.* (1988), however, reported positive and significant association of pod length and seeds per pod with grain yield in greengram which are not in conformity to the results of the present study. It was observed that days to flowering and days to maturity with each other and also with plant height, pod length and seeds per pod; branches per plant with seeds per pod and bunches per plant; pods per plant with bunches per plant and pods per bunch; pod length with seeds per pod; and bunches per plant with pods per bunch showed significant positive association. Significant negative correlation of days to flowering and absence of correlation of days to maturity with seed yield indicated that it would be possible to develop high yielding and early maturing genotypes of mungbean better suited to summer conditions.

The path coefficient analysis carried out to estimate the direct and indirect effects of various characters on seed yield revealed that bunches per plant followed by pod length, pods per bunch and days to flowering had the highest positive direct effects (Table 3). Remaining characters showed negative direct effects. Pods per plant by Chand *et al.* (1975) in gram, Tikka *et al.* (1977) in mothbean, and days to maturity followed by clusters per plant and pod length by Wanzari (1988) in blackgram reported as important yield components as they gave the highest direct positive effect.

It was interesting to note that pods per plant which showed significant positive correla-

tion with seed yield gave negative direct effect whereas days to flower and pod length which showed strong negative correlations exhibited positive direct effect for seed yield. The data further revealed that days to maturity contributed through its indirect effect via pod length, and bunches per plant whereas plant height via pod length and days to flowering; branches per plant via bunches per plant and pod length, pods per plant via bunches per plant and pods per bunch and seeds per pod via pod length mainly contributed towards seed yield. The indirect contribution of days to flower via pod length; bunches per plant via pods per bunch and pods per bunch via bunches per plant were also high and positive.

The overall study revealed wide range of variability for all the characters under study. High heritability followed by higher magnitude of genetic advance as percentage of mean for important traits like pods per plant, pod length, seeds per pod, bunches per plant and pods per bunch indicated that improvement in these traits can be rapidly brought about through selection. Highly significant positive association of bunches per plant and pods per bunch with seed yield at genotypic level and their high positive direct effect on seed yield indicated that these characters are the most important yield components which can be utilized as indirect selection criteria for the improvement of seed yield in mungbean during summer. However, for recommending broad based and reliable selection indices the indirect contribution of other important characters viz., branches per plant, pods per plant and seeds per pod should also be taken into consideration.

ACKNOWLEDGEMENT

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Cytogenetic Effects of Physical and Chemical Mutagens on Chillies (*Capsicum annuum* L.)*

P. C. Shaw, R. S. Fougat and B. H. Prajapati**

Department of Plant Breeding and Genetics, College of Agriculture, Gujarat Agricultural University,
Sardar Krushinagar-385 506

ABSTRACT

The seeds of a chilli (*Capsicum annuum* L.) cultivar G. Chillies-1 were irradiated with 15, 20 and 25 KR gamma rays and treated with 0.1, 0.2 and 0.3 per cent concentration of hydroxylamine and 0.001, 0.003 and 0.005 molar concentration of malaic hydrazide for two hours. The cytogenetical effects of mutagens in M_1 generation were studied. A number of meiotic abnormalities were frequently observed in PMCs of treated population which included univalents, multivalents, bridges, laggards and unequal distributions. PMCs carrying an extra chromosome, heteromorphic bivalents and interbivalent chromatin bridges were not uncommon. Extent of meiotic damage showed a linear relationship with the dose/concentration of the mutagen. Univalents were possibly induced following a change in chemical nature of gene controlling synapsis, whereas, multivalents following translocations and inversions. Bridges and laggards were the after-effects of structural aberrations. The generated chromosomal variability could be fruitfully utilized for genetic improvement in chillies.

(Received on 7th Sept., 1991)

INTRODUCTION

Chilli is an important spice crop of India and forms the principal ingredient of all Indian food preparation. Simultaneously; the crop has immense pharmaceutical value as well (Pureseglove, 1977). Looking to tremendous economic importance of the crop, efforts were made to evolve genetically improved cultivars through induced mutagenesis. The present paper reports the kind of chromosomal aberrations induced following mutagenic treatment in chillies and discusses their possible mode of origin and utility.

MATERIALS AND METHODS

Dry seeds of (*Capsicum annuum* L.) Var. G. Chillies-1 were irradiated with 15 KR, 20 KR and 25 KR gamma rays from 5770 curies gamma cell of Cobalt-60 at a rate of 129 rad per second. Two hours pre-soaked seeds were treated with freshly prepared solutions of hydroxylamine (0.1, 0.2 and 0.3 per cent) and maleic hydrazide (0.001, 0.003 and 0.005 molar) for two hours. M_1 generation was raised along with control. Microsporogenesis was studied in five plants selected at random from each treatment in M_1 generation, including control.

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**Present address : Assistant Professor (Agril. Statistics), College of Agriculture, GAU, Sardar Krushinagar.

For meiotic studies, flower buds of proper stage were fixed in freshly prepared ethanol : glacial acetic acid (3:1) for 24 hours. Fixed buds were stored in 70 per cent ethanol at 4° C. The anthers from stored buds were squashed in 1 per cent acetocarmine and temporarily mounted slides were studied for various chromosomal abnormalities. Photomicrographs were taken by using Olympus PM 6, 35 mm camera at X 1500 magnification.

RESULTS AND DISCUSSION

Chromosome enumeration of control and treated population revealed that, pollen mother cell meiosis was normal in control with regular pairing of homologues in prophase I, 12 bivalents at metaphase I and 12 : 12 chromosome distribution at anaphase I (Figs. 1-4).

1-4 : PMCs of G. Chillies 1 (Control) showing regular meiosis

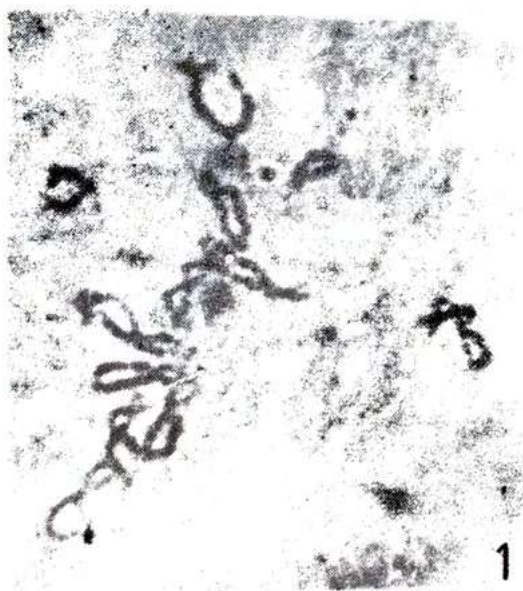


Fig. : 1. a PMC at diplotene

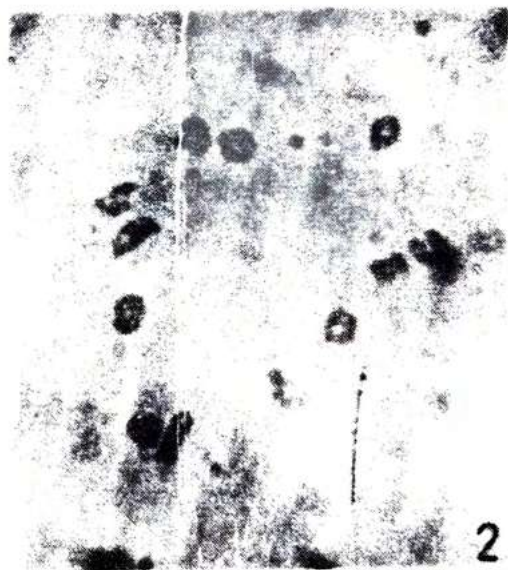


Fig 2. : a PMC at diakinesis



Fig 3. : a PMC at metaphase-I showing 12 bivalents

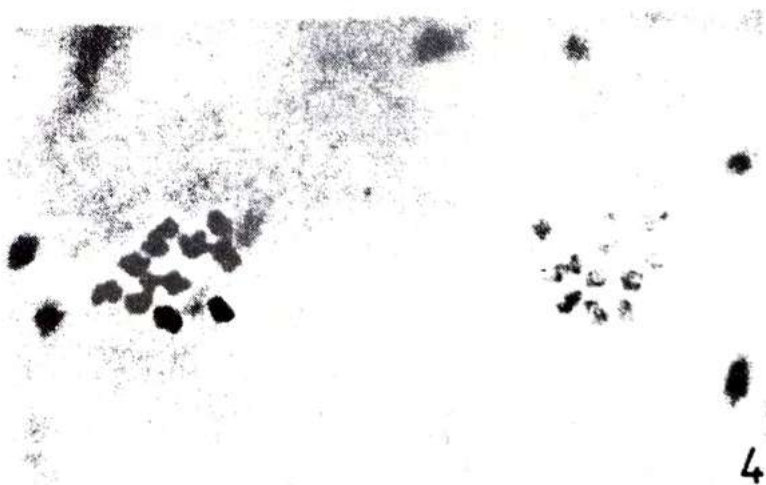


Fig 4. : a PMC at anaphase-I showing 12 : 12 normal disjunction

Meiosis in treated material, however, was erratic and PMCs possessing univalents, trivalents and quadrivalents, in addition to bivalents were frequently observed (Fig.5)

Frequency of PMCs carrying multivalents ranged between 7.69 - 26.14 per cent in different treatments (Table 1). Formation of univalents was dose/concentration dependent. Maleic hydrazide at a concentration of 0.005 M was most effective in inducing univalents. Whereas, 25 KR gamma rays and 0.003 M concentration of maleic hydrazide, induced maximum number of trivalents and quadrivalents, respectively. Comparatively, maleic hydrazide was more effective in bringing about pairing anomalies, followed

5.8 PMCs of G. Chillies-1 (treated) showing irregular meiosis

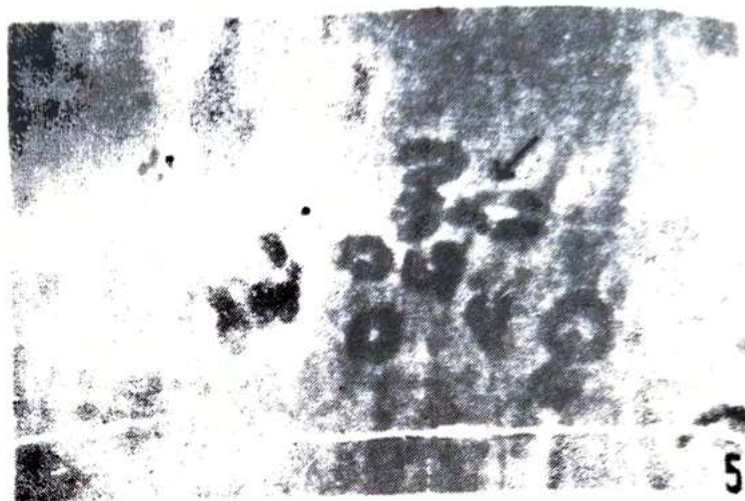


Fig. 5 : a PMC showing 1 IV + 10 II

by gamma rays as next potential mutagen (Table 1).

TABLE 1

Type and frequency of chromosome associations at metaphase-I in mutagenic treatments.

Treatments	Total cells scored	Percentage of cells showing				Total abnormal cells (%)
		univalents	bivalents	trivalents	quadrivalents	
Control	153	—	100.00	—	—	—
Gamma rays						
15 KR	165	6.67	86.67	2.42	7.88	13.33
20 KR	160	11.88	80.00	2.50	10.00	20.00
25 KR	155	14.84	77.42	3.23	9.68	22.58
Hydroxylamine						
0.01 %	158	5.70	92.41	0.06	4.43	7.59
0.2 %	160	8.75	83.75	1.25	10.00	16.25
0.3 %	161	14.29	79.50	0.06	10.56	20.50
Maleic hydrazide						
0.001 M	156	7.69	82.05	3.21	10.26	17.95
0.003 M	159	12.58	79.99	1.89	11.32	22.01
0.005 M	153	18.30	73.86	2.61	9.80	26.14

The occurrence of univalents and multivalents in the PMCs of treated material clearly reveals that, the three mutagens used have been quite effective in bringing about genetic change in the base population. Univalents were possibly induced following a change in the chemical nature of gene controlling synapsis,



Fig. 6: a PMC showing 12 II + 1 I

chromosome ($2n + 1$), and heteromorphous bivalents, indicating terminal deficiency, were not uncommon among various treatments. (Figs 6-8). The extra chromosome observed in 25 KR gamma rays treatment either remained free (Fig. 6) or associated itself with a bivalent to form a trivalent (Fig. 7).

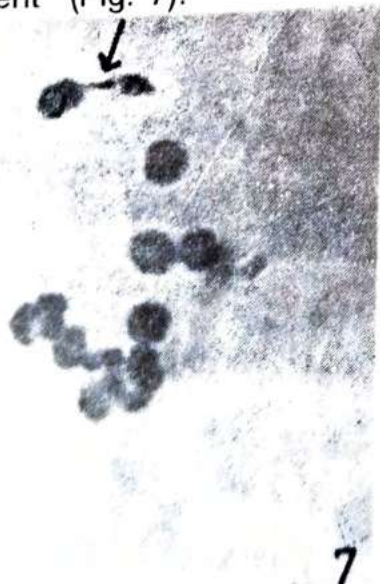


Fig. 7: a PMC showing 1 III + 11 II

whereas, multivalents resulted due to translocations and inversions. Similar opinion was put forth by Panda *et al.* (1987), while working on chillies.

In addition to pairing anomalies, plants whose PMCs carried an extra



Fig. 8: a PMC showing 11 homomorphic II and 1 Heteromorphic II

Sadanandam and Subhash (1985) also procured similar type of numerical aberrations and referred to it as trisomy. The extra chromosome seems to have originated following misdivision of a chromosome in mitosis. Heteromorphic bivalents might have resulted due to deletion of a terminal segment from one of the homologous chromosomes. Meshram and Narkhede (1983) reported the occurrence of heteromorphic bivalents in PMCs of mutagen treated population of chilli and traced their origin to deletions.

Another notable effect, particularly that of maleic hydrazide on dividing chromosomes was, appearance of interbivalent chromatin bridges (Fig. 9) which in extreme dose i.e. 0.005 M, resulted in movement of anaphase I chromosomes to two poles in a group (Fig. 10). These interbivalent

chromatin bridges also resulted in agglutination and sticky appearance of the chromosomes. In-

Figs 9-14 : PMCs of *G. Chillies-1* (treated) at metaphase-I and anaphase-I showing irregular meiosis.



Fig. 9 : a PMC showing interbivalent chromatin bridges

terbivalent chromatin bridges were probably formed due to multiple translocations.

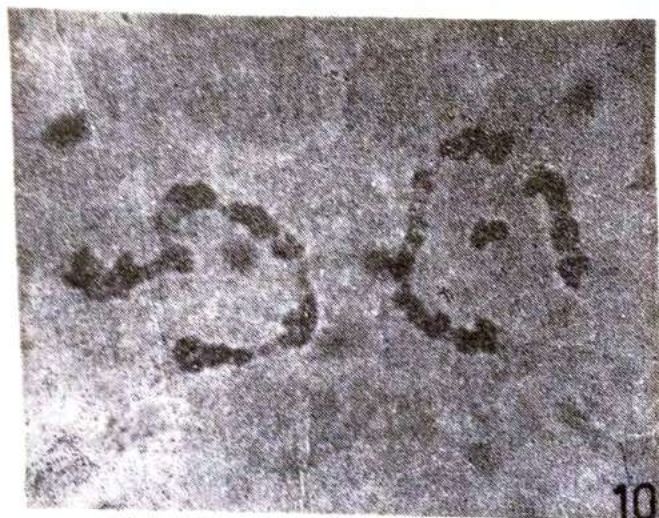


Fig. 10 : a PMC at anaphase-I showing movement of chromosomes to two poles in a group.

Different mutagenic treatments inflicted disturbances at anaphase I stage as well. Chromosome segregation was erratic (fig. 11) and PMCs carried varying number of chromatin bridges and laggards (Fig. 12-13). Data in respect to chromosomal anomalies observed at anaphase I are given in Table 2.

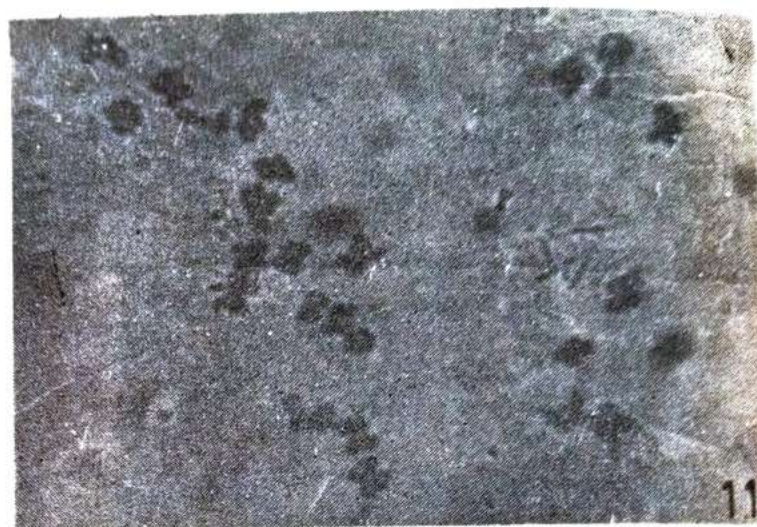


Fig. 11 : a PMC showing 17 : 7 mode of segregation

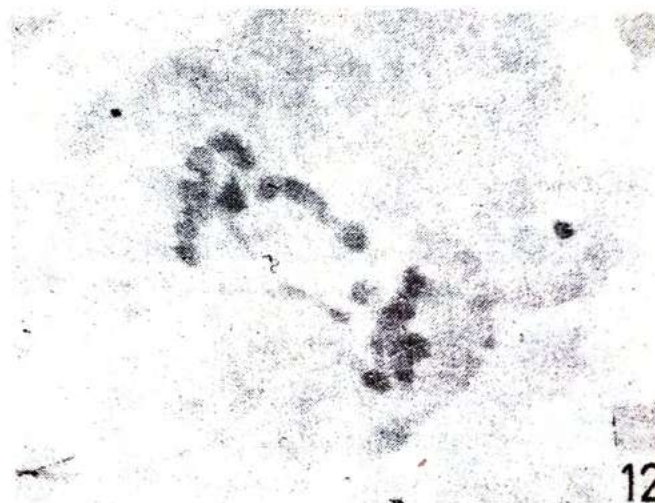


Fig. 12 : a PMC showing two chromatin bridges

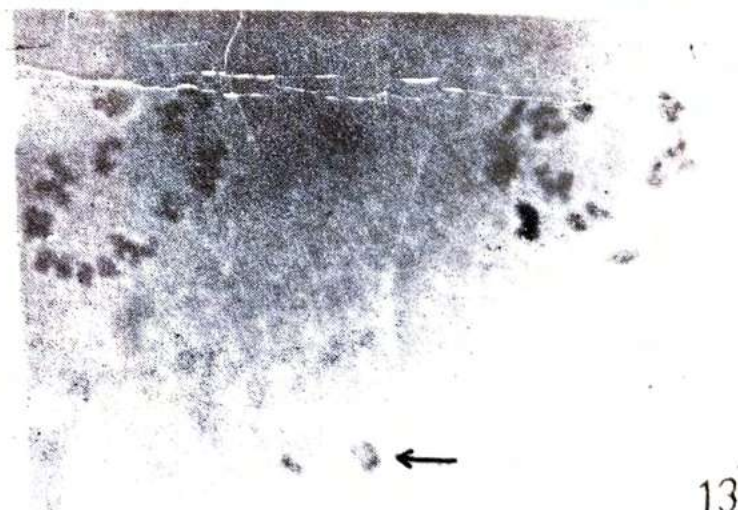


Fig. 13 : a PMC showing atleast two lagging chromosomes

TABLE 2

Effect of physical and chemical mutagens on chromosome distribution at anaphase-I.

Treatments	Total Cells Scored	Percentage of PMC's showing			Total* abnormal PMC's (%)
		bridges	laggards	unequal distribution	
Control	478	—	—	—	—
Gamma rays					
15 KR	512	0.78	0.98	0.39	1.76
20 KR	506	0.99	1.38	0.59	2.37
25 KR	494	1.21	1.42	0.61	2.83
Hydroxylamine					
0.1 %	487	0.62	0.82	0.62	1.64
0.2 %	521	0.96	1.34	0.96	2.69
0.3 %	515	1.36	1.55	1.17	3.30
Maleic hydrazide					
0.001 M	500	0.80	1.20	—	1.80
0.003 M	504	1.19	1.39	0.60	2.58
0.005 M	510	1.57	1.96	0.98	3.53

* A PMC may carry more than one anomaly at a time.

Unequal disjunction of chromosomes resulted in the formation of unequal sized nuclei at telophase I and II. Consequently, pollen grains of different sizes were produced which resulted in pollen sterility in the treated material (Fig. 14).

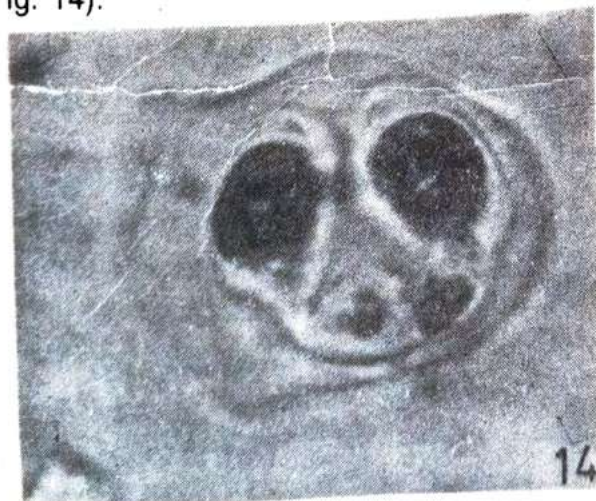


Fig. 14 : a microspore tetrad, two of the microspores are very small.

In accordance with Konzak *et al.* (1961), formation of bridges and laggards might be due to structural aberrations and asynapsis or desynapsis. Delayed terminalization and sticky ends of the chromosomes seems to be an additional cause in the appearance of bridges and laggards in present material. Unequal distribution of chromosomes at anaphase I might have been brought about by misformation of spindle apparatus, which ultimately had resulted in formation of unequal sized nuclei at telophase I and II, finally leading to pollen sterility.

Whatever may be the mode of origin of chromosomal aberrations in the presently studied material, the mutants generated could be fruitfully utilized in further

improvement of chillies through chromosomal manipulations. Trisomic and deletion mutants

could be helpful in gene mapping and their assignment to specific chromosomes.

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Comparative Efficiency of Single Capsule Descent and Bulk Methods in Sesame

T. Srinivas, G. Raghunatham and A. R. G. Ranganatha*

Department of Genetics and Plant Breeding, College of Agriculture and
Directorate of Oilseeds Research, Rajendranagar, Hyderabad-500 030

ABSTRACT

Bulk and single capsule descent (SCD) breeding procedures were evaluated for their relative efficiency in the F_6 generation of six crosses of sesame for seed yield and yield contributing characters. Bulk method of breeding exhibited marginal superiority over SCD procedure for yield and some yield attributes when compared across the crosses. However, a crosswise analysis for retention of superior lines indicated the effectiveness of bulk procedure for crosses of greater parental diversity viz., RCR-2 x AT-2, RCR-4 x AT-6, PDP 1-2 x JLT-8 and (GS-12 x TC-25) x AT-1 while SCD procedure was observed to be superior for crosses of low parental diversity viz., PDP 1-2 x JLT-9 and PDP 1-2 x JLT-2. The SCD procedure also exhibited greater level of variability retention.

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INTRODUCTION

Selection of superior genotypes is the primary objective of any crop improvement programme. Commonly adopted procedures for selection of desirable genotypes in segregating populations of autogamous species are pedigree and bulk methods. The single seed descent (SSD) method of breeding is also becoming popular because of its economy in advancing the generations. The main drawback with SSD however, lies in the strict population control which may result in the loss of potential genotypes, while bulk method suffers from genetic drift due to inadequate sampling and natural selection which affects the competitive ability of the genotypes. Considering the above aspects, the single capsule descent (SCD) breeding procedure

was formulated to combine the beneficial features of both bulk and SSD methods of breeding and evaluated for its relative efficiency with bulk method in six crosses of sesame.

MATERIALS AND METHODS

The experimental material in the present investigation comprised of 25 F_6 lines, each developed by bulk and SCD procedures for each of the six crosses of sesame viz., PDP 1-2 x JLT-9, RCR-2 x AT-2, RCR-4 x AT-6, PDP 1-2 x JLT-8, (GS-12 x TC-25) x AT-1 and PDP 1-2 x JLT-2. In the F_2 generation of each cross at harvest, bulk and SCD populations were constituted. The SCD population was constituted from seeds of a single random capsule from each of the F_2 plants and the bulk population, from the F_2 plants harvested *en masse*. These

*Mailing address : Scientist (Plant Breeding), Directorate of Oilseeds Research, Rajendranagar, Hyderabad-500 030.

populations were advanced by the respective procedures and in the F_5 generation, 25 plants were selected from each of the six crosses. This material was raised in the F_6 generation as plant to row progenies and evaluated in a double split plot design with crosses as main, breeding methods as sub and the progenies as sub-sub plots in three replications at the College Farm, A. P. Agricultural University, Rajendranagar, Hyderabad, during *kharif* 1989-90. A plot consisted of a single row of 4 m length of which a net plot of 3 m was fixed for recording the observations. The spacing adopted was 30 x 10 cm. Data on seed yield per plant, days to maturity, plant height, number of primary and secondary branches, productive capsules, abortive capsules and oil content were recorded on five random plants and the mean values were computed. The bulk and SCD procedures were compared on the basis of mean and variance values across crosses. The cross-wise variance of 25 lines and mean

of top 20 per cent lines for bulk and SCD procedures were computed and the variances were compared using two-tailed F-test. For days to maturity and number of abortive capsules, lines with lower values were considered for inclusion in the top 20 per cent lines.

RESULTS AND DISCUSSION

The mean and variance values for methods over crosses for seed yield and yield attributed are presente in Table-1, while the mean of top 20 per cent lines and variance of 25 lines are presented cross- wise in Table-2. Bulk breeding procedure exhibited significant superiority over SCD method when considered across crosses for mean seed yield and other important yield attributes such as plant height, secondary branches, productive and abortive capsules, while, SCD procedure recorded significant superiority for days to maturity,

TABLE 1

Mean and variance values for bulk and SCD methods across the crosses, for yield and yield components in sesame.

Character	Mean			Variance		
	Bulk	SCD	$\pm$ SE	Bulk	SCD	Fcal
Seed yield (g) per plant	3.8372	3.7378	.0050*	2.1000	2.1900	1.0428*
Days to maturity	93.2926	92.1099	.1508*	20.8617	23.0633	1.1055*
Plant height (cm)	136.7502	131.9165	.1833*	231.1083	244.4850	1.0579*
Primary branches	3.7281	3.8681	.0149*	1.4850	1.3550	1.0959*
Secondary branches	0.8831	0.7684	.0094*	0.8083	0.6583	1.2278*
Productive capsules	37.5480	36.9350	.0795*	141.3267	188.4967	1.3377*
Abortive capsules	6.0512	6.3987	.0240*	6.4117	8.5467	1.3330*
Oil content (%)	53.9980	54.3689	.0105*	7.8850	8.0200	1.0771*

* Significant at 0.05 level of significance.

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17.

PDP 1-2 X JLT-8

| | | | | | | | | | | | | | | | | |
|----------------------|--------------|-----------------------|----------|--------------|----------|--------------|----------|------------|------------|--------------|------------|--------------|----------|--------------|------------|------|
| Bulk | 7.20 | 2.77 | 86.63 | 10.73 | 159.10 | 156.34 | 4.90 | 1.17 | 0.98 | 0.08 | 60.36 | 219.00 | 1.80 | 5.37 | 53.64 | 6.89 |
| SCD | 5.78 | 1.86 | 86.80 | 10.90 | 150.32 | 201.80 | 5.12 | 1.01 | 1.56 | 0.27 | 52.50 | 117.23 | 2.40 | 6.31 | 53.36 | 2.43 |
| SE and (F_{cal}) | $\pm 0.01^*$ | $(1.49)^* \pm 0.37^*$ | (1.02) | $\pm 0.45^*$ | (1.29) | $\pm 0.04^*$ | (1.16) | ± 0.03 | $(3.37)^*$ | $\pm 0.20^*$ | $(1.87)^*$ | $\pm 0.06^*$ | (1.18) | $\pm 0.05^*$ | $(2.84)^*$ | |

(GS-12 X TC-25) X AT-1

| | | | | | | | | | | | | | | | | |
|----------------------|--------------|-----------------------|------------|--------------|------------|--------------|------------|--------------|----------|--------------|----------|--------------|------------|--------------|----------|------|
| Bulk | 6.96 | 2.74 | 85.40 | 18.34 | 147.00 | 151.46 | 6.14 | 1.76 | 4.58 | 1.76 | 61.46 | 165.50 | 3.06 | 14.04 | 54.14 | 9.30 |
| SCD | 5.68 | 1.81 | 84.80 | 9.71 | 156.02 | 260.17 | 4.92 | 0.93 | 1.52 | 0.87 | 59.34 | 176.19 | 3.72 | 6.24 | 53.88 | 8.07 |
| SE and (F_{cal}) | $\pm 0.01^*$ | $(1.51)^* \pm 0.37^*$ | $(1.89)^*$ | $\pm 0.45^*$ | $(1.72)^*$ | $\pm 0.04^*$ | $(1.89)^*$ | $\pm 0.03^*$ | (2.02) | $\pm 0.20^*$ | (1.06) | $\pm 0.06^*$ | $(2.25)^*$ | $\pm 0.03^*$ | (1.15) | |

PDP 1-2 X JLT-2

| | | | | | | | | | | | | | | | | |
|----------------------|----------------------|--------------|----------|--------------|------------|--------------|------------|------------|----------|--------------|------------|--------------|----------|--------------|------------|-------|
| Bulk | 5.20 | 1.37 | 94.00 | 26.57 | 172.48 | 284.39 | 4.88 | 1.44 | 2.56 | 1.49 | 46.14 | 137.46 | 5.24 | 4.50 | 53.22 | 11.49 |
| SCD | 5.60 | 3.53 | 91.00 | 28.60 | 147.22 | 177.24 | 4.90 | 0.75 | 2.54 | 1.31 | 49.42 | 193.05 | 5.12 | 4.87 | 53.06 | 20.40 |
| SE and (F_{cal}) | $\pm 0.01^*(2.51)^*$ | $\pm 0.37^*$ | (1.08) | $\pm 0.45^*$ | $(1.60)^*$ | $\pm 0.04^*$ | $(1.92)^*$ | ± 0.03 | (1.14) | $\pm 0.20^*$ | $(1.40)^*$ | $\pm 0.06^*$ | (1.08) | $\pm 0.03^*$ | $(1.78)^*$ | |

* Significant at 0.05 level of significance.

primary branches and oil content (Table-1). However, when the breeding procedures were studied cross-wise for retention of superior lines, bulk procedure exhibited a clear superiority in crosses, RCR-2 x AT-2, RCR-4 x AT-6, PDP 1-2 x JLT-8 and (GS-12 x TC-25) x AT-1. The superiority of bulk method over SSD procedure was also reported by Ndoni (1986) in wheat and by Ranganatha (1986) in sesame. The superiority of bulk method may be due to, an increase in population mean yield over generations resulting from natural selection (Palmer, 1952), shifting of gene frequencies for yield in a positive direction (Raeber and Weber, 1953), shift towards types adapted to the location (Taylor and Atkins, 1954), elimination of low seed number individuals through competition (Muehlbauer, *et al.*, 1981) or through retention of superior genotypes (Ranganatha, 1986). On contrary, the effectiveness of natural selection in bulk method of breeding was questioned by Sandfaer (1970).

The SCD procedure retained higher variability for majority of the characters studied in the present investigation. This may be because of representation of each genotype in the consecutive generations of modified SSD. The disadvantage of narrowing genetic base in SSD through loss of plants from generation to generation due to occasional inviability of the single seed used to propagate each individual (Muehlbauer *et al.*, 1981) might have been overcome in the present investigation by the use of single capsules. Similarly Jensen (1988) used single head descent (SHD) procedure in wheat to counter the loss of plants in SSD populations. The low variability noticed in bulk populations may be attributed to

stabilized selection occurring naturally in bulk populations (Khalifa and Qualset, 1975) and losses in genetic variability during generation advance as reported by Muehlbauer *et al.*, (1981).

A cross-wise analysis of variability across the traits in general (Table-2) indicated higher level of variability in SCD procedure for PDP 1-2 x JLT-9, RCR-2 x At-2, RCR-4 x AT-6 and PDP 1-2 x JLT-2 while, bulk procedure retained higher level in case of (GS-12 x TC-25) x AT-1 and PDP 1-2 x JLT-8. The bulk and SCD breeding procedures exhibited significantly different levels of variability for seed yield, days to naturity, plant height, primary branches and abortive capsules in (GS-12 x TC-25) x AT-1; for seed yield, plant height, primary branches, productive capsules and oil content in PDP 1-2 x JLT-2; for seed yield, secondary branches, productive capsules and oil content in PDP 1-2 x JLT-8; for plant height, secondary branches, productive capsules and oil content in RCR-2 x AT-2; for days to maturity, plant height, productive capsules and abortive capsules in RCR-4 x AT-6 and for secondary branches, productive capsules and abortive capsules in PDP 1-2 x JLT-9. Thus retention of variability by the breeding procedures varied with the cross and character involved, similar to the findings of Tee and Qualset (1975). The present study indicates the favourable response of sesame to bulk procedure in general. However SCD was observed to be effective for crosses of low parental diversity and for retention of higher level of variability. Hence, a better understanding of crosses and parents regarding genetic diversity and recombination potential would be advantageous in handling segregating generations.

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Effect of Plant Density, Nitrogen and Phosphorus on Growth Parameters of Radish (*Raphanus sativus* L.)*

P. C. Joshi, N. S. Patil** and N. P. Patel

Department of Horticulture, Gujarat Agricultural University, Sardar Krushinagar - 385 506

ABSTRACT

The wider inter and intra-row spacings significantly increased the number of leaves, root length and root diameter, while the plant height was not affected by plant density. The application of higher levels of nitrogen resulted into significantly favourable responses in plant height, number of leaves and root length, while root diameters was not affected. Contrarily the phosphorus application could not significantly affected any growth parameters. The treatment combinations, $W_1N_3P_3$, $S_3N_3P_2$, $S_3W_2N_3P_2$ and W_2P_2 were found significant in increasing plant height, number of leaves, root length and root diameter, respectively.

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INTRODUCTION

Radish (*Raphanus sativus* Linn.) is a popular root vegetable in India and abroad because of its food and medicinal value. Moreover it is a favourite crop of the kitchen garden. Because it can be easily grown and available for use within 3 to 6 weeks of sowing.

Not much work has been done so far regarding spacings and nutrition requirements of radish crop under Indian conditions. No doubt, a good deal of research information is available from foreign countries. But the results obtained in other countries are hardly applicable under our conditions. Hence, an experiment was conducted in *rabi* season, with a view to find out optimum inter and intra-row spacings, nitrogen and phosphorus for better growth character.

MATERIALS AND METHODS

The experiment was carried out in *rabi* season during the year 1987-88 at Instructional Farm, Department of Horticulture, Gujarat Agricultural University, Sardar Krushinagar in Banaskantha District, on 'Japanese White' variety of radish using split plot design with three randomized blocks. The main treatments comprised of 3 inter-row spacings (10, 20 and 30 cm) and 2 intra-row spacings (5 and 10 cm) while sub-treatments were 3 levels of nitrogen (30, 60 and 90 kg/ha) and also of phosphorus (0, 15 and 30 kg/ha). The half dose of nitrogen and full dose of phosphorus were applied as basal dose. The remaining half dose of nitrogen was applied during fourth week after sowing. The composite soil sample was drawn from the plot to a depth of 21 cm for chemical

*A part of the thesis submitted by the first author to Gujarat Agricultural University, Sardar Krushinagar Campus.

**Present address : Asstt. Professor, Dept. of Horticulture, College of Agriculture, Sardar Krushinagar.

determination. The soil was sandy-loam having PH 7.9. Available nitrogen, phosphorus and potash were 134.50, 42.24 and 179.41 kg/ha, respectively. Observation on growth parameters (plant height, number of leaves, root length and root diameter) were recorded after the harvest.

RESULTS AND DISCUSSION

Effect of spacings

The inter and intra-row spacings had significantly affected almost all the growth parameters except plant height (Table-1). Increased inter as well as intra-row spacings en-

TABLE 1

Effect of plant density, nitrogen and phosphorus on growth parameters of radish.

| <i>Treatments</i> | <i>Plant height (cm)</i> | <i>Number of leaves</i> | <i>Root length (cm)</i> | <i>Root diameter (cm)</i> |
|----------------------|--------------------------|-------------------------|-------------------------|---------------------------|
| (i) Main-plot | | | | |
| S ₁ | 35.74 | 11.32 | 12.43 | 2.20 |
| S ₂ | 35.78 | 12.60 | 14.21 | 2.58 |
| S ₃ | 34.27 | 13.84 | 15.35 | 2.67 |
| S. Em. ± | 0.57 | 0.19 | 0.20 | 0.04 |
| C. D. at 5% | NS | 0.60 | 0.62 | 0.12 |
| W ₁ | 35.68 | 11.87 | 12.96 | 2.30 |
| W ₂ | 34.85 | 13.30 | 15.04 | 2.67 |
| S. Em ± | 0.46 | 0.16 | 0.16 | 0.03 |
| C. D. at 5% | NS | 0.49 | 0.51 | 0.10 |
| C. V. % | 11.82 | 11.18 | 10.31 | 11.59 |
| (ii) Sub-Plot | | | | |
| N ₁ | 31.63 | 12.20 | 13.58 | 2.40 |
| N ₂ | 35.67 | 12.35 | 13.83 | 2.53 |
| N ₃ | 38.50 | 13.21 | 14.58 | 2.53 |
| S. Em. ± | 0.36 | 0.14 | 0.17 | 0.05 |
| C. D. at 5% | 1.02 | 0.38 | 0.47 | NS |
| P ₁ | 34.84 | 12.48 | 14.11 | 2.44 |
| P ₂ | 35.50 | 12.76 | 13.89 | 2.53 |
| P ₃ | 35.46 | 12.52 | 13.99 | 2.49 |
| S. Em. ± | 0.36 | 0.14 | 0.17 | 0.05 |
| C. D. at 5% | NS | NS | NS | NS |
| C. V. % | 7.53 | 7.92 | 8.68 | 13.71 |

hanced the number of leaves, and root size in length and diameter (Table-1). Thus, lower plant density as reflected by wider spacing improved the growth of radish. Comparatively more availability of soil water, nutrients, air and light under wider spacing might have resulted into better growth. Similarly significant effect of spacing was reported earlier on number of leaves in garlic (Purewal and Dargan, 1961) root length in onion (Singh, 1972) and root diameter in radish (Reimhersh and Batz, 1971).

Effect of Fertilization

Except root diameter, all the growth parameters showed significantly favourable response to higher levels of nitrogen application (Table-1). There was an increase of 6.87, 1.01 and 1.00 cm in plant height, number of leaves and root length, respectively by increasing the levels of nitrogen application from 30 to 90 kg/ha. The present findings were comparable with those reported for plant height and

number of leaves in radish (Roy and Seth, 1970) and root length in onion (Pandey and Mundra, 1971).

The important role of nitrogen in plant metabolism and thereby in plant growth is further confirmed from these results.

There was no significant effect of phosphorus application. Hence, all the growth parameters remained also unchanged over three levels of phosphorus.

Interaction

The interactions N X P, W X N and W X N X P were found significant in affecting plant height. The maximum plant height (40.19 cm) was for $W_1N_2P_3$ (Table-2) which was at par with treatments $W_1N_3P_2$ (39.55 cm), $W_2N_3P_1$ (39.31 cm), $W_2N_3P_2$ (39.01 cm) and $W_2N_3P_3$ (38.94 cm).

Interaction effect

TABLE 2

Character plant height (cm).

| Treatment | P_1 | P_2 | P_3 |
|-----------|-------|-------|-------|
| W_1N_1 | 33.72 | 31.99 | 32.20 |
| W_1N_2 | 36.27 | 37.68 | 35.52 |
| W_1N_3 | 34.02 | 39.55 | 40.19 |
| W_2N_1 | 30.29 | 31.55 | 30.00 |
| W_2N_2 | 35.42 | 33.24 | 35.88 |
| W_2N_3 | 39.31 | 39.01 | 38.94 |

S. Em. = 0.89, C. D. at 5% = 2.49

The number of leaves per plant were significantly affected by the interactions of N X P, S X N, W X P and S X N X P. The maximum number of leaves (15.73) were recorded for $S_3N_3P_2$ (Table-3) which was significantly

superior to all other combinations of S X N X P. The significant increase may be only due to wider inter-row spacings and higher dose of nitrogen.

TABLE 3

Character - Number of leaves.

| Treatment | P ₁ | P ₂ | P ₃ |
|-------------------------------|----------------|----------------|----------------|
| S ₁ N ₁ | 11.40 | 12.50 | 10.50 |
| S ₁ N ₂ | 10.93 | 11.17 | 11.53 |
| S ₁ N ₃ | 10.73 | 11.87 | 11.23 |
| S ₂ N ₁ | 12.43 | 11.87 | 11.87 |
| S ₂ N ₂ | 11.93 | 12.50 | 12.33 |
| S ₂ N ₃ | 13.37 | 13.10 | 14.03 |
| S ₃ N ₁ | 14.00 | 13.10 | 12.17 |
| S ₃ N ₂ | 13.27 | 13.03 | 14.43 |
| S ₃ N ₃ | 14.23 | 15.73 | 14.57 |

S. Em = 0.41, C. D. at 5% = 1.15

The interactions S X W, S X N, S X W X P, S X W X N, W X N X P, S X N X P and S X W X N X P were found significant in effecting root length. The highest root length (17.43

cm) was noted for S₃W₂N₃P₂ (Table-4). It might be due to the combined effect of wider spacings with maximum nitrogen and minimum phosphorus application.

TABLE 4

Character - Root length (cm).

| Treatment | P ₁ | P ₂ | P ₃ |
|--|----------------|----------------|----------------|
| S ₁ W ₁ N ₁ | 11.44 | 10.25 | 10.91 |
| S ₁ W ₁ N ₂ | 10.33 | 11.15 | 10.95 |
| S ₁ W ₁ N ₃ | 9.95 | 10.96 | 11.85 |
| S ₁ W ₂ N ₁ | 13.26 | 14.56 | 15.28 |
| S ₁ W ₂ N ₂ | 11.33 | 13.47 | 13.71 |
| S ₂ W ₁ N ₁ | 16.61 | 14.87 | 12.45 |
| S ₂ W ₁ N ₂ | 12.38 | 12.27 | 13.80 |
| S ₂ W ₁ N ₃ | 11.87 | 13.47 | 11.91 |
| S ₂ W ₂ N ₁ | 14.26 | 13.93 | 15.36 |
| S ₂ W ₂ N ₂ | 15.70 | 14.14 | 14.69 |
| S ₂ W ₂ N ₃ | 15.76 | 15.77 | 13.82 |

| 1. | 2. | 3. | 4. |
|-------------|-------|-------|-------|
| $S_3W_2N_3$ | 17.35 | 13.50 | 15.76 |
| $S_3W_1N_1$ | 13.47 | 14.93 | 12.44 |
| $S_3W_1N_2$ | 15.59 | 13.47 | 15.11 |
| $S_3W_1N_3$ | 16.45 | 13.76 | 17.05 |
| $S_3W_2N_1$ | 15.37 | 14.31 | 14.76 |
| $S_3W_2N_2$ | 16.37 | 17.31 | 17.50 |
| $S_3W_2N_3$ | 16.03 | 17.43 | 14.86 |

S. Em. = 0.70, C. D. at 5% = 1.97.

The significant increase in root diameter was found with the treatment W_2P_2 (2.76 cm)

given in Table-5, which was at par with W_2P_1 (2.69 cm).

TABLE 5

Character - Root diameter (cm).

| Treatment | P_1 | P_2 | P_3 |
|-----------|-------|-------|-------|
| W_1 | 2.20 | 2.30 | 2.41 |
| W_2 | 2.69 | 2.76 | 2.57 |

S. Em = 0.07, C. D. at 5% = 0.18

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Response of Sowing Dates and Nitrogen Levels on Growth Yield and Quality of Linseed (*Linum usitatissimum* L.)

R. L. Rajput* and D. S. Gautam

JNKVV-Regional Agricultural Research Station, Sarkanda, Bilaspur (M. P.)

ABSTRACT

A field experiment was conducted at JNKVV-Regional Agricultural Research Station, Sarkanda, Bilaspur (MP) during winter seasons of 1982-83 and 1983-84, five date of sowing (10, 25 October; 10, 25 November and 10 December) each at four nitrogen levels (0, 30, 60 and 90 kg N/ha) in a split plot design. Among five dates of sowing 10 November was found to be the most suitable date of sowing during both the years. However, suitable sowing period ranged from 10 to 25 November. The oil content increased due to planting on 10 October but protein content decreased. The seed yield, oil and protein content of Linseed increased with the increasing levels of nitrogen during both the years.

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INTRODUCTION

Linseed is an important oilseed crop of South eastern Madhya Pradesh. It was grown there as main crop in winter season in large area. It is also a common practice in Chhatisgarh tract to grow it after paddy under utera condition. Linseed is of unique significance for use of its oil in industries. Being a remunerative and low input requirement crop it is very much liked by farmers but due to its low productivity, the crop gets setback. Under double cropped area, specially after rice, sowing of linseed is also generally delayed. In view of above, the present investigation was taken up to find out suitable sowing period and response to different levels of nitrogen for getting maximum yield and economic return.

MATERIALS AND METHODS

A field experiment was conducted on clay loam soil (pH 7.1; organic carbon 0.42%, available nitrogen 230-260 kg/ha; phosphorus 20-22 kg/ha and potassium 170-180 kg/ha) during the winter seasons of 1982-83 and 1983-84 at JNKVV-Regional Agricultural Research Station, Bilaspur. The treatments consisting of various combination of five sowing dates (10 and 25 October, 10 and 25 November and 10 December), Four nitrogen levels (0, 30, 60 and 90 kg N/ha) were replicated four times in a split plot design, allocating sowing dates to main plots nitrogen levels to sub plots. Full dose of nitrogen (as per treatments), 30 kg P_2O_5 /ha and 20 kg K_2O /ha were applied at sowing. The crop was sown in lines at 30 cm apart. The variety was J-552. The crop was irrigated once before flowering.

*Present address JNKVV-Zonal Agricultural Research Station, P.B. No. 14 A.B. Road, Morena-476 001.

TABLE 1

Growth and yield attributing characters as influenced by sowing dates and nitrogen levels during 1982-83 and 1984.

| Treatments | Plant height (cm) | | Branches/plant | | Capsules/plant | | 1,000 seed weight (g) | |
|------------------------------|-------------------|---------|----------------|---------|----------------|---------|-----------------------|---------|
| | 1982-83 | 1983-84 | 1982-83 | 1983-84 | 1982-83 | 1983-84 | 1982-83 | 1983-84 |
| Sowing dates | | | | | | | | |
| 10 October | 47.4 | 38.2 | 9.9 | 7.1 | 27.4 | 22.8 | 6.3 | 6.2 |
| 25 October | 49.7 | 39.1 | 10.9 | 7.6 | 28.1 | 26.4 | 6.4 | 6.3 |
| 10 November | 52.0 | 42.3 | 11.8 | 8.3 | 31.1 | 29.6 | 6.5 | 6.4 |
| 25 November | 44.6 | 35.9 | 7.8 | 6.1 | 23.4 | 21.6 | 6.2 | 6.1 |
| 10 December | 41.0 | 32.9 | 6.3 | 4.9 | 19.5 | 19.0 | 6.1 | 6.1 |
| CD at 5% | 0.44 | 0.44 | 0.14 | 0.10 | 0.49 | 0.74 | 0.01 | 0.01 |
| Nitrogen levels kg/ha | | | | | | | | |
| 0 | 43.7 | 34.6 | 7.9 | 5.9 | 23.4 | 21.4 | 6.2 | 6.1 |
| 30 | 45.5 | 36.8 | 8.8 | 6.5 | 25.1 | 22.8 | 6.2 | 6.2 |
| 60 | 48.1 | 38.0 | 9.8 | 6.9 | 26.7 | 24.5 | 6.4 | 6.3 |
| 90 | 50.5 | 40.7 | 10.7 | 7.9 | 28.4 | 26.5 | 6.5 | 6.3 |
| CD at 5% | 0.35 | 0.03 | 0.09 | 0.09 | 0.34 | 0.36 | 0.01 | 0.01 |

TABLE 2

Grain yield, oil and protein content as influenced by sowing dates and nitrogen levels.

| Treatments | Grain yield (kg/ha) | | Oil content (%) | | Protein content (%) | | Net profit Rs/ha | |
|------------------------------|---------------------|---------|-----------------|---------|---------------------|---------|------------------|---------|
| | 1982-83 | 1983-84 | 1982-83 | 1983-84 | 1982-83 | 1983-84 | 1982-83 | 1983-84 |
| Sowing dates | | | | | | | | |
| 10 October | 860 | 670 | 40.9 | 39.2 | 21.5 | 18.2 | 2500 | 1550 |
| 25 October | 1060 | 750 | 40.1 | 38.4 | 22.0 | 19.8 | 3500 | 1950 |
| 10 November | 1150 | 870 | 39.4 | 37.2 | 22.3 | 20.1 | 3950 | 2550 |
| 25 November | 1040 | 850 | 38.9 | 36.9 | 22.9 | 20.8 | 3400 | 2450 |
| 10 December | 670 | 540 | 38.2 | 36.1 | 23.2 | 21.1 | 1550 | 900 |
| CD at 5% | 195 | 76 | 0.05 | 0.03 | 0.04 | 0.04 | — | — |
| Nitrogen levels kg/ha | | | | | | | | |
| 0 | 820 | 560 | 38.6 | 36.2 | 21.4 | 18.7 | 2300 | 1000 |
| 30 | 930 | 710 | 39.3 | 37.6 | 22.2 | 19.6 | 2700 | 1600 |
| 60 | 1010 | 790 | 39.9 | 38.2 | 22.8 | 19.9 | 2950 | 1850 |
| 90 | 1090 | 870 | 40.2 | 39.1 | 23.2 | 20.8 | 3200 | 2100 |
| CD at 5% | 100 | 80 | 0.06 | 0.04 | 0.05 | 0.04 | — | — |

RESULTS AND DISCUSSION

Sowing dates

The effects of sowing dates on plant height, branches, capsules per plant, 1000 seed weight, grain yield, oil and protein content were significant during both the seasons (Table 1 & 2). Early sown crop (10 November) recorded 58.4 and 62.1 per cent higher grain yield over late sown crop (10 December) during first and second years, respectively. The highest grain yield of (1150 kg/ha) was recorded on 10 November sown crop but it was at par with 25 October (1060 kg/ha) and 25 November (1040 kg/ha) sown crop during first year. Similarly 10 November (870 kg/ha) also out yielded significantly over 10, 25 October and 10 December sowing dates in second year. Thus, it was concluded that November 10 was the most suitable date of sowing for this crop but suitable period of sowing ranged from October 25 to November 25. The increase in yield was mainly due to increase in various plant characters contributing towards yield. The late sowing reduced the grain yield as in 10 December sowing, it was only 800 kg/ha. The yield reduction in late sowing, dates is mainly attributable to shorter growth period at the disposal of the late sown crop as the time taken by the crop to mature to decreased with delay in sowing. The present findings are in agreement with the findings of Maliwal (1985).

The oil content in seed was higher in early sowing. It may be attributed to the fact that seeds in late sown crop did not develop fully and also contained more protein (Table 2) which is negatively correlated with the oil con-

tent (Norton and Haris, 1975). Further, the higher temperature that prevailed at the vegetative and reproductive phases of the crop planted earlier might have decreased the protein content.

Nitrogen levels

Significantly higher grain yield and net profit was recorded under 90 kg N/ha which was better than that due to control and 30 kg N/ha. The differences between 30 to 60 and 60 to 90 kg N/ha were not significant during both the years. However, the increase in yield was in linear order with the increasing levels of nitrogen. The effect of nitrogen on growth and development of linseed on various characters like plant height, branches, capsules per plant and 1000 seed weight was in positive direction (Table 1). The results showed significant increase in yield attribute characters due to increasing levels of nitrogen from (0 to 90 kg N/ha). Kosta and Battawar (1981) also recorded similar results in linseed. Oil and protein content was also significantly increased with the increasing levels of nitrogen during both the years.

The interaction effect between sowing dates and nitrogen levels revealed that application of 90 kg N/ha significantly increased the grain yield when linseed was planted on 25 October, 10 and 25 November (1982-83) as compared to 10 October and 10 December, whereas 10 November planting date produced significantly higher grain yield (1370 kg/ha) over 25 October and 25 November (Table 3). However, application of 60 kg N/ha also produced significantly higher grain yield (1220 kg/ha)

TABLE 3

Grain yield as affected by sowing dates and nitrogen levels.

| Sowing dates | 1982-83 | | | | 1983-84 | | | |
|--------------|---------|------|------|------|---------|-----|------|------|
| | | | | | | | | |
| | 0 | 30 | 60 | 90 | 0 | 30 | 60 | 90 |
| 10 October | 760 | 890 | 870 | 920 | 560 | 660 | 720 | 750 |
| 25 October | 920 | 1050 | 1120 | 1160 | 670 | 730 | 740 | 940 |
| 10 November | 910 | 1090 | 1220 | 1370 | 580 | 670 | 1080 | 1150 |
| 25 November | 910 | 990 | 1070 | 1190 | 610 | 880 | 890 | 1000 |
| 10 December | 590 | 540 | 760 | 800 | 480 | 630 | 530 | 530 |
| CD at 5% | 82.0 | | | | 179 | | | |

Nitrogen levels kg/ha

when planted on 10 November during 1982-83 than other planting dates. More or less the similar trend was observed in grain production

under 60 and 90 kg N/ha during 1983-84, but the differences between treatment combinations remained nonsignificant.

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Carbofuran Residues from Banana and Potato

M. F. Raj, P. G. Shah, J. A. Patel and B. K. Patel*

AICRP on Pesticide Residues, Gujarat Agricultural University, Anand Campus, Anand-388 110

ABSTRACT

Residues of carbofuran were estimated under field conditions from banana cv. Basrai, following the soil incorporation of carbofuran @ 1.5 g/plant twice at 6 and 7 1/2 months after planting and from potato cv. Kufri Chandramukhi by applying carbofuran @ 3.0 kg a.i./ha, half at planting and half at earthing up stage. At harvest time the residues in peeled banana were 0.357 ppm, which were above the tolerance limit of 0.1 ppm, whereas in potato tubers residues were below detectable limits at the time of harvest.

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INTRODUCTION

Banana (*Musa paradisiaca* L.) is attacked by plant parasitic nematodes. Sasser (1988) reported 19.7% loss due to plant parasitic nematodes in banana on world basis. Patel *et al.* (1991) tested phenamiphos, phorate, ethoprophos and carbofuran under field conditions in banana crop and reported superiority of carbofuran. Nair (1979), Fagan (1989) and Ternisien (1989) have also reported reduction in nematode population due to application of carbofuran in banana. Potato (*Solanum tuberosum* L.) an important staple vegetable crop is also attacked by root-knot nematodes. In an experiment carried out at Deesa during 1987-88, for the control of root-knot nematodes, application of carbofuran significantly produced more healthy tubers compared to ethoprophos and phorate (Anon., 1987). However, the information regarding residues of carbofuran from banana and potato is not generated under Gujarat conditions.

Therefore, the present experiments were carried out to know the magnitude of residues of carbofuran from peeled banana and potato tubers.

MATERIALS AND METHODS

Field experiments

Banana

The experiment was carried out in a randomized block design with three replications on a farmer's field at Jabugam village in Vadodara district of the Gujarat State during 1986-87. Carbofuran was applied in the rhizosphere of standing crop @ 1.5 g/plant at 6 and 7 1/2 months after planting. The banana variety Basrai following recommended agronomic practices for the region was cultivated. The raw banana fruit samples at harvest were collected from bunches and kept for natural ripening. The residues were determined from ripe banana fruit peeled pulp.

*Address for mailing : Senior Biochemist (Tobacco), Bidi Tobacco Research Station, Gujarat Agricultural University, Anand Campus, Anand-388 110.

Potato

A field experiment on potato variety 'Kufri Chandramukhi' was conducted at Potato Research Station, Gujarat Agricultural University, Deesa (Dist. Banaskantha) during 1987-88. All the recommended agronomic practices were followed for the experiment. Carbofuran @ 3.0 kg a.i./ha, half at planting and half at the time of earthing up was applied to the crop. At harvest, potato tuber samples were collected for residue analysis.

Residue analysis

Extraction

The method described by Thomas and Cook (1980) was used for residue analysis of carbofuran from banana and potato. Ten gramme each of representative peeled banana pulp and potato tuber samples were taken for residue analysis. The sample was extracted with 300 ml 0.25 N HCl and a pinch of celite as filter aid. From the filtrate, 30 ml aliquot was further extracted four times with n-hexane using 60 ml each time. The emulsion formed during extraction was removed using 4% aqueous sodium lauryl sulphate. The combined hexane extract was extracted with anhydrous diethyl ether. The latter was decanted through the bed of anhydrous sodium sulphate which was pre-washed with ethyl acetate and air dried. The dried extract was concentrated to 5 ml in a vacuum rotatory evaporator, which was concentrated to 1 ml under nitrogen stream.

Florisil column clean-up

Ten gramme of 100-200 mesh Florisil deactivated to a moisture content of $2.5 \pm 0.3\%$ on weight basis was taken in a 30 cm x 19 mm column topped with 0.5 cm of sea sand. The column bed was approximately 11 cm. The column was prewetted with 20-30 ml of hexane. The sample was transferred to the column by giving several rinses of 1:9 ethyl acetate :

hexane (v/v). Elution was performed with 100 ml of 1:9 ethyl acetate : hexane (v/v) as a wash and discarded. Further eluted with 60 ml of 3:7 ethyl acetate : hexane (v/v) and the eluant was collected. Two ml of toluene was added to the eluant which served as a keeper and injection solvent. The eluate was concentrated under vacuum rotatory evaporator and further concentration was done under nitrogen stream.

GLC parameters

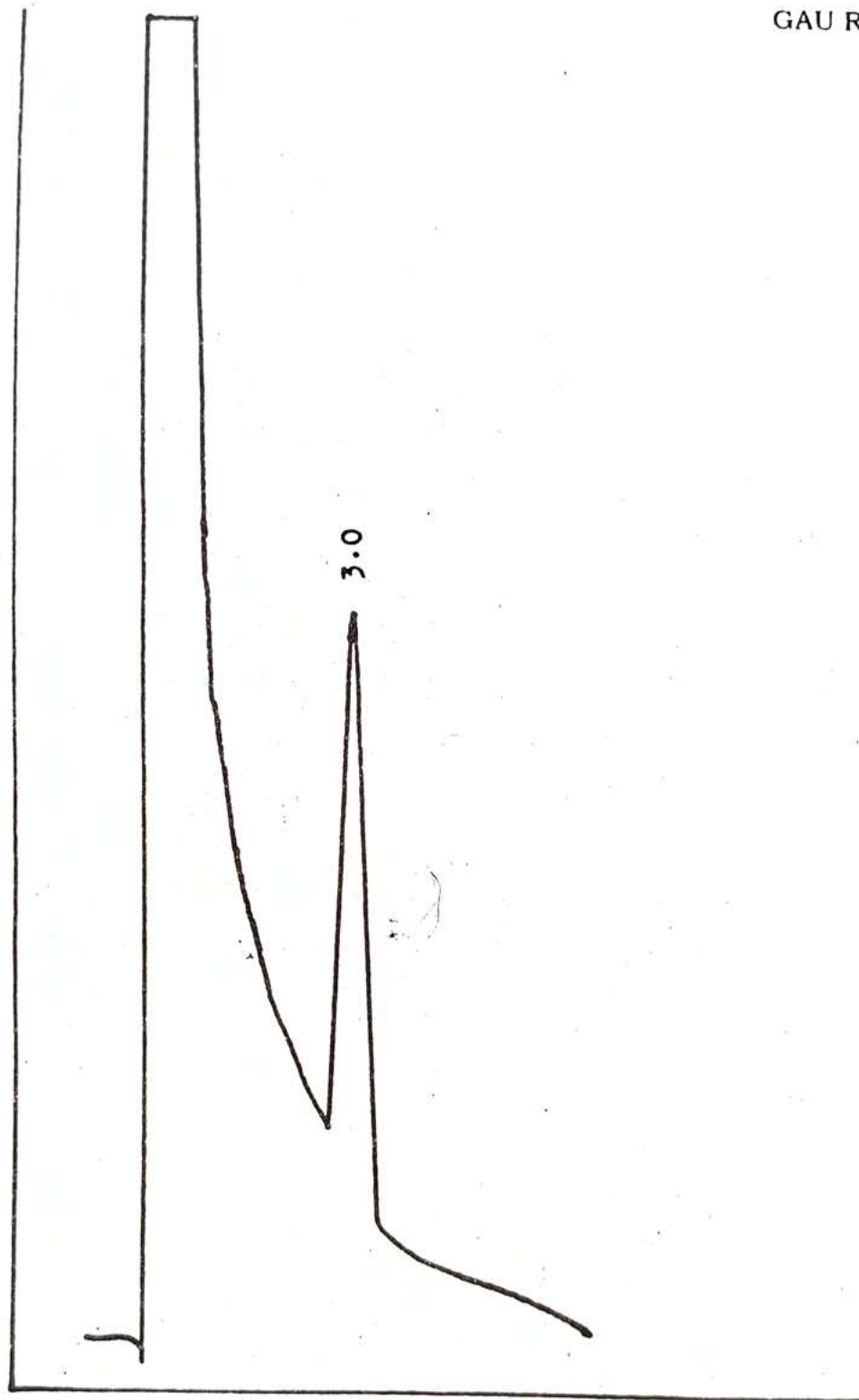
Carbofuran residues were analysed by GC-TSD (Varian Model 3700) having 200 cm x 6 mm glass column packed with 2.5% OV-17 on 100-200 mesh W (HP). Temperatures ($^{\circ}\text{C}$) of column, detector and injector were maintained at 220, 240 and 270, respectively. The flow rate of carrier gas (nitrogen), hydrogen and air was maintained at 30, 5 and 300 ml per minute, respectively. At these parameters, the retention time of carbofuran was 3 minutes (Figure 1). The recovery study carried out by fortifying samples at 1 ppm concentration indicated 111% recovery. Data reported have not been corrected for recovery.

RESULTS AND DISCUSSION

Residues from banana

The data on residues of carbofuran from peeled banana pulp at harvest are given in Table 1. The residues were not detectable from the control plots. At harvest, in peeled banana pulp, the residues of carbofuran were 0.357 ppm with an application of carbofuran @ 1.5 g/plant twice at 6 and 7½ months after planting which was above the maximum residue limit (MRL) of 0.1 ppm. Venugopal *et al.* (1978) also reported 0.15 ppm residues of carbofuran with the application of carbofuran @ 80 and 40 g/sucker at planting and five months after planting, respectively. However, the experiment conducted at Coimbatore on banana variety Dwarf Cavendish with one application of carbofuran @ 1.2 g/sucker at planting indicated

RECORDER RESPONSE



RETENTION TIME (MIN)

Fig. 1 : GLC Chromatogram of Carbofuran

TABLE 1

Residues of carbofuran from banana and potato.

| Treatment | Residue level (ppm) | |
|-------------|---------------------|---------------|
| | Banana pulp | Potato tubers |
| Non-treated | BDL | Nil |
| Treated | 0.357 | BDL |

BDL : Below detectable limit

ND and 0.005 ppm carbofuran residues from fruits and peel, respectively (Anon., 1977). However, in the present experiment, the residues were above MRL which may be due to the application of nematicide at higher dose and later stage of the crop growth. Therefore, if application of carbofuran is given at the time of planting residue problem could be avoided.

Residues from potato

Data presented in Table 1 indicate carbofuran residues obtained in potato tubers,

variety Kufri Chandramukhi with the application of carbofuran @ 3 kg a.i./ha half at planting and half at the time of earthing up. The residues were below detectable limit from the treated plots. Mithyantha *et al.* (1977) also reported carbofuran residues from potato tubers below the tolerance limit with different rates applied at planting. The experiment conducted at Bangalore (Anon., 1977) by soil application of carbofuran at planting also indicated that residues in potato tubers were below the tolerance limit.

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Profit Structure of Soybean, Cotton and Sorghum Cultivation in Central Narmada Valley of India

D. S. Gautam* and S. B. Nahatker*

Indo-German Extension and Research Project, Harda, M. P.

ABSTRACT

Study of Central Narmada valley reveals that cost A_1 of soybean, cotton and sorghum required 66.97%, 69.9% and 52.13% of the cost C_2 . The yields of cotton, soybean and sorghum was obtained by sample farms were 8.76 qts, 7.77 qts and 7.97 qts/ha with the farm business income of Rs. 1993.43, Rs. 910.10 and Rs. 625.19 per hectare, respectively. Cotton cultivation gave the highest profit per hectare followed by soybean and sorghum. Beside these findings, policy implications have also been suggested.

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INTRODUCTION

According to approach paper the "Seventh Five Year Plan" aimed at an accelerated rate of agricultural development and self sufficiency in food, fiber and edible oils at higher levels of consumption. Confrontation of farmers with the problem of choosing optimum product combinations, determining the profitability with the increasing levels of variable input needs proper evaluation due to adoption of new agricultural technology in crop production. In Central India, cotton, soybean and sorghum crops contribute 7.1%, 84.2% and 12.4% area respectively of the country (1986-87).

Competitive situation of production of crops depends on return from production process with given resources and appropriate technology. Hence, study is directed with the resource requirements, i.e. cost structure and revenue obtained from competitive crops, viz., soybean, cotton and sorghum in Central

Narmada Valley of India (Madhya Pradesh).

The objective of study was to examine the cost and profitability structure of cotton, soybean and sorghum cultivation.

MATERIALS AND METHODS

Hosangabad division of Madhya Pradesh was purposively selected for study. From the tehsils of selected district, one block Harda was selected purposively on the basis of highest acreage under sorghum, cotton and soybean cultivation in tehsil. Three villages from Harda block were selected by the method of probability proportionate sampling (proportion of area under crops to total cropped area of kharif), viz., Ramhaikala, Masavgaon and Balagaon. From the list of farmers of selected villages 90 sample farms (30 farms from each village) were randomly selected for collection of necessary data with the help of pretested schedules by adopting survey method of data

*Present address : Department of Agricultural Economics and Farm Management, Jawaharlal Nehru Krishi Vishwa Vidyalyaya, Jabalpur (M. P.)-482 004.

collection. The study was related to agricultural year 1987. The collected data were analysed

on the basis of cost and profitability concepts as used by Gautam (1989).

TABLE 1

Cost structure of cultivation for cotton, soybean and sorghum in selected farms.

| Cost items | (Rs/ha) | | |
|---|-----------------|-----------------|----------------|
| | Cotton | Soybean | Sorghum |
| Human labour | 484.56 (11.79) | 316.51 (15.87) | 141.50 (13.96) |
| Bullock labour | 449.81 (10.95) | 287.51 (14.42) | 175.09 (17.28) |
| Seed | 201.85 (4.91) | 252.08 (12.64) | 28.25 (2.79) |
| Fertilizers & Manures | 862.63 (21.00) | 332.57 (16.68) | 78.79 (7.77) |
| Pesticides | 221.67 (5.39) | 60.34 (3.02) | 29.72 (2.93) |
| Irrigation | 102.79 (2.50) | — | — |
| Land revenue tax | 13.68 (0.33) | 13.35 (0.67) | 10.88 (1.07) |
| Interest on working capital | 85.30 (2.08) | 26.26 (1.32) | 9.66 (0.95) |
| Depreciation on Farm assets | 132.91 (3.25) | 46.81 (2.35) | 54.92 (5.42) |
| Total Cost A_1 | 2555.20 (62.19) | 1335.43 (66.97) | 528.81 (52.18) |
| (ii) Cost- $B_1 =$ | | | |
| Cost A_1 + Interest on fixed capital | 150.05 (3.65) | 50.01 (2.51) | 58.13 (5.74) |
| Total Cost B_1 | 2705.25 (65.84) | 1385.44 (69.48) | 586.94 (57.32) |
| (iii) Cost $C_1 =$ | | | |
| Cost B_1 + imputed value of family labour | 266.06 (6.47) | 47.02 (2.36) | 137.93 (13.61) |
| Total Cost C_1 | 2971.31 (72.32) | 1432.46 (71.84) | 724.87 (71.53) |
| (iv) Cost $B_2 =$ | | | |
| Cost B_1 rental value of owned land | 1137.16 (27.68) | 561.38 (28.16) | 288.50 (28.47) |
| Total Cost B_2 | 3842.41 (93.53) | 1946.82 (97.64) | 875.44 (86.39) |
| (v) Cost $C_2 =$ Cost | | | |
| B_2 + imputed value of family labour | 266.06 (6.47) | 47.02 (2.36) | 137.93 (13.61) |
| Total Cost C_2 | 4108.47 (100.0) | 1993.84 (100) | 1013.37 (100) |

Figures in parentheses show the percentage to cost C_2 .

Cost concepts

The cost classification as recommended by special Expert Committee on Cost Estimates¹ was used for the analysis of cost of

cultivation as shown in table 1. Profitability concepts : The following profitability concepts were used to provide up to date information on profit earned from each crop.

¹ Report of Special Expert Committee on Cost of Production Estimates, Ministry of Agriculture, Department of Agriculture and Cooperation, Govt. of India, 1980, New Delhi.

TABLE 2

Cost structure of production for cotton, soybean and sorghum in selected farms.

| Crops | Cost A ₁ | Cost B ₁ | Cost C ₁ | Cost B ₂ | Cost C ₂ |
|---------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Cotton | 279.68 | 296.82 | 327.19 | 428.63 | 457.00 |
| Soybean | 147.87 | 154.31 | 160.36 | 226.56 | 232.61 |
| Sorghum | 36.46 | 43.76 | 61.09 | 80.01 | 97.33 |

Interest on working capital was calculated @ 12.5% for half of the duration of the crop.

Interest on fixed capital was calculated @ 10% and allocated according to gross acreage.

Rental value of owned land was calculated @ 1/4 of the gross income from the crop.

- (i) Net Farm Income : Defined as, Gross income-Cost C₂.
- (ii) Family labour income : Defined as, Gross income cost B₂.
- (iii) Farm Investment Income : Defined as, Net farm income + Interest on fixed capital + rental value of owned capital.
- (iv) Farm business income : It is defined as, Gross income-cost A₁.

RESULTS AND DISCUSSION

I Cost of cultivation

The per hectare cost structure of crops is given in Table 1. From the table it was seen that the over all cost i.e., cost C₂ was maximum for cotton (Rs. 4108.47) followed by soybean (Rs. 1993.84) and sorghum (Rs. 1013.37). However, in terms of operational cost i.e. cost A₁, it also followed the same trend but percentage breakup showed that out of total cost soybean required maximum i.e., 66.97 per cent followed by cotton 62.9 per cent and sorghum 52.18 per cent. This might be due to higher expenditure on hired human labour for post harvest opera-

tion of soybean i.e., nearby 16 per cent of the total cost. The major cost items for three crops are rental value of owned land, which is nearby 28 per cent for all the crops followed by expenditure on fertilizers and manures for cotton (21.00%) and soybean (16.68%) and expenditure on bullock labour (17.28%) in case of sorghum. The expenditure on human labour was highest for soybean (15.87%), followed by sorghum (13.98%) and cotton (11.79%). The higher percentage expenditure on imputed value of family labour (13.61%) in case of sorghum revealed that the use of family labour was higher in sorghum production as compared to soybean and cotton. The higher value of owned land reflected towards higher prices of the crop in the market, because rental value of land estimated as 1/4 of the gross income from the crop. This was also reported by Gautam *et al.* (1990).

II Cost of production

The cost per quintal is given in the table 2 for all the three crops, which shows that the per quintal cost was highest for cotton, followed by soybean and jowar, at all cost concepts. The overall cost (Cost C₂) was estimated to be Rs. 457.00 for cotton, Rs. 232.61 for soybean and Rs. 97.33 for sorghum. This suggested that

the farm harvest price/support price must be higher than the cost to meet out the all operational and overhead costs. The operational cost A_1 was estimated at Rs. 279.68, Rs. 147.87 and Rs. 36.46/q for cotton, soybean and sorghum respectively. The per quintal cost B_2 increased significantly over cost C_1 for cotton & soybean. It indicates that rental value of land for

these two crops had a significant contribution in the cost.

III Profitability

Table 3 shows the profitability of soybean, cotton and sorghum per unit of area and per unit of productivity.

TABLE 3

Profitability of cotton, soybean and sorghum in selected farms.

| Crops | Yield
(q/ha) | Gross*
income | Farm
business
income | Farm
invest-
ment
income | Family
labour
income | Net farm
income |
|---------|-----------------|---------------------|----------------------------|-----------------------------------|----------------------------|--------------------|
| Cotton | 8.76 | 4548.63
(507.25) | 1993.43
(227.57) | 1727.37
(185.19) | 706.22
(80.62) | 440.16
(50.25) |
| Soybean | 7.77 | 2245.53
(265.00) | 910.10
(117.13) | 863.08
(87.08) | 298.71
(38.44) | 251.69
(32.39) |
| Sorghum | 7.97 | 1154.00
(115.00) | 625.19
(78.54) | 487.26
— | 278.56
(35.00) | 140.63
(19.67) |

* included return from by-product.

Figures in parentheses given the profit per quintal.

From the table it was observed that the cotton was the most profitable crop as compared to soybean and sorghum. The farm business income was Rs. 1993.43 per ha for cotton, followed by Rs. 910.10 per ha for soybean and Rs. 625.19 per ha for sorghum, the per quintal figures for the same crops were Rs. 227.57, Rs. 117.13 and Rs. 78.54 respectively. However, the net farm income per ha was only Rs. 440.16 for cotton, Rs. 251.69 for soybean and Rs. 140.63 for sorghum revealed that the overhead cost like interest on fixed capital and rental value of land was much higher than other cost items. For increasing profitability from these crops and reducing overhead cost the intensive farming should be adopted so that the overhead cost will be allocated to more acreage and thereby net farm

income can increase. The per quintal net farm income was only Rs. 50.25 for cotton while it was low for soybean (Rs. 32.39) and still lower for sorghum (Rs. 17.67). Again this indicated that for increasing profitability per hectare, productivity of crops should be increased at lowest marginal cost of production. This was also suggested by Lavania and Dixit (1968).

Policy Implication

(a) The cash component involved in the production of cotton and soybean substantially goes up, therefore, it needs upward revision of existing scale of crop loan by nationalised and cooperative banks of Central India.

(b) Production efficiency of cotton, soybean and sorghum can be increased by adoption of improved techniques.

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Usefulness of Cotton Research Station as Perceived by Cotton Growers

P. P. Patel, D. N. Pandya, R. R. Kulkarni, S. D. Wangikar

Department of Extension, N. M. College of Agriculture, Gujarat Agricultural University, Navsari

ABSTRACT

In order to study the usefulness of the Cotton Research Station, Surat as perceived by cotton growers the study was carried out in 16 villages within the radius 30 kms. from Cotton Research Station, Surat. The respondents (200) were selected with the help of random sampling technique. A field survey was conducted through structured interview schedule. The results of the study revealed that 86.5 per cent cotton growers has perceived the cotton research station useful as an information centre and 89.5 per cent perceived the cotton research station as a source of inspiration for adoption of improved farm practices. On the basis of the findings, it is suggested that the authority of the Cotton Research Station and extension agency will have to exert more in order to aware the farming community regarding the research activities being carried out at the Research Station and being technological change in cotton growing area.

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INTRODUCTION

Rapid advances in agricultural sciences and technology offer better prospects to farmers for achieving significant increases in productivity, production and consequently higher incomes. The need is for taking the fruits of research faster to farmers and enable them to adopt these technologies for their economic betterment. Agricultural research station plays a major role in solving the problems of agriculture and allied sciences for the purpose of aiding the development of agriculture and for the benefit of rural population of the state. Another main role of research station is to build relationship and increase confidence among the farmers so that they may develop

favourable attitude and feeling towards the research station. This may result in motivating them to take advantage of the research station. Earlier studies by Dudhani and Rao (1969), Laxminarayan and Satyanarayan (1970) indicated that extension agency (including i.e. government agriculture college) was found to be a major sources of first information.

In order to study the usefulness of the Cotton Research Station, Surat as perceived by cotton growers the present study was undertaken with following objectives :

1. To determine the usefulness of the cotton research station as on the basis of the opinions expressed by cotton growers :

- as a information centre.
- as a source of inspiration for adoption of improved farm practices.

2. To know the cotton growers' awarness about the activities being carried out by the station.
3. To determine type of advantages availed by the cotton growers from the station.

MATERIALS AND METHODS

The method used for the study was a field survey undertaken through structured interview schedule. The sample consisted of 200 farmers from 3 villages of Olpad and 8 villages of Choryashi taluka of Surat district of Gujarat State.

TABLE 1

Distribution of respondents according to their perception regarding usefulness of the Cotton Research Station, Surat as an information centre.

N = 200

| Sr. No. | Usefulness | No. of respondents (out of 200) | Percentages |
|---------|---|---------------------------------|-------------|
| I | Number of cotton growers who perceived the Cotton Research Station as an information centre for : | 173 | 86.5 |
| | <u>Cotton Seed</u> | | |
| | Information regarding improved variety | 170 | 85.0 |
| | Information regarding sources of procuring seeds of improved varieties | 150 | 75.0 |
| | Information regarding seed rate/hectare | 143 | 71.5 |
| | Information regarding seed treatment | 47 | 23.5 |
| | <u>Chemical fertilizers</u> | | |
| | Information regarding proper time for applying fertilizers | 173 | 86.5 |
| | Information regarding doses of fertilizers | 134 | 67.0 |
| | Information regarding method of applying fertilizers. | 75 | 37.5 |

The sampling method used for the study was a random sampling procedure. All 16 villages were selected from these two talukas with following criteria :

- (i) A village falling within a radius of 30 kms from the cotton research station and
- (ii) A village in which cotton cultivation is the regular feature of the cropping pattern.

RESULTS AND DISCUSSION

Utility of Cotton Research Stations

The respondents were asked to narrate usefulness of the cotton research station, Surat. These responses were tabulated in Table 1.

| 1. | 2. | 3. | 4. |
|--|----|-----|------|
| <u>Plant protection measures</u> | | | |
| Information regarding insecticides and fungicides to be used against the insects of cotton crops | | 166 | 83.0 |
| Information regarding the proportion of insecticides and fungicides to be used | | 145 | 72.5 |
| Information as to when and how to apply insecticides and fungicides | | 65 | 32.5 |
| <u>Irrigation</u> | | | |
| Information regarding the time to irrigate cotton crop | | 157 | 78.5 |
| Information regarding the number of irrigation | | 74 | 37.0 |
| <u>Crop rotation</u> | | | |
| Information regarding the type of crop rotation | | 159 | 79.5 |
| Information regarding the importance of crop rotation | | 108 | 54.0 |
| <u>Hybrid seed production</u> | | | |
| Information regarding the scientific method of hybrid seed production | | 106 | 53.0 |

An examination of the data given in Table 1 revealed that out of 200 growers, 86.5 per cent had perceived the cotton research station useful as an information centre.

Cotton seed

Majority of the cotton growers (85.0 per cent) had considered the cotton research station as a source of information regarding improved varieties of cotton while 75.0 and 17.5 per cent cotton growers had expressed their views as a source of information regarding source of procuring seeds of improved varieties and seed rate/hectare, respectively.

Chemical fertilizers

Majority of the cotton growers (86.5 per cent) expressed their views that information regarding proper time for applying fertilizers could be obtained from the research station.

Out of 200 farmers, 67 per cent mentioned that the research station as a source of information regarding doses of fertilizers and 37.5 per cent considered it as a source of information regarding the methods of applying fertilizers.

Plant protection measures

Eighty three per cent cotton growers considered the research station as a source of information regarding insecticides and fungicides to be used against insects, pests and diseases of the crop. The data further revealed that 72.5 per cent respondents mentioned the cotton research station as a source of information regarding the proportion of insecticides and fungicides to be used. While 32.5 per cent expressed it as a source of information as to when and how to apply insecticides and fungicides.

Irrigation

The data revealed that majority of respondents (78.5 per cent) mentioned the research station as a source of information regarding the time to irrigate the crop and 37.0 per cent considered it as a source of information regarding the number of irrigation to be given to the crop.

Crop rotation

Majority of the cotton growers (79.5 per cent) perceived the usefulness of the research station as a source of information regarding the type of crop rotation to be followed in the cotton crop, while 54.0 per cent indicated it as

a source of information regarding the importance of crop rotation.

Hybrid seed production

The data revealed the research station as a source of information regarding the scientific method of hybrid seed production was perceived by 53.0 per cent of the respondents.

The respondents were further asked to report regarding the usefulness of the cotton research station, Surat as a source of inspiration for adoption of improved practices. These responses were tabulated as reported in Table 2.

TABLE 2

Distribution of respondents according to their perception regarding the usefulness of the Cotton Research Station, Surat as a source of inspiration for adoption of improved farm practices.

N = 200

| Sr. No. | Usefulness | No. of respondents (out of 200) | Percentage |
|---------|--|---------------------------------|------------|
| I. | Number of cotton growers considering Cotton Research Station, Surat as a source of inspiration for adoption of improved agricultural practices | 179 | 89.5 |
| | Inspiration regarding sowing improved seeds | 179 | 89.5 |
| | Inspiration regarding the use of improved implements | 53 | 26.5 |
| | Inspiration regarding the adoption of plant protection measures | 125 | 62.5 |
| | Inspiration regarding the use of chemical fertilizers | 92 | 46.0 |
| | Inspiration regarding weed control | 119 | 59.5 |
| | Inspiration regarding maintenance of varietal purity | 83 | 41.5 |
| | Inspiration regarding adoption of improved cultivation practices | 90 | 45.0 |
| | Inspiration for doing all agricultural operations regularly and in time | 51 | 25.5 |

The data presented in Table 2 indicates that 89.5 per cent cotton growers perceived the usefulness of the Cotton Research Station, Surat as a source of inspiration for adoption of improved farm practices.

Eightynine per cent respondents were inspired for sowing improved seeds, while 26.5 per cent respondents were inspired for the use of improved implements. Out of 200 farmers, 62.5 per cent were inspired for adoption of plant protection measures and 46.0 per cent inspired

for the use of chemical fertilizers. The data further indicates that 41.5 per cent respondents and 45.0 per cent respondents were inspired for maintaining varietal purity and adoption of improved cultivation practices, respectively.

Awareness of activities

The respondents were further asked to report regarding awareness about the activities being carried out on the Cotton Research Station, Surat. These responses were tabulated as reported in Table 3.

TABLE 3

Distribution of cotton growers according to their awareness about the activities being carried out at the Cotton Research Station, Surat.

N = 200

| Sr.
No. | Activities | No. of
respondents
(out of 200) | Percentage |
|------------|--|---------------------------------------|------------|
| 1. | Conducting Rsesarch | 70 | 35.0 |
| 2. | Finding suitable plant protection measures | 36 | 18.0 |
| 3. | Improvement of quality of cotton | 26 | 13.0 |
| 4. | Evolving improved varieties | 18 | 9.0 |
| 5. | Organising farmers' day | 122 | 61.0 |
| 6. | Laying out demonstrations | 45 | 22.5 |
| 7. | Cultivation for hybrid seed cultivation | 23 | 11.5 |

The data presented in Table 3 revealed that the majority of respondents (61.0 per cent) indicated that they knew about the organization of farmers' day on the research station. The respondents were not found to be aware of the type of research that was being carried out at the Cotton Research Station, Surat. It was found that only 18.0 per cent respondents were aware of the research on plant protection measures in cotton crop being carried out and

only 13.0 per cent and 9.00 per cent respondents indicated their awareness about the research related to the improvement of cotton quality and evolving of improved varieties. The awareness of activity of laying out demonstration was mentioned by 22.5 per cent respondents and the awariness of the activity of hybrid seed production was indicated by only 11.5 per cent.

Benefits availed

Respondents were further asked to narrate the types of advantages of the Cotton

Research Station, Surat taken by them. Their responses were tabulated and depicted in Table 4.

TABLE 4

Distribution of cotton growers according to advantages of Cotton Research Station, Surat availed by them.

N = 200

| Sr. No. | Type of benefit availed | No. of respondents (out of 200) | Percentage |
|---------|---|---------------------------------|------------|
| 1. | Information about the methods of application and doses of fertilizers | 169 | 84.5 |
| 2. | Information regarding insecticides and fungicides and their proportion and methods of use | 161 | 80.5 |
| 3. | Information regarding improved implements useful for cotton cultivation and their use | 29 | 14.5 |
| 4. | Information regarding cultivation method for hybrid seed production | 112 | 56.0 |
| 5. | Information regarding irrigation in cotton crop | 141 | 70.5 |
| 6. | Information regarding crop rotation | 111 | 55.5 |
| 7. | Information regarding picking of cotton | 31 | 15.5 |

The data presented in Table 4 indicated that the majority of the respondents (84.5 per cent) obtained information about the methods of application and doses of fertilizers. While 80.5 per cent got information regarding selection, concentration and methods of application of insecticides/fungicides. Out of 200 farmers, 14.5 per cent got information regarding purchase of new improved implements for cultivation and their use. While 56.0 per cent respondents had taken advantages by learning scientific cultivation methods for hybrid seed production. About 70.0 per cent and 55.5 per cent respondents took

advantages of knowing irrigation practices for the crop and information regarding crop rotation, respectively.

The conclusions emerging from this study indicated that out of 200 cotton growers 86.5 per cent has perceived the Cotton Research Station useful as an information centre. Similarly 89.5 per cent perceived that the cotton research station, Surat as a source of inspiration for adoption of improved farm practices. With regard to awareness of cotton growers, about the activities being carried out at the station was expressed by 61.0 per cent

farmers know about organization of farmers' day at the station.

But only 9.0 per cent, 13 per cent and 18 per cent respondents knew regarding the research activities of evolving improved varieties, improvement of quality of cotton and finding suitable plant protection measures respectively. This indicated that the main aim of the Cotton Research Station is to breed better cotton varieties and to develop appropriate technology of its cultivation was not known by the majority of the respondents, therefore, it is suggested that the authority of the Cotton Re-

search Station and extension agency will have to exert more in order to aware the farming community regarding the research activities being carried out at the Research Station and being technological change in cotton growing area.

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Use of Non-Parametric Tests in Extension Education

Arun A. Patel* M. N. Popat and P. P. Patel

Department of Extension Education, Gujarat Agricultural University, Ahmedabad

ABSTRACT

Non-Parametric Statistical tests are very useful in extension research. Therefore, to study the extent of utilization of such non-parametric tests in extension research published in different journals was carried out. In extension research, 18.57% articles were found with the use of non-parametric statistical tests. The X^2 test is most popular and used 71.79% from the total use of non-parametric tests. The other non-parametric tests were used scantily. The use of non-parametric tests in different journals, years and areas of extension education were found homogeneous.

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INTRODUCTION

In extension education research, one has to deal with different heterogeneous population, varied sample size, weak assumption about the nature of distribution, lack of an adequate scale and so on. In such situation, the advantages of non-parametric statistical tests (NPT) are : (1) If sample sizes as small as $N=6$ are used, there is no alternative to use a non-parametric statistical test unless the nature of the population distribution is known exactly. (2) There are suitable NPT for treating samples made up of observations from different populations. (3) NPT can treat the data which are simply classificatory. (4) NPT are available to treat data which are inherently in ranks as well as data whose seemingly numerical scores have the strength of ranks. (5) Probability statements obtained from most NPT are exact probabilities (except in the case of large samples, where excellent approximations are available).

regardless of the shape of population distribution from which the random sample was drawn. (6) NPT are easy to learn and apply. Thus, in extension education research, NPT help in great extent. However, at what extent researchers are preferring/using the NPT is matter of study.

MATERIALS AND METHODS

Out of different journals of extension education two journals i.e. (1) Indian Journal of Extension Education (IJ) and (2) Maharashtra Journal of Extension Education (MJ) were found related to extension education and all most all articles published in these journals were of research base. Hence, these two journals were finally selected for study. Amongst these journals the volume published during 1981 to 1988 of IJ and volume published during 1985 to 1988 of MJ were selected to study, as they were available at source.

*Present address : Associate Extension Educationist, Directorate of Extn. Edn., Gujarat Agril. University, Ahmedabad



The classification of the research articles published in IJ during 1981 to 1987 in different areas of extension education is available in IJEE, Vol. XXIII, 1987 which was taken as base to study the use of NPT in respected area of extension education in proportion with the total articles in that area of extension education.

To test the homogeneity of proportion between; the research articles published and the number of articles with NPT, use of NPT in IJ and MJ, use of NPT in different years, use of NPT in different areas of extension education, the X^2 (Chi-square) test was used.

The percentage were also calculated for the different comparisons and ranks were also given according to the percentages.

RESULTS AND DISCUSSION

1. Use of NPT in IJ

Out of 255 research articles studied, 42 (16.17%) research articles were found with the use of NPT in IJ. Whereas 25 (17.60%) research papers (RP) and 17(15.04%) research notes (RN) were found with the use of NPT, out of 142 and 113 research papers and research notes published respectively. However, the X^2 value for the homogeneity (Table-1) in different years were found non-significant. Thus, the research papers, research note and total articles published in IJ during the different years have a proportionate use on NPT.

TABLE 1

Use of NPT in IJ.

| Year | Research Paper | | Research Note | | Articles (Total) | |
|---------------|----------------|----------|---------------|----------|------------------|----------|
| | Published | NPT used | Published | NPT used | Published | NPT used |
| 1981 | 21 | 4 | 11 | 4 | 32 | 8 |
| 1982 | 19 | 4 | 10 | 1 | 29 | 5 |
| 1983 | 20 | 3 | 14 | 3 | 34 | 6 |
| 1984 | 14 | 5 | 15 | 2 | 28 | 7 |
| 1985 | 23 | 0 | 17 | 3 | 40 | 3 |
| 1986 | 21 | 3 | 12 | 2 | 33 | 5 |
| 1987 | 17 | 4 | 24 | 1 | 41 | 5 |
| 1988 | 7 | 2 | 11 | 1 | 18 | 3 |
| Total | 142 | 25 | 113 | 17 | 255 | 42 |
| Percentage | | 17.60% | | 15.04% | | 16.47% |
| X^2 - Value | | 6.92 | | 5.04 | | 4.40 |

2. Use of NPT in MJ

Out of 165 research articles of MJ, 36(21.81%) were found with the use of NPT. Similarly, out of 103 and 62 RP and RN published, 26(25.24%) and 10(16.12%) were found with the use of NPT, respectively. The X^2 test

for the homogeneity (Tabel-2) for the different years were found non-significant. Thus, the research papers, research notes and total articles published in MJ during the different years have proportionate use of NPT.

TABLE 2

Use of NPT in MJ.

| Year | Research Papers | | Research Note | | Article (Total) | |
|------------|-----------------|----------|---------------|----------|-----------------|----------|
| | Published | NPT used | Published | NPT used | Published | NPT used |
| 1985 | 23 | 9 | 10 | 0 | 33 | 9 |
| 1986 | 24 | 4 | 12 | 3 | 36 | 7 |
| 1987 | 31 | 9 | 13 | 2 | 44 | 11 |
| 1988 | 25 | 4 | 27 | 5 | 52 | 9 |
| Total | 103 | 26 | 62 | 10 | 165 | 36 |
| Percentage | | 25.24% | | 16.12% | | 21.81% |
| X^2 | | 2.728 | | 2.165 | | 1.008 |

3. Use of NPT in RP and RN

The X^2 value for the homogeneity for the use of NPT between RP and RN was found

non-significant. Thus, the use of NPT in research papers and research notes (published in both journals) was homogenous (Table-3).

TABLE 3

Use of NPT in RP and RN.

| Detail | RP/RN published | RP/RN with use of NPT |
|----------------|-----------------|-----------------------|
| Research paper | 245 | 51 |
| Research Note | 175 | 27 |
| Total | 420 | 78 |
| X^2 value | 1.35 | |

4. Use of NPT in IJ and MJ

Out of 420 articles published in IJ and MJ, 78 (18.17%) articles were found with use of NPT. The X^2 for the homogeneity between two

journals in respect of the use of NPT were found non-significant. Thus, the use of non-parametric tests in both the journals were homogenous (Table-3).

TABLE 4

Use of NPT in IJ and MJ.

| Name of Journals | Research paper | | Research Note | | Total Article | |
|------------------|----------------|----------|---------------|----------|---------------|----------|
| | Published | NPT used | Published | NPT used | Published | NPT used |
| IJ of EE | 142 | 25 | 113 | 17 | 255 | 42 |
| MJ of EE | 103 | 26 | 62 | 10 | 165 | 36 |
| Total | 245 | 51 | 175 | 27 | 420 | 78 |
| Percentage | | 20.81% | | 15.42% | | 18.57% |
| X^2 value | | 1.372 | | 0.026 | | 1.2891 |

5. Use of NPT in different years

The X^2 value 1.37 was found non-significant for the use of NPT during the years

1981 to 1988. Thus, the use of NPT for the different years were homogenous (Table-5).

TABLE 5

Use of NPT in different years.

| Year | Number of Articles | | percentage |
|-------------|--------------------|----------|------------|
| | Studied | NPT used | |
| 1981 | 32 | 8 | 25.00 |
| 1982 | 29 | 5 | 17.24 |
| 1983 | 34 | 6 | 17.65 |
| 1984 | 28 | 7 | 15.00 |
| 1985 | 73 | 12 | 16.94 |
| 1986 | 69 | 12 | 17.39 |
| 1987 | 85 | 16 | 18.82 |
| 1988 | 70 | 12 | 17.14 |
| Total | 420 | 78 | 18.57 |
| X^2 value | | 1.370 | |

6. Use of different NPT

Only nine types of NPT were used in the journals. Out of which, the X^2 test was used most frequently, i.e. about 71.79% from the total used of NPT. Whereas Kendall Co-efficient of Concordance was used about 10.26% at second rank. At third rank, Spearman Rank Correlation was used about 5.15%. Further, the tests i. e. :

- (1) Wilcoxon matched-pairs signed rank test
- (2) Median test
- (3) Mann-Whitney 'U' test
- (4) Kolmogorov-Smirnov two sample test
- (5) Kolmogorov — Smirnov one sample test
- (6) Kandal Rank Correlation were used scantily.

The other NPTs e.g. (1) Binominal test (2) One sample rank test (3) Mc. Neman test for the significant of changes (4) Sign test (5) Walsh test (6) Randomization test for

matched pairs (7) Fisher exact probability test (8) Walswol-fowitz test (9) Moses test of extreme reactions (10) Cochran Q test (11) Friedman two-way analysis of variance by ranks (12) Contengenes Coefficient etc. were not found used at all during the survey (Table-6).

7. Use of NPT in different areas of extension education

The total articles published in different areas in Indian Journals of Extension Education during 1981 to 1988 and out of it the articles in which NPT used were compared proportionately. The X^2 value 11.92 was found non-significant. Thus, the use of NPT in different areas of extension education was homogeneous. However, NPT were used 36.36% in the area of 'Special Group' at first rank, whereas in the area of 'Diffusion and Adoption of Innovation' 23.19% articles were with the use of NPT at second rank (Table-7).

TABLE 6

Use of different NPT.

| Area of work | χ^2 Test | Kendall co-
efficient of
concordance
'W' | Spearman
rank co-
relation
co-efficient | Wilcoxon
matched
pairs
signed
rank test | Median
test | Mann
Whitney
'U'
Test | Kolmogorv
Two sample
test | Smirnov
One sample
test | Kendal
rank
correlation
coefficient |
|--|---------------|---|--|---|----------------|--------------------------------|---------------------------------|-------------------------------|--|
| 1. Agril. Communication | 12 | 1 | 1 | — | — | — | — | — | — |
| 2. Agril. Education | — | 1 | — | — | — | — | — | — | — |
| 3. Diffusion and Adoption
of Innovation | 17 | 3 | 2 | 1 | — | 2 | 2 | 1 | 1 |
| 4. Extension Management | 2 | 2 | — | — | 1 | — | — | — | — |
| 5. Programme planning | 7 | — | — | — | — | — | — | — | — |
| 6. Research Methodology | — | 1 | — | — | — | — | — | — | — |
| 7. Rural Institutions | 1 | — | — | — | — | — | — | — | — |
| 8. Special Groups | 13 | — | 1 | 1 | 1 | — | — | — | — |
| 9. Training | 3 | — | — | — | — | — | — | — | — |
| 10. Others | 1 | — | — | — | — | — | — | — | — |
| Total Articles | 56 | 8 | 4 | 2 | 2 | 2 | 2 | 1 | 1 |
| Percentage | 71.79 | 10.26 | 5.15 | 2.56 | 2.56 | 2.56 | 2.56 | 1.28 | 1.28 |
| Rank | I | II | III | IV | IV | IV | IV | V | V |

TABLE 7

Use of NPT in different areas of extension education.

| Area of work | No. of Articles | | Percentage | Rank |
|---|--------------------|----------|------------|------|
| | Published
in IJ | NPT used | | |
| 1. Agril. Communication | 44 | 9 | 20.45 | 3 |
| 2. Agril. Extension | 12 | 1 | 8.33 | 6 |
| 3. Difference and Adoption of
Innovation | 69 | 16 | 23.19 | 2 |
| 4. Extension Management | 44 | 4 | 9.09 | 5 |
| 5. Programme Planning | 21 | 2 | 9.52 | 4 |
| 6. Research Methodology | 9 | — | 0.00 | 9 |
| 7. Rural Institutions | 12 | 1 | 8.33 | 7 |
| 8. Special groups | 22 | 8 | 36.36 | 1 |
| 9. Training | 18 | 1 | 5.56 | 8 |
| 10. Others | 4 | — | 0.00 | 10 |
| Total : | 255 | 42 | 16.47 | — |
| X ² Value | | 11.92 | — | — |

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Prediction of Area Under Castor Crop in the Major Castor Growing Districts of Gujarat State

M. K. Chaudhari and N. M. Patel

Department of Agril. Statistics, B. A. College of Agriculture, Gujarat Agricultural University, Anand Campus, Anand-388 110

ABSTRACT

The crop statistics for the period 1965-66 to 1986-87 showed increasing trend in the area and production of castor crop in Gujarat. More than 85 per cent of the total castor area in Gujarat is shared by Ahmedabad, Banaskantha, Mehsana, Saarkantha and Kutch districts. Analysis showed that lag one year area under castor crop had positive significant influence on castor area. The other important variables influencing castor area are lag one year harvest price of castor for Ahmedabad, Mehsana and Sabarkantha districts, relative profitability of castor over cotton for Mehsana district, lag one year productivity and variation in castor price for Ahmedabad district; total rainfall for Kutch district and lag one year Jower area for Banaskantha district. The precised prediction equations were developed for predicting castor area in major castor growing districts of Gujarat State.

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INTRODUCTION

Castor (*Ricinus communis*, L.) is one of the important oilseed crops grown in arid and semi-arid areas of the country. It is one of the important hard currency earners for the

country. India is the second largest producer after Brazil and accounts for nearly 25 per cent of the total world castor production (George *et al.* 1985). In India this crop is grown in Andhra Pradesh, Gujarat, Orissa, Karnataka and Tamil Nadu (Table 1).

TABLE 1

Area ('000 ha), production ('000 tonnes) and productivity (kg/ha) of castor for the year 1986-87.

| State | Area | Production | Productivity |
|----------------|-------|------------|--------------|
| Andhra Pradesh | 270.3 | 53.1 | 196 |
| Gujarat | 208.8 | 129.3 | 619 |
| Orissa | 34.8 | 18.5 | 532 |
| Karnataka | 28.1 | 23.0 | 818 |
| Tamil Nadu | 21.6 | 6.6 | 306 |
| India | 592.2 | 236.6 | 400 |

Source : Agricultural situation in India, Vol. 43 (2) : 187.

The cultivation of castor in Gujarat is largely concentrated in North Gujarat and Kutch regions covering Ahmedabad, Banaskantha, Mehsana, Sabarkantha and Kutch districts (Fig. 1), which accounted for more than 85 per cent and about 90 per cent production. Castor is a drought tolerant crop. Area statistic of this crop in Gujarat State (Table 2) shows

continuous increasing trend (2.18 per cent). The present study was therefore undertaken (i) to study the influence of price and non-price variables on hectareage of castor crop in five major castor growing districts of Gujarat State and (ii) to develop hectareage response model for castor crop based on price and non-price variables.

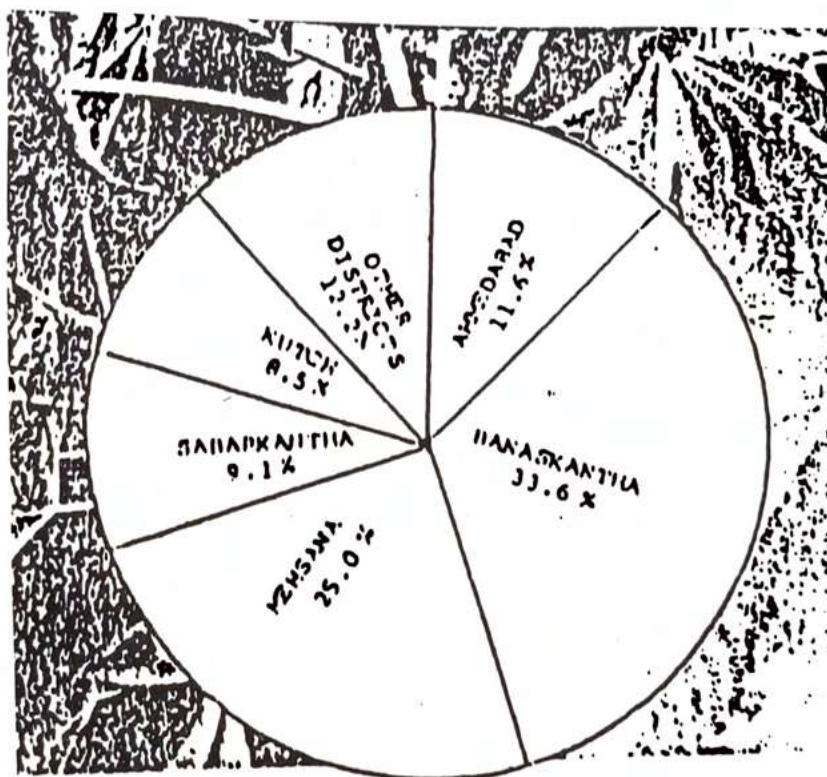


Fig. 1: Castor growing area in Gujarat.

TABLE 2

Area ('00 ha) under castor crop in five districts and Gujarat State for the period 1965-66 to 1986-87.

| Year | Ahmedabad | Banaskantha | Mehsana | Sabarkantha | Kutch | Gujarat |
|---------|-----------|-------------|---------|-------------|-------|---------|
| 1965-66 | 25 | 145 | 206 | 35 | 63 | 555 |
| 1970-71 | 23 | 166 | 157 | 44 | 103 | 577 |
| 1975-76 | 38 | 314 | 323 | 41 | 108 | 938 |
| 1980-81 | 147 | 490 | 585 | 120 | 242 | 1810 |
| 1985-86 | 218 | 679 | 650 | 220 | 322 | 2399 |
| 1986-87 | 243 | 705 | 521 | 189 | 177 | 2088 |

Source : Season and crop reports, Directorate of Agriculture, Gujarat State, Ahmedabad.

MATERIALS AND METHODS

The data on area, production, productivity and harvest price of castor as well as competitive crops (cotton, bajri and jowar) and rainfall for the period 1965-66 to 1986-87 were collected from the Directorate of Agriculture, Gujarat State. These data were used to derive variables like lag area, lag year productivity, lag year price, risk variables (worked out by standard deviation), relative risk variables (worked out by C.V.%) and ratio type variables (relative profitability). The data were subjected to regression analysis including step-wise regression.

RESULTS AND DISCUSSION

The results (Table 2) indicated that the area under castor crop in Gujarat State has increased from 55,500 ha in 1965-66 to 2,08,800 ha in 1986-87 (i.e. 3.8 times). During the same period, the increase in area under castor was from 2500 ha to 24,300 ha in

Ahmedabad district (9.7 times), from 14,500 ha to 70,500 ha in Banaskantha district (4.9 times), from 20,600 ha to 52,100 ha in Mehsana district (2.5 times), from 3500 ha to 18,900 ha in Sabarkantha district (4.5 times), from 6300 ha to 17,700 ha in Kutch district (2.8 times). The increasing trend in crop area could be attributed to increased demand of oil in national as well as international market and low risk in cultivation of crop being drought tolerant (George *et al.*, 1985).

The correlation analysis revealed that the area under castor crop in current year (CA_t) was significantly influenced by the lag one year area under castor (CA_{t-1}) in all the districts (Table 3). The trend was linear ($r < 0.90$). These results are akin to those reported by Boom-Raung *et al.* (1971) and Acharya and Bhatiya (1974). Similarly CA_t had positive significant association with lag one year castor price (CP_{t-1}) and productivity of castor in lag one year (CY_{t-1}).

TABLE 3

Estimates of correlation coefficients between area under castor (CA_t) and other variables.

| Variables | Ahmedabad | Banaskantha | Mehsana | Sabarkantha | Kutch |
|---------------|-----------|-------------|-----------|-------------|----------|
| CA_{t-1} | 0.9602** | 0.9725** | 0.9630** | 0.9220** | 0.7493** |
| CY_{t-1} | 0.5853** | 0.8803** | 0.8054** | 0.5319* | 0.1189 |
| CP_{t-1} | 0.9160** | 0.8412** | 0.8455** | 0.8883** | 0.6537** |
| $C\hat{O}P_t$ | 0.5949** | 0.5734** | 0.4114 | 0.7793** | 0.2098 |
| $B.A_{t-1}$ | -0.5433** | -0.6118** | -0.7097** | -0.4304* | -0.1915 |
| $CO.A_{t-1}$ | -0.4679* | — | -0.5326* | -0.2580 | — |
| $CO.Y_{t-1}$ | -0.1790 | — | 0.0992 | -0.7428** | — |
| $CO.P_{t-1}$ | 0.8664** | — | 0.8845** | 0.7738** | — |
| $J.A_{t-1}$ | — | -0.2304 | — | — | — |
| $J.P_{t-1}$ | — | 0.8367** | — | — | — |
| RT | 0.0641 | -0.0700 | 0.1035 | -0.1101 | 0.3362 |

Legend : * and ** indicate significant at 5 and 1 per cent level of significance respectively.

The latter was not significant for Kutch district. The CA_t had negative association with area under bajra crop in previous year (BA_{t-1}). Like Bajra, cotton in Ahmedabad, Mehsana and Sabarkantha district and jowar in Banaskantha district were the competing crops for castor crop.

The results (Table 3) showed that some of variables had no significant impact or low

effect on CA_t indicating that inclusion of such variables in models may not be much useful from simplicity as well efficiency view points. The step-wise regression analysis helps in determining appropriate model. The following prediction models for major castor growing districts were obtained through step-wise regression analysis having high predictability (as well as simplicity).

| District | Model | | | | | | R^2 |
|-------------|--------------|---|------------|------------|---|------------|-------|
| Ahmedabad | $\hat{CA}_t$ | = | 0.7045 | CA_{t-1} | + | 0.2896 | 0.96 |
| | | | (0.0927) | | | (0.0673) | |
| Banaskantha | $\hat{CA}_t$ | = | 0.9852 | CA_{t-1} | - | 0.2054 | 0.96 |
| | | | (0.0472) | | | (0.0772) | |
| Mehsana | $\hat{CA}_t$ | = | 0.7916 | CA_{t-1} | + | .0954 | 0.95 |
| | | | (0.0726) | | | (0.0310) | |
| Sabarkantha | $\hat{CA}_t$ | = | 0.6168 | CA_{t-1} | + | .2562 | 0.93 |
| | | | (0.0951) | | | (0.0518) | |
| Kutch log | $\hat{CA}_t$ | = | 0.7370 log | CA_{t-1} | + | 0.4890 log | 0.75 |
| | | | (0.1143) | | | (0.1185) | |

(Note : Figures in parentheses given with each equation indicate S.E. of regression coefficient)

$\hat{CA}_t$ = Predicted castor area in the year 't' ('00 ha)

CA_{t-1} = Actual castor area in the year 't-1' ('00 ha)

CY_{t-1} = Productivity of castor in the year 't-1' (kg/ha)

CP_{t-1} = Harvest price of castor in the year 't-1' (Rs/q)

JA_{t-1} = Jowar area in the year 't-1' ('00 ha)

R_t = Total rainfall in the year 't' (mm)

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Prediction of Leaf Area Index of Cotton Hybrid 4 Using Non-Destructive Variables

V. B. Darji and N. M. Patel

Department of Agril. Statistics, B. A. College of Agriculture, Gujarat Agricultural University, Anand Campus, Anand

ABSTRACT

A model for predicting leaf area index of cotton hybrid 4 is developed using non-destructive type of variables. The commercial crop was grown at 120 cm x 60 cm spacing. The number of leaves per plant (NOL), leaf weight (LW) and leaf area index (LAI) showed quadratic trend due to stages of measurement (days after sowing, D). The equation derived was $LAI = 0.5595 + 0.0085 NOL - 0.0098 D$. It accounted 92 per cent variation in LAI.

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INTRODUCTION

Leaf Area Index (LAI) is one of the important crop growth parameters having direct positive influence on crop yield. It could also be utilized to determine total vegetation of the crop like cotton for which insecticidal spray has become a must. Knowing the total vegetation, one can estimate precisely the quantity of insecticides to be sprayed at a given growth stage of the crop and thereby minimise cost of production as well as pollution. The estimation of LAI consumes lot of time. While generating information on LAI one has to pluck all the leaves of plants which result into poor plant growth affecting crop yield. An attempt was made to develop a statistical model to predict LAI based on variables which are non-destructive in nature.

MATERIALS AND METHODS

Cotton Hybrid 4 was planted in about 0.15 hectare at 120 cm x 60 cm spacing during 1985-86 at the Plant Breeding Research Farm, GAU, Anand. The crop cultivation practices including plant protection measures in vogue were followed. The cropped field was divided into four blocks. Each block was divided into nine plots for collecting observations at nine growth stages of crop (30, 45, 60, 75, 90, 120, 150, 180 and 210 days after sowing). At each stage, four plots (one from each block) were selected at random for the purpose. The competitive plants from these plots were cut from ground level and brought to the laboratory. The leaves of each plant were plucked and total leaf area per plant was determined using automatic Leaf Area Meter (Model LI 3000; accuracy $\pm 2\%$).

The LAI was worked out by taking ratio of total leaf area per plant to the total area of the ground surface per plant (Watson, 1958). The green leaf weight (leaf weight) of all the leaves of each plant was recorded in gramme (g) after completing leaf area measurement.

RESULTS AND DISCUSSION

The results (Table 1) showed significant variation in number of leaves per plant (NOL), Leaf area (LA), Leaf area index (LAI) and Leaf weight (LW) due to stages of measurement. The mean values of each character increased upto 120 days of sowing, then after they

showed decreasing trend. These results are akin to those reported by Anonymous (1985-86) and El-Shaer *et al.*, (1979). The inter-character association indicated that the LAI had positive significant high association with NOL ($r = 0.8596$) and LW ($r = 0.9912$), while its association with time trend (stages of measurement) was positive but not significant ($r = 0.2550$).

Further analysis showed that linear as well as quadratic effects were significant for NOL due to stages of measurement. The response model accounted 84 per cent variation in NOL. The LA, LAI and LW showed significant quadratic trend accounting 76, 76

TABLE 1

Mean values of various characters of Cotton Hybrid 4.

| Stages
(days after
sowing) | No. of
plants
studied | Number
of
leaves | Leaf area
(sq. cm.) | Leaf area
index | Leaf weight
(g) |
|----------------------------------|-----------------------------|------------------------|------------------------|--------------------|--------------------|
| D | | NOL | LA | LAI | LW |
| 30 | 38 | 8.7 | 321 | 0.04 | 7.9 |
| 45 | 32 | 34.7 | 2015 | 0.28 | 43.4 |
| 60 | 31 | 121.0 | 8045 | 1.12 | 166.6 |
| 75 | 30 | 135.2 | 8411 | 1.17 | 190.0 |
| 90 | 20 | 218.4 | 14553 | 2.02 | 336.4 |
| 120 | 16 | 477.7 | 25644 | 3.56 | 681.0 |
| 150 | 16 | 277.0 | 13046 | 1.81 | 359.4 |
| 180 | 16 | 225.0 | 8604 | 1.19 | 244.0 |
| 210 | 16 | 165.0 | 3068 | 0.63 | 140.6 |
| Trend | Linear | * | NS | NS | NS |
| | Quadratic | ** | ** | ** | ** |
| | b1 | 9.25 | 529.3 | 0.074 | 13.55 |
| | b2 | -0.03 | -2.1 | -0.0003 | -0.05 |
| | R ² | 0.84 | 0.76 | 0.76 | 0.74 |

Legend : * and ** indicate significant at 5 and 1 per cent level respectively.

and 74 per cent variation respectively. The LAI showed significant quadratic response due to stages of measurement (D) with $R^2 = 76$ per cent. The leaf weight could be utilized for predicting LAI with very high predictability ($R^2 = 98$ per cent). But leaf weight is destructive type of variable. For improving efficiency of prediction, two variables (NOL and D) were used in generating prediction model for LAI. The equation obtained was $\hat{LAI} = 0.5595 + 0.0085 \text{ NOL} - 0.0098 \text{ D}$ ($R^2 = 92$ per cent).

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The R^2 for this equation is quite high. The other advantages of this prediction model is that it is based on non-destructive type of variables. It involves number of leaves per plant at D days after sowing of crop. Both variables could be counted easily even by farmers. Similar results were reported by Hunsigi (1976).

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Clinico-Biochemical Changes in Experimental Hypocalcaemia in Male Buffalo Calves

R. G. Jani, G. C. Mandali and M. R. Dave

Department of Medicine, Veterinary College, Gujarat Agricultural University, Anand

ABSTRACT

Clinical response and biochemical changes induced by intravenous administration of 0.47% Na₂ EDTA were studied in male buffalo calves. The hypocalcaemia was produced within 50 to 65 min. after infusion of 560 to 600 ml of 0.47% Disodium EDTA. The illness lasted for 40 to 55 min. The symptoms included extreme weakness of hind quarters, inability to stand, recumbency, muscular twitching, restlessness leading to comatose stage. Serum calcium fell down from 9.520 ± 0.0254 to 5.820 ± 0.097 mg/dl, and inorganic phosphorus from 6.466 ± 0.304 to 4.124 ± 0.319 mg/dl. Increase in blood glucose level from 60.00 ± 8.367 to 120.00 ± 12.247 mg/dl was also recorded. Serum magnesium level was within normal range.

(Received on 28th June, 1991)

INTRODUCTION

Disturbances of calcium homeostasis that produce an abnormally low serum calcium concentration are encountered frequently about the time of parturition in dairy animals and complicated by metabolic factors other than hypocalcaemia (Blood *et al.*, 1989). To have a proper understanding of the pathogenesis of the hypocalcaemia a detailed knowledge of the clinical and biochemical response is most needed. Present study describes the clinico- biochemical response of experimental hypocalcaemia in male buffalo calves.

MATERIAL AND METHODS

Five healthy male buffalo calves of about six to eight months of age and weighing about 80 kg were selected and maintained. As a control study each animal was given a slow intravenous infusion of 500 ml of normal saline solution (0.9%). After this infusion animals were rested for five days.

Hypocalcaemia was induced in each animal by slow intravenous infusion of 0.47% Disodium Ethylene Diamine Tetra Acetate (Na₂ EDTA) until characteristic sign (recumbent - comatose) of hypocalcaemia was observed. The course of disease with clinical signs was

recorded. Blood samples from calves were collected at 0, 1, 2, 4, 6, 8, 10 and 24 hours intervals for biochemical estimations. Serum calcium was estimated as described by Webster (1962). Serum inorganic phosphorus and serum magnesium were estimated as described by Varley (1969). Blood glucose was estimated as per Frankel *et al.* (1970).

RESULTS AND DISCUSSION

Clinical symptoms appeared 50 to 65 minutes of infusion of 560 to 600 ml of 0.47% Na₂ EDTA. Salivation, frequent urination and shallow respiration were observed within 20 minutes of infusion. Uneasiness, restlessness, muscular twitching of shoulder and thigh muscles, paddling movement, dribbling of urine, defecation, laboured breathing, sternal recumbency with a latral kink of the neck and comatosed condition were recorded in all calves within 40 to 50 min. post infusion. Affected calves remained in comatosed condition upto 40 to 55 min. and were able to get up with slight staggering thereafter. They recovered within 8 to 10 hours. Similar observations in induced hypocalcaemia by the same method have been recorded in calves by earlier workers (Ramberg *et al.*, 1967; Pandey and Dwivedi, 1988).

Biochemical changes observed in hypocalcaemia are depicted in figure 1. The mean serum calcium concentration decreased from 9.520 ± 0.254 to 5.820 ± 0.097 mg/dl at two hour and remained so upto four hours ($P < 0.05$). Pandey and Dwivedi (1988) also recorded significant decrease in serum calcium

in cow calves at 82 min. post infusion of 5% Na₂ EDTA. In the present study the serum calcium gradually increased to almost pre-experimental values after 8 hours of withdrawal of EDTA infusion. Serum inorganic phosphorus level decreased from 6.466 ± 0.304 to 4.124 ± 0.319 mg/dl. The present results of decrease in serum inorganic phosphorus level are in agreement with the findings of Pandey and Dwivedi (1988). Serum magnesium level was within normal range. Blood glucose level increased from $60.00 \pm 8.36\%$ to $120.00 \pm 12.24\%$ mg/dl indicating hyperglycaemia during hypocalcaemic stage. Hayashi *et al.* (1979) also observed hyperglycaemia in cows suffering from milk fever. He opined that low level of calcium decreased secretion of insulin and increase in plasma cortisol with free fatty acids and glucose level. Cows with milk fever are in fact diabetes mellitus like condition due to inability to release insulin (Littledike *et al.*, 1969, Blum *et al.*, 1973).

The control calves infused with normal saline solution (0.9%) remained healthy during the study. Their biochemical parameters of various intervals did not show any significant alteration.

In the present study calcium, inorganic phosphorus concentration and clinical symptoms were similar to those of natural cases of milk fever. Further, this study also indicated hyperglycaemic stage during hypocalcaemia. The study showed the utility of calves in place of dairy buffaloes for undertaking basic studies on clinical conditions attributable to hypocalcaemia.

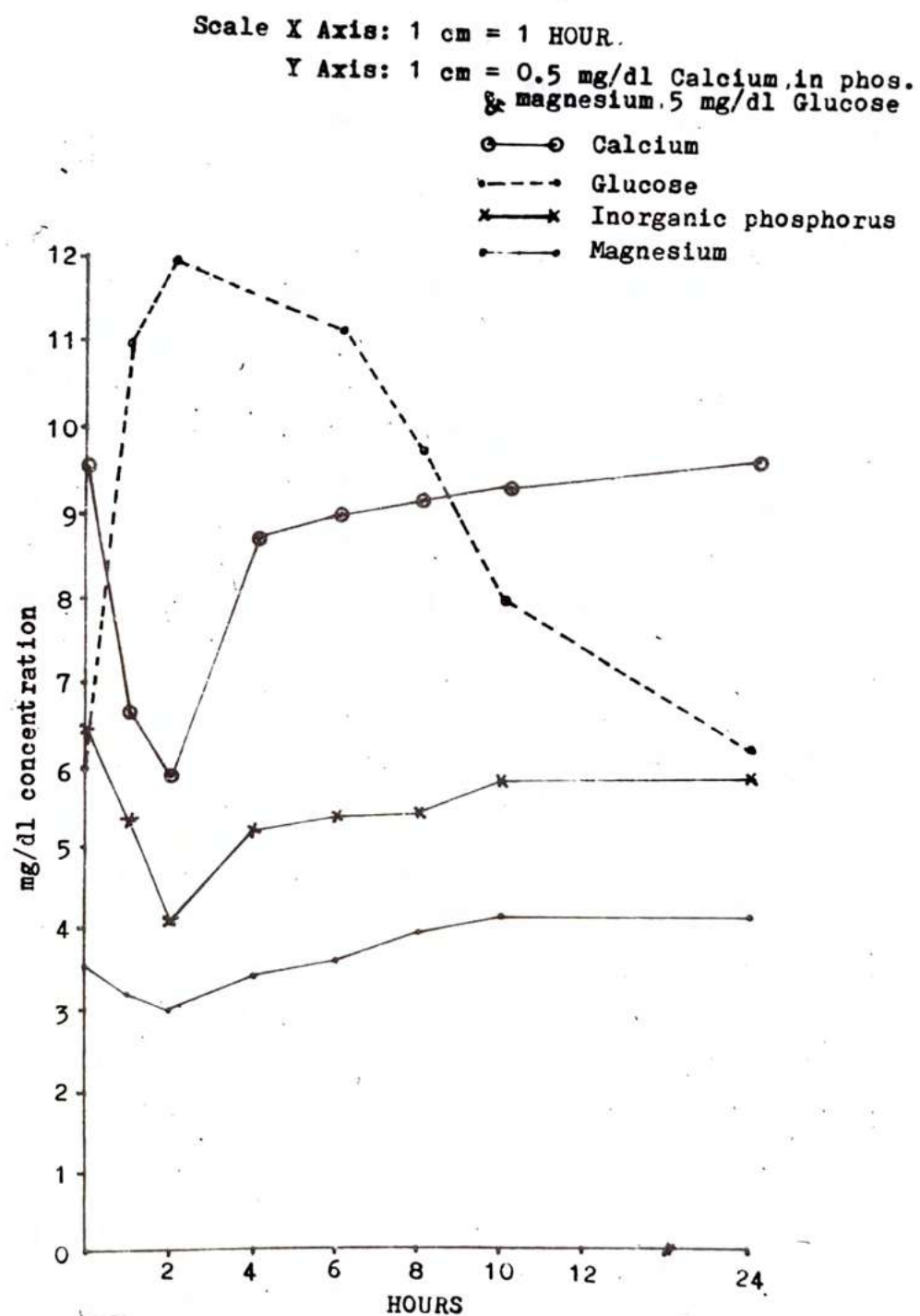


Fig. 1 : Biochemical changes in experimental hypocalcaemia in buffalo calves.

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Chemical Composition of the Haulms of Different Groundnut Varieties of Gujarat

P. R. Pandya, P. M. Talpada and D. R. Vashi

Animal Nutrition Department, Gujarat Agricultural University, Anand Campus, Anand (Gujarat) 388 110

ABSTRACT

Groundnut haulms, a byproduct of legume crop was found to be rich in protein and calcium and to some extent in phosphorus. The average chemical composition of groundnut haulm was 8.5% crude protein, 2.2% ether extract, 31.5% crude fibre, 45.1% nitrogen free extract, 12.7% ash, 4% silica, 0.5% phosphorus and 1.5% calcium. The DM, crude protein and calcium yields (kg/hectare) were found to be higher (12674.00, 1083.62 and 176.16 respectively) in SEL 7-95. Out of ten different varieties, SG 84 contained highest crude protein (9.6%) and lowest crude fibre (27.6%).

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INTRODUCTION

Groundnut haulms, leaves and plant constitute good fodder when green or can be used as dry fodder. Because of the shortage of fodder and periodical droughts at regular intervals, groundnut haulms can be used as a source of dietary fibre to the animals.

MATERIALS AND METHODS

Haulms of ten groundnut varieties were procured from the Plant Breeding Department of Anand Campus of Gujarat Agricultural University and marked as individual treatment namely T₁ (ICGV 87189), T₂ (ICGV 87191), T₃ (ICGV 86309), T₄ (SG 84), T₅ (SEL 7-95), T₆ (J-19), T₇ (J-22), T₈ (J-11 NC), T₉ (ICG 44 NC) and T₁₀ (GC-2 LC). Quadruplicate samples of the haulms of each groundnut variety were analysed for moisture, crude protein, ether extract, crude fibre, Ash and silica following

AOAC (1975) and the phosphorus and calcium by ISI (1975) method. Statistical analysis of the data was carried out as per procedures of Snedecor and Cochran (1968).

RESULTS AND DISCUSSION

Chemical composition

The average values of various constituents have been presented in Table 1. The average crude protein content of the haulms of different groundnut varieties were ranging from 7.49% (J-19) to 9.58% (SG 84) ($P < 0.05$). These results are in close agreement with the values reported by Krishnamohan *et al.* (1985); while higher values of crude protein levels have been reported by Rao and Mathur (1971).

The haulms of different varieties of groundnut contained 1.67% (GC-2 LC) to 2.69% (J-11 NC) ether extract. The treatment differences were observed to be

TABLE 1

Average chemical composition of haulms of different groundnut varieties (g per 100 g DM).

| Constituents | Groundnut varieties | | | | | | | | | | Average |
|--------------|---------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | ICGV
87189 | ICGV
87191 | ICGV
86309 | SG
84 | SEL
7-95 | J
19 | J
22 | J-11
NC | JCG-44
NC | GC-2
LC | |
| C. protein | 8.86
± 0.36 | 8.40
± 0.25 | 8.04
± 0.25 | 9.58
± 0.67 | 8.55
± 0.40 | 7.49
± 0.36 | 7.70
± 0.22 | 8.34
± 0.23 | 9.34
± 0.47 | 8.86
± 0.24 | 8.50
± 0.20 |
| E. extract | 2.54
± 0.19 | 2.20
± 0.08 | 2.43
± 0.11 | 2.42
± 0.22 | 1.92
± 0.16 | 2.16
± 0.19 | 2.14
± 0.22 | 2.69
± 0.18 | 2.29
± 0.17 | 1.67
± 0.18 | 2.24
± 0.08 |
| C. Fibre | 29.51
± 1.18 | 31.02
± 0.94 | 31.34
± 1.30 | 27.56
± 0.55 | 31.23
± 1.11 | 32.98
± 0.96 | 31.73
± 1.27 | 33.66
± 1.26 | 30.92
± 0.95 | 35.01
± 0.43 | 31.49
± 0.63 |
| NFE | 46.15
± 1.50 | 44.83
± 0.70 | 46.22
± 1.33 | 47.33
± 0.51 | 43.71
± 1.53 | 45.71
± 0.78 | 46.63
± 1.32 | 43.72
± 1.00 | 44.17
± 1.40 | 42.99
± 1.27 | 45.09
± 0.42 |
| Ash | 12.94
± 0.88 | 13.55
± 1.37 | 11.97
± 0.52 | 13.11
± 0.59 | 14.59
± 2.31 | 11.66
± 0.65 | 11.80
± 0.44 | 11.59
± 1.01 | 13.28
± 0.53 | 11.47
± 0.97 | 12.68
± 0.30 |
| Silica | 4.61
± 0.99 | 5.17
± 1.40 | 3.18
± 0.30 | 4.91
± 0.32 | 5.82
± 2.10 | 2.67
± 0.27 | 3.67
± 0.72 | 2.52
± 0.53 | 3.84
± 0.60 | 2.98
± 0.74 | 3.94
± 0.24 |
| P | 0.46
± 0.99 | 0.41
± 0.02 | 0.45
± 0.05 | 0.35
± 0.01 | 0.42
± 0.04 | 0.67
± 0.05 | 0.61
± 0.02 | 0.51
± 0.02 | 0.46
± 0.01 | 0.55
± 0.05 | 0.49
± 0.29 |
| Ca | 1.38
± 0.02 | 1.45
± 0.05 | 1.62
± 0.12 | 1.40
± 0.09 | 1.39
± 0.06 | 1.68
± 0.14 | 1.60
± 0.04 | 1.62
± 0.03 | 1.51
± 0.04 | 1.47
± 0.04 | 1.51
± 0.03 |

DM and nutrient yield from haulms of different groundnut varieties (kg/ha).

| Constituent | Groundnut varieties | | | | | | | | J-11
NC | ICG-44
NC | GC-2
LC |
|-------------|----------------------|----------------------|----------------------|---------------------|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|------------|
| | ICGV
87189 | ICGV
87191 | ICGV
86309 | SG 84 | SEL
7-95 | J-19 | J-22 | | | | |
| Dry matter | 10417.50
± 896.59 | 10417.50
± 400.96 | 12501.00
± 567.05 | 7118.00
± 593.00 | 12674.00
± 1147.40 | 10938.25
± 593.07 | 10417.25
± 283.52 | 10591.00
± 521.00 | 10590.75
± 715.98 | 11285.50
± 593.00 | |
| C. protein | 922.99
± 53.31 | 875.07
± 35.63 | 1008.08
± 39.59 | 681.90
± 106.69 | 1083.62
± 286.50 | 819.26
± 63.74 | 802.12
± 24.47 | 883.28
± 42.78 | 987.17
± 55.20 | 999.89
± 63.93 | |
| E. extract | 264.60
± 31.10 | 229.19
± 15.96 | 303.17
± 18.06 | 172.25
± 25.55 | 243.34
± 35.51 | 236.26
± 21.03 | 222.92
± 28.93 | 284.89
± 24.28 | 242.52
± 18.11 | 188.46
± 26.13 | |
| C. fibre | 3074.20
± 364.90 | 3231.50
± 155.24 | 3917.81
± 283.77 | 1961.72
± 139.65 | 3958.09
± 425.51 | 3607.43
± 275.37 | 3305.39
± 245.07 | 3564.93
± 250.37 | 3274.65
± 262.67 | 3951.05
± 233.03 | |
| NFE | 4807.67
± 359.67 | 4670.16
± 86.32 | 5777.96
± 302.55 | 3368.94
± 254.88 | 4539.80
± 532.27 | 4999.87
± 211.47 | 4857.56
± 68.47 | 4630.38
± 201.31 | 4677.93
± 424.07 | 4851.63
± 169.93 | |
| Ash | 1348.02
± 195.98 | 1411.57
± 206.49 | 1496.36
± 121.19 | 933.16
± 39.32 | 1849.13
± 306.14 | 1275.39
± 102.49 | 1229.25
± 91.40 | 1227.49
± 161.65 | 1406.45
± 51.93 | 1294.44
± 145.47 | |
| P | 47.92
± 5.40 | 42.71
± 3.62 | 56.25
± 10.30 | 24.91
± 4.40 | 53.23
± 5.50 | 73.28
± 7.07 | 63.54
± 1.38 | 54.01
± 5.26 | 48.71
± 2.14 | 62.07
± 4.42 | |
| Ca | 143.76
± 9.40 | 151.05
± | 202.51
± 22.52 | 99.45
± 14.71 | 176.16
± 23.50 | 183.76
± 12.70 | 166.67
± 4.15 | 171.57
± 10.80 | 159.12
± 11.29 | 165.87
± 5.56 | |

significant ($P < 0.05$). The present results are in agreement with that of Hussain and Ahmed (1970) and Durgaprasad *et al.* (1986). The crude fibre content in the haulms of different groundnut varieties ranged between 27.56% (SG 84) and 35.01% (GC-2 LC) ($P < 0.05$). Similar results have been reported by Rao and Mathur (1971) and NFE content of the haulms ranged from 42.99% (GC-2 LC) to 47.33% (SG 84). The values of NFE are in agreement with the values given by Shukla *et al.* (1985), however, Krishnamohan *et al.* (1985) reported lower values for NFE in the groundnut haulms. The percentage of ash in haulms of different varieties of groundnut ranged from 11.47% (GC-2 LC) to 14.59% (SEL 7-95). The results are in agreement with the values given by Rao and Mathur (1971). The silica content in groundnut haulms were ranged between 2.52% (J-11NC) and 5.82% (SRL 7-95). Treatment

differences were found nonsignificant. The phosphorus and calcium content in groundnut haulms were of the order of 0.35% (SG 84) to 0.67% (J-19) and 1.38% (ICGV 87189) to 1.68% (J-19), respectively.

Nutrient yields

The average yield of drymatter and different nutrients per hectare from different varieties of groundnut haulms have been presented in Table 2. The varietal differences for crude protein and ash were nonsignificant while highly significant treatment differences were observed for DM and rest of the nutrients. Among the different varieties of groundnut, variety SEL 7-95 yielded highest DM, crude protein and calcium (12674.00, 1083.62 and 176.16 kg/ha, respectively) as compared to other varieties.

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Short Communications

Response of Wheat to Date of Sowing and Nitrogen

P. M. Vaghasia* and P. G. Patel

Department of Agronomy,
Gujarat Agricultural University, Navsari

Wheat is the most important staple food crop grown in India and its own outstanding importance as a human food. Fertilizer responsive high yielding dwarf wheat varieties are available. Yield of the wheat can be boost up by adopting the proper agronomical practices including date of sowing and nitrogen fertilizers (Singh *et al.*, 1985). The information on response of fertilizers and date of sowing is very scanty under heavy black soil of south Gujarat. Therefore, an attempt is made to study the response of irrigated wheat crop to date of sowing and nitrogen fertilizer.

A field experiment was conducted during the winter season of 1985-86 at the college farm of Gujarat Agricultural University, Navsari to study the effect of dates of sowing and nitrogen levels on the growth and yield attributing characters of wheat (Var. J-405). The treatments consisting of all combination of four dates of sowing (15th and 25th November and 5th and 15th December) in main plots and four levels of nitrogen (75, 100, 125 and 150 kg N/ha) as sub-plots were tested in split plot

design with four replications. All the plots received uniform dose of 60 kg P_2O_5 /ha in the form of single super phosphate at the time of sowing. Nitrogen as per treatments in the form of urea was applied in two splits, half at the time of sowing and remaining half top dressed 25 days after sowing at the time of first irrigation. The soil of experimental plot was clayey in texture containing 0.04% total nitrogen, 28 kg available P_2O_5 /ha and 38 kg available K_2O /ha. The pH of the soil was 7.9.

The results indicated that crop sown on 5th December recorded maximum grain yield of 43.90 q/ha which was significantly higher than rest of the sowing dates (Table 1). The increased in grain yield under 5th Dec. Sowing was high which evidently has resulted from remarkably more number of effective tillers/plant, higher earhead length, more number of spikelets and grains/earhead and higher 1000 grain weight (Table 1). These are the important yield attributing characters which showed significant positive correlation with the grain yield and were influenced favourably by environment particularly that of temperature prevailed during the time of sowing and vegetative and reproductive stages. These findings lend support the date reported by Singh *et al.* (1971) and Singh and Dixit (1985). Sowing on 5th December was also found beneficial for harvesting maximum straw yield.

*Present address : Main Oilseeds Research Station, Gujarat Agricultural University, Junagadh.

TABLE 1

Effect of dates of sowing and levels of nitrogen to yield and yield attributing characters of wheat.

| Treatments | Effective tillers/
plant | Earhead length
(cm) | Number of grains/
earhead | Test weight
(g) | Yield (q/ha) | | Net ICBR |
|-------------------------|-----------------------------|------------------------|------------------------------|--------------------|--------------|-------|----------|
| | | | | | Grain | Straw | |
| Sowing dates | | | | | | | |
| 15th November | 2.80 | 7.41 | 31.99 | 42.20 | 38.54 | 61.72 | |
| 25th November | 2.89 | 7.55 | 33.58 | 43.15 | 40.19 | 63.68 | |
| 5th December | 3.10 | 8.13 | 35.54 | 43.46 | 43.92 | 68.44 | |
| 15th December | 2.95 | 7.80 | 31.27 | 42.19 | 38.80 | 60.86 | |
| C.D. at 5% | 0.07 | 0.11 | 1.31 | 0.75 | 1.28 | 2.12 | |
| Nitrogen levels (kg/ha) | | | | | | | |
| 75 | 2.73 | 7.45 | 32.03 | 41.68 | 37.76 | 59.64 | - |
| 100 | 2.92 | 7.55 | 32.55 | 42.21 | 39.40 | 62.36 | 1:1.84 |
| 125 | 2.99 | 7.93 | 33.37 | 43.20 | 41.75 | 65.67 | 1:2.43 |
| 150 | 3.05 | 7.96 | 34.43 | 43.92 | 42.53 | 67.03 | 1:1.74 |
| C.D. at 5% | 0.08 | 0.14 | 0.83 | 0.41 | 8.10 | 1.83 | |

Crop fertilizer with 125 kg N/ha yielded significantly higher (42.5 q/ha) over rest of the levels. Higher grain yield recorded with 125 kg N/ha was probably due to positive and significant effect of nitrogen on yield contributing characters viz., test weight, effective tillers, earhead and number of grains/earhead. The results are substantiated with the studies conducted by Singh *et al.* (1985). Similar trend was also observed in case of straw yield of wheat.

Maximum net ICBR of 1:2.43 was recorded with 125 kg N/ha and turned out to be profitable among all the levels (Table 1).

Results of one year experimentation indicated that potential production and profit from wheat (J-405) can be obtained by sowing the crop on 5th December with application of 125 kg N/ha.

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Spacing and Nitrogen Requirements of Rice Varieties

H. M. Virdia, H. S. Patel and M. P. Patel

Regional Sugarcane Research Station
Gujarat Agricultural University, Navsari

An experiment was conducted at the college farm, Navsari during *kharif* 1989-90 on clayey soil having 7.7 pH, low in total nitrogen, medium in available phosphorus and high in available potash. In all there were 24 treatment combinations comprising of two varieties (Masuri and 1-30-1-1) and three spacings (20 x 15, 25 x 15 and 30 x 15 cm) as main plot treatments and four levels of nitrogen (0, 50, 100 and 150 kg N/ha) as sub plot treatments and replicated thrice in split plot design. A common dose of 60 kg P_2O_5 /ha was applied. Nitrogen was applied in four splits viz., 1/4 dose each at puddling 25, 55 and 75 days after transplanting. Uniform 3-5 cm standing water level was maintained except at the time of each top dressing.

Effect of varieties :- The genotype 1-30-1-1 recorded significantly more test weight, grain weight/hill and subsequently higher grain yield (4781.8 kg/ha) and net realization (Rs. 7026/ha). Whereas, variety Masuri which had registered taller plants and flowered late with longer panicles, more filled grains/panicle and straw weight/hill, produced higher straw yield.

(Table 1) Such varietal difference might be due to their genetic makeup. Similar results also reported by Prajapati *et al.* (1982).

Effect of spacing :- Grain yield of rice was significantly altered due to various spacings. Closer spacing (20 x 15 cm) emerged out superior in terms of grain 5123.0 kg/ha and straw (7745.5 kg/ha) yields as well as net realization (7858 Rs/ha) as compared to other wider spacings. But higher values of growth and yield attributes were observed under wider spacings. Lower plant productivity noticed under closer spacing might be due to acute competition between neighbouring plants for various resources which adversely affected the per plant performance but due to more number of hills per unit area under closer spacing, yield of paddy was compensated. These findings are in close conformity with those of Singh *et al.* (1989).

Effect of Nitrogen :- The data further revealed that application of 150 kg N/ha recorded remarkably higher plant height, effective tillers/hill, straw weight/hill and finally grain (5943.0 kg/ha) and straw (9366.6 kg/ha) yields but this level of N was found at par with 100 kg N/ha in respect of panicle length, filled grains/panicle, test weight, grain weight/hill, and net realization. It indicated that 100 kg N/ha was seems to be optimum dose for paddy crop.

TABLE 1

Growth and yield of rice varieties as influenced by various treatments.

| Treatment | Plant height (cm) | Days to 50% flowering | Effective tillers/hill | panicle length (cm) | Filled grains/panicle | Test weight/ hill (g) | Grain weight/ hill(g) | Straw weight/ hill (g) | Yield (kg/ha) | | Net realization (Rs./ha) |
|------------------|-------------------|-----------------------|------------------------|---------------------|-----------------------|-----------------------|-----------------------|------------------------|---------------|--------|--------------------------|
| | | | | | | | | | Grain | Straw | |
| Varieties | | | | | | | | | | | |
| Masuri | 106.48 | 84.31 | 9.37 | 25.27 | 241.53 | 13.26 | 15.67 | 36.53 | 4223.2 | 8201.9 | 5880.97 |
| 1-30-1-1 | 72.53 | 69.14 | 9.98 | 13.03 | 161.36 | 13.93 | 19.19 | 26.00 | 4781.8 | 5555.6 | 7026.03 |
| S. Em ± | 2.01 | 0.33 | 0.23 | 0.16 | 9.18 | 0.05 | 0.67 | 0.95 | 131.2 | 239.0 | 358.57 |
| C.D. at 5% | 6.33 | 1.03 | N.S. | 0.50 | 28.93 | 0.16 | 2.12 | 2.99 | 413.4 | 752.9 | 1129.62 |
| Spacing (cm) | | | | | | | | | | | |
| 20 x 15 | 91.33 | 75.76 | 8.58 | 21.96 | 194.87 | 13.61 | 14.38 | 26.71 | 5123.0 | 7745.5 | 7857.50 |
| 25 x 15 | 91.20 | 76.58 | 9.72 | 22.17 | 200.69 | 13.59 | 16.83 | 31.96 | 4431.9 | 6880.0 | 6348.21 |
| 30 x 15 | 85.99 | 78.13 | 10.74 | 22.32 | 208.78 | 13.59 | 21.08 | 35.13 | 3952.9 | 6010.8 | 5153.92 |
| S Em ± | 2.46 | 0.40 | 0.27 | 0.19 | 11.25 | 0.06 | 0.82 | 1.16 | 160.7 | 292.7 | 439.15 |
| C.D. at 5% | N.S. | 1.26 | 0.87 | N.S. | N.S. | N.S. | 2.59 | 3.66 | 506.3 | 922.1 | 1993.50 |
| Nitrogen (kg/ha) | | | | | | | | | | | |
| 0 | 75.79 | 72.60 | 7.02 | 19.59 | 156.16 | 13.38 | 10.11 | 19.56 | 2860.0 | 4160.8 | 23.90 |
| 50 | 85.17 | 76.28 | 8.24 | 21.94 | 198.72 | 13.48 | 14.78 | 26.67 | 3897.7 | 5684.9 | 4969.89 |
| 100 | 94.73 | 77.89 | 10.84 | 23.27 | 221.46 | 13.66 | 21.78 | 36.83 | 5294.9 | 8302.6 | 9635.04 |
| 150 | 102.33 | 80.11 | 12.60 | 23.79 | 229.46 | 13.86 | 23.06 | 42.00 | 5943.0 | 9366.6 | 10093.72 |
| S. Em ± | 2.49 | 0.29 | 0.16 | 0.24 | 7.98 | 0.07 | 0.87 | 1.17 | 112.7 | 314.7 | 303.58 |
| C.D. at 5% | 7.15 | 0.84 | 0.46 | 0.69 | 22.91 | 0.21 | 2.50 | 3.35 | 323.4 | 902.9 | 870.97 |

Similar results were also obtained by Hussain *et al.* (1989),

On the basis of one year experimentation it may be concluded that higher production and

profit from *kharif* rice can be secured by transplanting rice culture 1-30-1-1 at 20 x 15 cm row spacing and fertilizing it with 100 kg N/ha on clayey soils of South Gujarat region.

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Effect of Nitrogen, Phosphorus and Potash on Growth and Yield of Onion

M. U. Vachhani and Z. G. Patel

Department of Agronomy, N. M. College of Agriculture,
Gujarat Agricultural University, Navsari

An experiment was conducted in a split plot design during the *rabi* season of 1987-88 at the Instructional Farm, Gujarat Agricultural University, Navsari to study the effect of NPK fertilizers on the growth and yield of onion. Nine treatment combinations of nitrogen (50, 100, 150 kg N/ha) and phosphorus (25, 50, 75 kg P_2O_5 /ha) were kept in main plots and three levels of potash (50, 100, 150 kg K_2O /ha) in sub

plots. Each treatment was repeated three times.

The soil of the experimental plot was clayey in texture, deficient in nitrogen (0.055% total N), moderate in phosphorus (30.9 kg P_2O_5 /ha) and sufficient in potash (348 kg K_2O /ha) with pH 7.9. Full dose of phosphorus and potash and half dose of nitrogen was applied at the time of transplanting and the remaining quantity of nitrogen was topdressed 45 days after transplanting. Onion cultivar Pusa Red was transplanted in the first week of January and was harvested at the end of April.

The data presented in Table-1 revealed that application of nitrogen significantly influenced the growth and yield of onion.

TABLE 1

Effect of nitrogen, phosphorus and potash on growth and yield attributes and bulb yield of onion.

| Treatments | Plant height (m) | Number of leaves | Weight of bulb (g) | Diameter of bulb (cm) | Bulb yield (q/ha) |
|------------------|------------------|------------------|--------------------|-----------------------|-------------------|
| Nitrogen (kg/ha) | | | | | |
| 50 | 52.90 | 10.4 | 44.6 | 4.5 | 208.5 |
| 100 | 59.20 | 11.5 | 51.3 | 5.0 | 225.8 |
| 150 | 62.30 | 12.7 | 54.2 | 5.2 | 239.5 |
| S. Em $\pm$ | 0.83 | 0.13 | 1.19 | 0.06 | 5.00 |
| C.D. at 5% | 2.49 | 0.40 | 3.58 | 0.19 | 14.83 |
| C.V. % | 7.41 | 6.02 | 12.39 | 6.64 | 11.42 |

| 1. | 2. | 3. | 4. | 5. | 6. |
|--|-------|------|-------|------|-------|
| Phosphorus (kg P₂O₅/ha) | | | | | |
| 25 | 57.80 | 10.8 | 47.2 | 4.6 | 210.7 |
| 50 | 57.90 | 11.4 | 50.2 | 4.9 | 220.5 |
| 75 | 58.60 | 12.4 | 52.7 | 5.1 | 242.5 |
| S. Em ± | 0.83 | 0.13 | 1.19 | 0.06 | 5.00 |
| C.D. at 5% | NS | 0.40 | 3.58 | 0.19 | 14.83 |
| C.V. % | 7.41 | 6.02 | 12.39 | 6.64 | 11.42 |
| Potash (kg K₂O/ha) | | | | | |
| 50 | 57.80 | 11.3 | 47.8 | 4.8 | 219.5 |
| 100 | 58.10 | 11.6 | 50.4 | 4.9 | 227.7 |
| 150 | 58.50 | 11.7 | 51.8 | 4.9 | 226.7 |
| S. Em ± | 0.59 | 0.09 | 1.22 | 0.07 | 4.83 |
| C.D. at 5% | NS | 0.25 | NS | NS | NS |
| C.V. % | 5.25 | 3.89 | 12.65 | 7.33 | 11.26 |

Significantly the highest plant height (62.3 cm), number of leaves per plant (12.7), weight of bulb (54 g), diameter of bulb (5.2 cm) and bulb yield (239.5 q/ha) were recorded with the highest level of nitrogen (150 kg N/ha), but it remained statistically at par with 100 kg N/ha in respect of bulb weight. This might be due to nitrogen which improved the vegetative growth, accelerated the photosynthesis and translocation of photosynthates to the storage organ of bulb resulting in an increased diameter and weight of bulb. Similar results were also reported by Verma *et al.* (1972), Pande *et al.* (1969) and Randhawa and Singh (1974).

The results further indicated that significantly the highest number of leaves per

plant (12.4), weight of bulb (52.7 g), diameter of bulb (5.1 cm) and bulb weight (242.5 q/ha) were recorded with the highest level of phosphorus (75 kg P₂O₅/ha), but it remained at par with 50 kg P₂O₅/ha with respect to weight of bulb and diameter of bulb. However, the plant height remained unaffected due to phosphorus application. Similar results were also reported by Pande and Mundra (1971) and Randhawa and Singh (1974).

Application of potash did not manifest any significant effect on growth and yield of onion, except number of leaves per plant were increased by higher level of potash application (150 kg K₂O/ha).

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Nutrient Status of Coastal and Inland Saline-Sodic Soils and their Relationship with Soil Properties

G. L. Maliwal and N. K. Timbadia

Department of Agricultural Chemistry and Soil Science,
Gujarat Agricultural University, Junagadh

Several soil testing laboratories are working in the country to provide information to farmers on the manurial needs of their normal soils, but no effort has been made to assess the saline- sodic soils which are considered poten-

tially fertile. An attempt has been made to study the available nutrient status (N, P_2O_5 , K_2O , Zn, Fe, Mn & Cu) and organic carbon content of saline-sodic soils of Saurashtra and their relationship with soil properties.

76 surface sample (0-15 cm) of Saline-Sodic soils varying from silty loam to clayey in texture from coastal and interior areas covering from Vallabhipur to Maliya on the coast and Amreli, Liliya and Lathi talukas for interior area of Saurashtra, Gujarat were collected during May, 1983 and analysed for different nutrients and soil properties.

TABLE 1

Range and average of chemical characteristics and nutrient status of irrigated surface saline-sodic soils of coastal and inland areas of Saurashtra.

| Indices | Range | Average | S. Em. |
|--|------------|---------|--------|
| Chemical characteristics | | | |
| ECe (dsm^{-1}) | 3.0-37.0 | 20.0 | 0.987 |
| pH ₂ | 7.6-9.4 | 8.5 | 0.051 |
| SAR _{SE} | 2.4-39.7 | 21.1 | 2.438 |
| ESP | 13.4-58.5 | 36.0 | 1.237 |
| Nutrient status | | | |
| Organic carbon (%) | 0.21-1.23 | 0.72 | 0.029 |
| Available N (kg ha^{-1}) | 188-439 | 313.50 | 8.066 |
| Available P_2O_5 (kg ha^{-1}) | 15.4-99.8 | 48.20 | 5.744 |
| Available K_2O (kg ha^{-1}) | 120-2262 | 841.00 | 51.026 |
| DTPA extractable nutrients | | | |
| Iron (ppm) | 0.77-11.26 | 6.02 | 0.187 |
| Zinc (ppm) | 0.12-5.38 | 1.06 | 0.109 |
| Copper (ppm) | 0.60-6.10 | 2.30 | 0.845 |
| Manganese (ppm) | 2.57-31.30 | 14.30 | 0.216 |

ECe and pH_2 were determined using solubridge and pH meter with glass electrode. SAR and ESP was calculated as per formula given by Richard (1954). Available N, P_2O_5 , K_2O and organic carbon were determined as per methods described by Jackson (1966). DTPA extractable micro-nutrients were determined by Atomic Absorption spectrophotometer, shimadzu Model 640.

The data on range and average values for different chemical characteristics, major and micro nutrients status are presented in Table 1. The data revealed that the total salt concentration ranged from 3.0 to 37.0 ds/m while pH from 7.6 to 9.4. The exchangeable sodium percentage varies from 13.4 to 58.5. Thus the result showed that normal, saline, sodic and saline-sodic soils are exist.

The available N was low to medium while available P_2O_5 and K_2O were low to high. The medium to high status of available P_2O_5 and K_2O and organic carbon may be due to the fact that farmers are invariably applying FYM in the field for cultivating the crops.

The DTPA extractable zinc and manganese were low to high, Fe was low to medium while copper was high. The results are in conformity with Zende and Raman (1978) and Srivastava and Srivastava (1992).

The correlation coefficient values between soil properties and nutrient status for surface are presented in Table 2. The ECe of soil was positively correlated with DTPA extractable Zn ($r = 0.454^{xx}$) and Cu ($r = 0.385^{xx}$) while no correlation was observed with organic carbon, available N, P_2O_5 and K_2O and also with DTPA extractable Fe and Mn. The sodium absorption ratio of saturation extract was positively corre-

lated with Cu ($r = 0.232^x$) although at a low level of significance in the surface soils. The correlation with organic carbon, available N, P_2O_5 and K_2O and DTPA extractable Fe, Mn and Zn was not observed.

The available nitrogen ($r = 0.285^{xx}$), potash ($r = 0.476^{xx}$) were negatively correlated with ESP while available P_2O_5 was positively correlated ($r = 0.246^x$). Similarly, Chhabra *et al.* (1981) reported positive relationship between ESP and Olsen's extractable P. The pH_2 was negatively correlated with organic carbon ($r = 0.474^{xx}$), available N ($r = 0.420^{xx}$), while positive correlation was observed with available P_2O_5 ($r = 0.256$). These results showed that available nitrogen content decreased significantly with increase in pH and ESP. Similar result was observed by Chawla (1969). The positive correlation of available P_2O_5 with pH_2 was also observed by Gupta *et al.* (1989) who have reported increase in water soluble P with alkalinity via-a-vis pH.

Zinc is negatively correlated with pH ($r = 0.327^{xx}$). This showed that the availability of zinc decreased with the increase in pH of soil. The decrease in availability of zinc with an increase in pH may be due to the decreased solubility of zinc (Camp, 1945, Lindsay, 1972 and Swarup, 1992). Similar observations were recorded by Nair and Mehta (1959), Vittal and Gangwar (1974) and Srivastava and Srivastava, 1992).

The pH had also negatively correlated with Mn ($r = 0.225^x$). This is because of the concentration of divalent Mn in the soil solution of a given soil is dependent on soil pH and on its oxidation reduction potential. In alkali soils the divalent Mn undergo rapid atmospheric oxidation to form insoluble manganese dioxide and

TABLE 2

Correlation coefficient values between soil characteristics and available nutrients in coastal and inland problematic soils of Saurashtra.

| Soil characteristics | Organic carbon | Available macro nutrients | | | DTPA extractable nutrients | | | | |
|----------------------|----------------|---------------------------|-------------------------------|------------------|----------------------------|----------|---------|---------|--|
| | | N | P ₂ O ₅ | K ₂ O | Fe | Zn | Cu | Mn | |
| ECe | 0.220 | 0.188 | 0.145 | 0.017 | -0.097 | 0.454** | 0.385** | 0.213 | |
| SAR _{SE} | -0.145 | -0.093 | 0.054 | 0.203 | 0.058 | 0.054 | 0.232* | -0.019 | |
| ESP | -0.147 | -0.285** | 0.246 | -0.476** | 0.181 | -0.018 | 0.208 | 0.187 | |
| pH _c | -0.474** | -0.420** | 0.256* | -0.025 | 0.113 | -0.327** | -0.042 | -0.225* | |

* Significant at P = 0.05

** Significant at P = 0.01

other manganese oxides (Ponnamperuma, 1972). Similar result was observed by Brar *et al.* (1980), Swarup (1985a).

The results of the present investigation revealed that the availability of nitrogen in soil

is decreased with the increase in ESP and pH while phosphorus availability increased (Gupta *et al.* 1989). Therefore, the nitrogen requirement will be more in sodic soils. The soil testing laboratories may keep this point in view while recommending N-fertilizers for sodic soils.

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Effect of Nitrogen Levels and Time of Application with Cutting Systems on Yield and Protein Content of Oats Forage (*Avena sativa* L.)

P. C. Patel and J. C. Patel

Agricultural Chemistry and Soil Science
Department, B. A. College of Agriculture, GAU, Anand

In forage oats, increased vegetative growth and nutritional quality of the produce are the main consideration where livestock production is involved or in dairy milk-shed area during the winter season. The response of forage oats to nitrogen application (80 to 200 kg N/ha) in different soil types has been reported by some workers (Anon., 1973a, Joshi and Prasad, 1979). Sinha (1968) observed higher increase in crude protein (CP) content by applying N (0 to 120 kg N/ha) in three-split-dressing at sowing/tillering/flowering than applying in a single dressing at sowing. Singh *et al.* (1976) suggested that oats should be cut twice (55-60 DAS and 125 DAS/earring stage) for maximum production of good quality fodder. Since, very little work has been reported on forage oats for middle Gujarat region, it needs experimentation to find out the optimum nitrogen level and time of its application under one-cutting and two-cutting systems for getting maximum forage yield and good quality. A field experiment with oats (Var. Kent) was

conducted in a randomized block design on sandy loam soil at Forage Research Project Farm, GAU, Anand during Rabi 1982-83. The available nitrogen, phosphorus and potash were 213, 68 and 156 kg/ha, respectively. There were three nitrogen levels (90, 120 and 150 kg/ha) and two cutting systems, i.e. (i) fodder harvesting at early dough stage (111 DAS) - C₁ and (ii) crop cutting before boot-stage (64 DAS) and regrowth cutting at early dough-stage (59 DAS) - C₂. Each dose of nitrogen was applied in different splits as shown below :

Treatments T₁ to T₅ - 90 kg N/ha (Urea)

T₁C₁ : 2/3 BD + 1/3 30 DAS

T₂C₁ : 1/2 BD + 1/4 30 DAS + 1/4 60 DAS

T₃C₂ : 1/3 BD + 1/6 30 DAS + 1/2 AFC

T₄C₂ : 1/2 BD + 1/4 30 DAS + 1/4 AFC

T₅C₂ : 1/3 BD + 1/6 30 DAS + 1/4 AFC + 1/4 DAFC

Where, BD - Basal dressing; DAS - Days after sowing; AFC - After first cut; DAFC - Days after first cut. In a similar way, 120 and 150 kg N/ha (urea) were split for T₆ to T₁₀ and T₁₁ to T₁₅ treatments, respectively. The sowing of oats was done with 25 cm row spacing on 23rd October, 1982 using 100 kg seed/ha. A common dose of superphosphate (30 kg P₂O₅/ha) and muriate of potash (25 kg K₂O/ha) was applied

*Present address : Research Scientist, Biochemistry Deptt., B.A.C.A., Anand.

TABLE 1

Green forage, dry matter and crude protein yields (q/ha) and crude protein content (per cent) of oats (Var. Kent) at different levels and time of nitrogen application under one (C₁) and two cutting (C₂) systems.

| Treatment | | | Yield (q/ha) | | | Crude protein content (%) |
|--|------|--------------------------------------|--------------|------------|---------------|---------------------------|
| | | | Green forage | Dry matter | Crude protein | |
| N ₉₀ | (1) | T ₁ C ₁ | 525 | 105.3 | 14.37 | 13.14 |
| | (2) | T ₂ C ₁ | 527 | 102.4 | 14.28 | 14.03 |
| | | Mean N ₉₀ C ₁ | 526 | 103.9 | 14.33 | 13.59 |
| | (3) | T ₃ C ₂ | 683 | 99.8 | 14.10 | 14.87 |
| | (4) | T ₄ C ₂ | 744 | 109.9 | 14.26 | 13.67 |
| | (5) | T ₅ C ₂ | 700 | 102.9 | 14.79 | 15.05 |
| | | Mean N ₉₀ C ₂ | 709 | 104.2 | 14.38 | 14.53 |
| N ₁₂₀ | (6) | T ₆ C ₁ | 598 | 116.1 | 15.32 | 13.27 |
| | (7) | T ₇ C ₁ | 640 | 99.7 | 14.65 | 14.82 |
| | | Mean N ₁₂₀ C ₁ | 569 | 107.9 | 14.99 | 14.05 |
| | (8) | T ₈ C ₂ | 802 | 114.5 | 18.26 | 16.05 |
| | (9) | T ₉ C ₂ | 790 | 110.9 | 16.06 | 15.15 |
| | (10) | T ₁₀ C ₂ | 756 | 106.3 | 17.50 | 16.48 |
| | | Mean N ₁₂₀ C ₂ | 783 | 110.6 | 17.27 | 15.89 |
| N ₁₅₀ | (11) | T ₁₁ C ₁ | 550 | 107.0 | 17.12 | 15.56 |
| | (12) | T ₁₂ C ₁ | 575 | 104.0 | 17.32 | 16.72 |
| | | Mean N ₁₅₀ C ₁ | 562 | 105.7 | 17.22 | 16.29 |
| | (13) | T ₁₃ C ₂ | 796 | 99.9 | 17.07 | 16.91 |
| | (14) | T ₁₄ C ₂ | 871 | 112.2 | 21.39 | 18.64 |
| | (15) | T ₁₅ C ₂ | 771 | 97.4 | 16.34 | 16.57 |
| | | Mean N ₁₅₀ C ₂ | 813 | 103.2 | 18.27 | 17.37 |
| Mean for Nitrogen | | N ₉₀ | 636 | 104.1 | 14.36 | 14.15 |
| | | N ₁₂₀ | 697 | 109.3 | 16.36 | 15.13 |
| | | N ₁₅₀ | 713 | 104.3 | 17.85 | 16.94 |
| Mean for Cuts | | C ₁ | 553 | 105.8 | 15.51 | 14.64 |
| | | C ₂ | 768 | 106.0 | 16.64 | 15.93 |
| C. D. at 5% and 1% level | | | | | | |
| | | | 5% 1% | 5% 1% | 5% 1% | 5% 1% |
| N levels | | | 20.2 27.0 | 4.38 5.85 | 1.08 1.44 | 0.87 1.17 |
| N ₉₀ /N ₁₂₀ /N ₁₅₀ /C | | | 25.3 39.0 | NS NS | 1.51 2.02 | 1.26 1.68 |
| Individual treatment | | | 45.2 60.4 | 9.93 13.27 | 2.12 2.83 | 1.95 2.61 |

in furrow at the time of sowing. In all nine irrigations were given as and when required. Fresh green forage and dry matter yields were recorded after each cutting. Nitrogen content of plant samples was estimated by Kjeldahl's method (Jackson, 1967) and crude protein content was calculated by multiplying nitrogen per cent with 6.25.

Green forage yield (GFY)

The data (Table 1) indicated that the green forage yield of oats increased significantly with the increase in the rate of N application from 90 to 150 kg/ha. However, the yield produced by 120 kg N/ha was at par with that of 150 kg N/ha treatment. Application of nitrogen @ 120 and 150 kg N/ha resulted in increased yield by 9.6 and 12.0 per cent over 90 kg N/ha, respectively. Two-cutting system gave significantly higher (38.9%) GFY over one-cutting system. It is interesting to note that the application of 150 kg N/ha under two-cutting system produced significantly (at 1% level) higher forage yield than under one-cutting system. Similar was the case for other levels also. The highest GFY (871 q/ha) obtained under two-cutting treatment - $T_{14}C_2$ (150 kg N/ha + $\frac{1}{2}$ BD + $\frac{1}{4}$ 30 DAS + $\frac{1}{4}$ AFC) was statistically significant (at 1% level) over all the treatment. Similarly, application of 90 and 120 kg N/ha in three splits under two-cutting system produced reasonably good yields of forage oats (e.g. $T_{14}C_2$: 744 q/ha; T_9C_2 : 790 g/ha). The highest yield obtained under $T_{14}C_2$ as compared to $T_{13}C_2$ and $T_{15}C_2$ can be ascribed to higher amount of nitrogen applied at early stage of the crop growth. It was also true for other N levels under both the cutting systems except at 120 kg N/ha with two cuts. The response of oats to N application upto 100 kg/ha (Bokde, 1968), 120 kg/ha (Saxena *et al.*, 1971) and 200 kg/ha (Joshi and Prasad, 1979)

has also been reported by different researchers. Singh *et al.* (1972) obtained the maximum profit with 76 kg N/ha, when applied three-fourths at sowing and one-fourth after the first cut in oats. Singh *et al.* (1976) and Abichandani *et al.* (1973) also observed the higher yields of green forage and dry matter of oats under two cuts than single cut.

Dry matter yield (DMY)

Application of 120 kg N/ha produced significantly higher dry matter yield of oats as compared to 90 and 150 kg N/ha (Table 1). Cutting systems did not influence in enhancing the dry matter yield. The highest DMY of 116.1 q/ha obtained under treatment T_6C_1 which was significantly superior to rest of the treatments but at par with $T_{11}C_1$, T_4C_2 , T_8C_2 , T_9C_2 , $T_{10}C_2$ and $T_{14}C_2$. The trend in DMY under two-cutting system is not similar to that observed in respect of GFY. It was mainly due to more leafy portion and moisture content at early dough-stage harvesting (first cutting). In general, it can be said that N applied at early stage of the crop growth had beneficial effect in increasing the DMY irrespective of cutting system (Singh *et al.*, 1972).

Crude protein content

Crude protein (cp) content (Table 1) of oats was enhanced significantly (at 1% level) with the application of 150 kg N/ha (16.94%) over 90 kg N/ha (14.15%) and 120 kg N/ha (15.13%). Two-cutting system resulted in significantly higher (8.8%) CP content over one-cutting. Application of 120 kg N/ha under two-cutting system resulted in significantly higher CP content (13.1%) than under one-cutting. Similar was the case with 90 to 150 kg N/ha levels, but differences did not reach to the level of significance. The highest CP value (18.64%) was noticed under two-cutting

treatment - $T_{14}C_2$ (150 kg N/ha : $\frac{1}{2}$ BD + $\frac{1}{4}$ 30 DAS + $\frac{1}{4}$ AFC). The trial conducted at Anand revealed that CP content in oats plant increased from 9.9 to 12.4% as the level of N increased from 0 to 120 kg N/ha (Anon., 1973b). Higher increases in CP content (5.43 to 6.35%) have been reported (Sinha, 1968) by applying N (0 to 120 kg N/ha) in three split dressing at sowing/tillering/flowering than applying in a single dressing at sowing.

Crude protein yield (CPY)

Application of 150 kg N/ha to oats produced significantly higher (24.3% and 10.0%) crude protein yield over 90 and 120 kg N/ha (Table 1). Two-cutting system gave significantly higher (15.2%) CPY over one-cutting system at 120 kg N/ha level. Similar was the case with 150 kg N/ha level, but the differences did not reach to the level of

significance. The highest CPY (21.4 q/ha) synthesized under the treatment $T_{14}C_2$ (150 kg N/ha : $\frac{1}{2}$ BD + $\frac{1}{4}$ 30 DAS + $\frac{1}{4}$ AFC) was significantly (at 1% level) superior over rest of the treatments. Results of the trial conducted at Anand showed that CPY in oats plant increased from 11.02 to 16.07 q/ha as the level of N increased from 0 to 120 kg N/ha (Anon., 1973b). In a varietal trial of oats conducted at Hissar (Anon., 1973a) higher CPY were reported under multicut than single cut management system.

The present study indicated that 150 kg N/ha applied in three splits ($\frac{1}{2}$ BD + $\frac{1}{4}$ 30 DAS + $\frac{1}{4}$ AFC) to oats (Var. Kent) crop grown on sandy loam soil of Anand (Gujarat) under two-cutting system produced the highest green forage, dry matter, crude protein yields as well as crude protein content.

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Field Evaluation of Different Insecticides for the Control of Banana Lace Wing Bug, *Stephanitis typicus* Dist

P. K. Borad, M. G. Patel, J. R. Patel and C. C. Patel

Department of Entomology B. A. College of Agriculture,
Gujarat Agricultural University, Anand Campus,
Anand-388 110

Banana is one of the oldest fruits known to mankind. Simmonds (1966) has listed 182 insect pests on banana. Among them 36 insect species are reported attacking banana leaves. Lace wing bug, *Stephanitis typicus* Dist. is one of the important insect pests of banana which

sucks the cell sap from the leaves. No information for its chemical control is available. With a view to find out effective and economical insecticide for its control, an experiment was conducted at farmer's field in Bakrol village near Anand during summer, 1988.

Field experiment was conducted in randomized block design with 10 treatments including one control (Table-1) replicated thrice. Plot size was 7.5 x 7.5 m with 25 plants in each plot. Five leaves from net plot area in each treatment were tagged randomly for recording the bug population. The data on population count of nymphs per leaf was recorded periodically and analysed statistically by using $\sqrt{x + 0.5}$ transformation.

TABLE 1

Relative efficacy of different insecticides for the control of banana lace wing bug, *S. typicus* Dist.

| Insecticide | Av. No. of bug nymph/leaf | | | | | Cost of one spray (Rs.) |
|---------------------------|---------------------------|----------------|----------------|----------------|-----------------|-------------------------|
| | Before spray | 24 h | 48 h | 2 Week | 3 Week | |
| 1. Phosphamidon 0.03% | 10.71*
(114.20) | 1.59
(2.03) | 0.88
(0.27) | 1.66
(2.26) | 2.01
(3.54) | 110* |
| 2. Dimethoate 0.03% | 9.93
(98.10) | 1.93
(3.22) | 1.16
(0.85) | 2.22
(4.43) | 3.11
(9.17) | 147 |
| 3. Monocrotophos 0.036% | 8.91
(78.89) | 1.51
(1.78) | 0.93
(0.36) | 0.71
(0.00) | 1.47
(1.66) | 228* |
| 4. Methyl-o-demeton 0.05% | 8.84
(77.65) | 1.84
(2.89) | 1.44
(1.57) | 2.15
(4.12) | 2.80
(7.34) | 270 |
| 5. Dichlorvos 0.05% | 9.28
(85.62) | 1.36
(1.35) | 0.79
(0.12) | 1.75
(2.56) | 3.40
(11.06) | 162 |

| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. |
|-----|----------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|
| 6. | Endosulfan
0.07% | 9.21
(84.32) | 0.71
(0.00) | 0.71
(0.00) | 1.95
(3.30) | 2.66
(6.58) | 228 |
| 7. | Formothion
0.05% | 9.60
(91.66) | 1.26
(1.09) | 1.00
(0.50) | 3.40
(11.06) | 4.48
(19.57) | 235 |
| 8. | Quinalphos
0.05% | 9.58
(91.28) | 2.14
(4.08) | 1.04
(0.58) | 3.45
(11.40) | 4.72
(21.78) | 298 |
| 9. | Fenvalerate
0.01% | 8.99
(80.32) | 1.99
(3.46) | 0.71
(0.00) | 1.10
(0.71) | 2.20
(4.34) | 182 |
| 10. | Control | 7.26
(52.21) | 7.63
(57.72) | 7.92
(62.23) | 8.70
(75.19) | 8.76
(76.24) | — |
| | S.E.m. $\pm$ | 0.62 | 0.43 | 0.21 | 0.43 | 0.30 | |
| | C.D. at 5% | NS | 1.28 | 0.62 | 1.27 | 0.90 | |
| | C.V. % | 11.68 | 34.07 | 21.64 | 27.41 | 14.80 | |

* $\sqrt{x + 0.5}$ transformed values.

Figures in parentheses are retransformed values.

+ Labour charge Rs. 15 per day i.e. $15 \times 4 = \text{Rs. } 60$

Note : Sandovit (2 ml/l) was mixed with all the insecticides.

The nymphal population of lace wing bug (Table-1) indicated significant superiority of all the insecticides to control till 3 weeks after their applications. However, among the insecticides endosulfan 0.07% gave cent per cent mortality of the bugs within 24 h of application which was significantly higher than quinalphos 0.05%. Endosulfan higher effectiveness was found till 3 weeks after spraying the quinalphos. Rest of the insecticides tested showed equal effectiveness as endosulfan after 24 h of application. However, banana plants sprayed with monocrotophos 0.036% had significantly low bug population as compared to methyl-o-demeton 0.05% dimethoate 0.03%, formothion 0.05% and quinalphos 0.05% after 2 and 3 weeks of application. Whereas after 2 weeks of application crop sprayed with endosulfan and

dichlorvos 0.05% had equal bug population as monocrotophos treated crop but earlier both the insecticides lost their persistent effect and bug population was found significantly higher than monocrotophos after 3 weeks spray. Phosphamidon 0.03% and fenvalerate 0.01% remained equally effective as monocrotophos since 24 h of application till 3 weeks of application. Of course both were at par to endosulfan and methyl-o-demeton. Among the systemic insecticides monocrotophos and phosphamidon proved more effective than dimethoate and methyl-o-demeton till 3 weeks after spray.

Considering the effectiveness and cost of the insecticides phosphamidon is preferred for the control of lace wing bug, *S. typicus* infesting banana than the other tested insecticides.

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Ovipositional Preference of *Earias vittella* (Fabricius) on Different Host Plants*

H. C. Ratanpara and R. K. Bharodia

Department of Entomology, College of Agriculture, GAU,
Junagadh Campus, Junagadh

Okra (*Abelmoschus esculentus* (L.) Moench) shoot and fruit borer, *Earias vittella* (Fab.) survives on many of the alternate hosts in offseason. Moths that emerged in January

and February laid the eggs on dry cotton stick, malvaceous weeds and hollyhock (Hussain and Lal, 1923). Hence, a study was carried out to see the ovipositional preference of *E. vittella* on different cultivated and wild host plants.

A laboratory trial was conducted at the Department of Entomology, College of Agriculture, Junagadh during 1987 and was replicated four times with seven host plants viz., cotton (*Gossypium hirsutum* L.), okra (*Abelmoschus esculentus* (L.) Moench), *Khapat* (*Abutilon indicum* L.), *Jasud* (*Hibiscus rosasinensis* (L.)),

TABLE 1

Mean fecundity of *E. vittella* on host plants.

| Sr. No. | Host plant | Mean number of eggs laid/female |
|------------|---|---------------------------------|
| 1. | Cotton
(<i>Gossypium hirsutum</i> L.) | 237.0 ^a |
| 2. | Okra
(<i>Abelmoschus esculentus</i> (L.) Moench). | 231.0 ^a |
| 3. | <i>Khapat</i>
(<i>Abutilon indicum</i> L.) | 209.5 ^a |
| 4. | <i>Jasud</i>
(<i>Hibiscus rosasinensis</i> L.) | 204.0 ^a |
| 5. | wild okra
(<i>Hibiscus abelmoschus</i> L.) | 142.0 ^b |
| 6. | <i>Hollyhock</i>
(<i>Althoea rosea</i> L.) | 37.5 ^c |
| 7. | Mulberry
(<i>Morus alba</i> L.) | 32.0 ^c |
| (P = 0.05) | | 50.2 |

*Part of M. Sc.(Agric.) thesis submitted by the senior author to the Gujarat Agricultural University, Sardar Krushinagar.

wild okra (*Hibiscus abelmoschus* L.) hollyhock (*Althoea rosea* L.) and mulberry (*Morus alba* L.). The eggs of *E. vittella* were collected from the mass culture, developed in the laboratory for rearing. After hatching, fresh fruiting bodies of seven host plants were provided separately in wooden cages until pupation. After the emergence of adults, one pair was confined in individual glass jar and fed with 5 per cent honey solution soaked in cotton swab daily. Fresh leaves and branches with buds flowers and fruits of respective host plants were provided daily to different glass jars and were covered with muslin cloth. The number of eggs laid by the female on

different host plants were counted daily till the death of the female.

Statistical analysis of the data indicated that the maximum number of eggs 237.0 were laid on cotton which was at par with okra (231.0, *Khapat* (209.5) and *Jasud* (204.0) followed by wild okra (142.0) eggs/female. The less preferred host plants for oviposition were hollyhock and mulberry as evident from the less number of eggs laid 37.5 and 32.0 per female, respectively. These results are in agreement with Mehta and Saxena (1970), who reported unripened fruits of okra and the leaves of cotton as the most preferred sight of host plants for oviposition of this pest.

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Bio-Ecology and Reproductive Potentiality of *Helicoverpa* (*Heliothis*) *armigera* Hubner on Different Host Crops

V. M. Valand and J. R. Patel

Department of Entomology B. A. College of Agriculture,
Gujarat Agricultural University, Anand Campus,
Anand-388 110

Gram pod borer, *Helicoverpa* (*Heliothis*) *armigera* Hubner (Noctuidae : *Lepidoptera*) is a cosmopolitan polyphagous pest. The larva causes severe damage to cotton, *Gossypium hirsutum* L. gram, *Cicer arietinum* L. pigeonpea, *Cajanus indicus* Sprengl, tomato, *Lycopersicum esculentum* Mill. potato, *Solanum tuberosum* L., cabbage, *Brassica oleracea* (capitata) L. etc. by boring the bolls, pods and fruits. Information about its development and reproductive potentiality on these host crops is scanty so such laboratory-cum-field study was carried out during 1989-90.

The larvae of *H. armigera* collected from the tomato field were reared on tomato fruits in the laboratory by following the rearing technique developed by Patel *et al.*, (1968). First instar larvae hatched out from the eggs laid by these moths were reared separately on different hosts (Table-1). Fifty larvae were reared on each host crop separately in plastic

tubes (7.0 x 3.5 cm) till second instar and then they were reared on respective host crop in field condition till pre-pupation by releasing 10 larvae per plant. The plants were caged after releasing the larvae. The prepupae were brought to the laboratory and kept separately till emergence of adults. The newly emerged moths were paired and transferred in glass chimney for oviposition on the twigs of respective host plant which were kept in the chimney by wrapping cotton wool in plastic tube containing water for keeping the leaves in turgid condition. Every day twigs of various host crops and honey solution which was kept as food of moths were replaced. The eggs after counting were under observation till hatching. The data collected were statistically analysed.

The study on the influence of food on the development of *H. armigera* (Table-1) in various abiotic conditions in *kharif* revealed significantly prolonged larval period on pigeonpea as compared to groundnut at $28.04 \pm 7.76^{\circ}\text{C}$ and 84% R. H. Whereas, no significant difference in larval period was observed for larvae reared on cotton to pigeonpea as well as groundnut. The larval survival on pigeonpea was significantly higher as compared to cotton and groundnut. Ofcourse, the larvae reared on later two hosts did not show any significant difference in the survival. Pre-pupal period was significantly longer on groundnut at $26.90 \pm 9.08^{\circ}\text{C}$

*Present address : Professor Head, Department of Entomology, B.A. College of Agriculture, GAU, Anand.

TABLE 1

Effect of food and meteorological conditions on the development of *H. armigera* Hb. in different seasons.

| Host | Mean period (days) of the various stages | | | | | | | | | | Hatching (%) | Larval survival (%) | Adult emergence (%) | Growth index |
|-------------|--|------------|------------|-----------|-----------|--------|-----------------|--------|-------------------|-------|--------------|---------------------|---------------------|--------------|
| | Egg | Larval | Pre-pupal | Pupal | Adult | | Total life span | | Average fecundity | | | | | |
| | | | | | Male | Female | Male | Female | | | | | | |
| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | |
| KIHARIF | | | | | | | | | | | | | | |
| Temp °C | 28.92±5.09 | 28.04±7.76 | 26.90±9.08 | 26.7±7.79 | 25.9±8.25 | | 27.27±7.76 | | | | | | | |
| R. H. (%) | 88.5 | 84.0 | 81.4 | 78.0 | 76.35 | | 81.47 | | | | | | | |
| Pigeonpea | 4.00 | 14.95 | 1.91 | 6.22 | 4.60 | 6.00 | 31.68 | 33.08 | 599.3 | 71.88 | 84.00 | 74.0 | 5.60 | |
| Groundnut | 4.00 | 12.88 | 2.38 | 6.63 | 4.67 | 6.33 | 30.56 | 32.22 | 582.5 | 75.00 | 52.0 | 75.0 | 3.01 | |
| Cotton | 4.00 | 13.93 | 1.93 | 9.50 | 3.80 | 6.00 | 33.16 | 35.36 | 446.0 | 65.00 | 56.0 | 57.0 | 3.85 | |
| S. Em. ± | — | 0.54 | 0.13 | 0.77 | 0.99 | 0.88 | — | — | 130.16 | 3.94 | 1.63 | 2.24 | 0.07 | |
| C. D. at 5% | — | 1.51 | 0.37 | 2.20 | NS | NS | — | — | NS | NS | 5.65 | 7.74 | 0.24 | |
| C. V. % | — | 21.10 | 22.66 | 37.24 | 49.17 | 27.86 | — | — | 41.03 | 9.96 | 4.42 | 5.64 | 2.87 | |

RABI

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. |
|-------------|--------------|------------|------------|------------|------------|------------|-------|-------|--------|-------|-------|-------|------|-----|
| Temp °C | 23.92 ± 2.02 | 21.65±6.53 | 17.55±4.24 | 20.25±2.85 | 21.92±2.62 | 21.23±3.48 | | | | | | | | |
| R. H. (%) | 75.0 | 75.71 | 71.6 | 71.05 | 72.61 | 73.19 | | | | | | | | |
| Tomato | 5.0 | 31.50 | 2.36 | 22.64 | 5.50 | 9.71 | 66.50 | 70.71 | 415.0 | 45.27 | 28.00 | 96.67 | 0.90 | |
| Potato | 5.0 | 24.18 | 1.86 | 16.94 | 9.73 | 11.50 | 57.71 | 59.48 | 546.0 | 48.16 | 44.00 | 93.33 | 1.82 | |
| Gram | 5.0 | 30.00 | 2.33 | 22.08 | 7.00 | 10.17 | 66.41 | 69.58 | 415.0 | 37.50 | 32.00 | 89.33 | 1.58 | |
| Cabbage | 5.0 | 24.94 | 2.38 | 26.46 | 8.00 | 9.67 | 66.78 | 68.47 | 227.5 | 46.95 | 34.00 | 88.33 | 1.36 | |
| S. Em. ± | — | 0.94 | 0.13 | 2.24 | 1.33 | 1.52 | — | — | 156.61 | 4.70 | 2.53 | 3.37 | 0.04 | |
| C. D. at 5% | — | 2.65 | 0.39 | 6.29 | NS | NS | — | — | NS | NS | 8.26 | NS | 0.11 | |
| C. V. % | — | 14.08 | 24.00 | 37.50 | 41.24 | 32.66 | — | — | 61.38 | 17.92 | 12.72 | 6.35 | 0.09 | |

and 81.4% R. H. Whereas, pupal period at $26.71 \pm 7.79^{\circ}\text{C}$ and 78% R. H. was longer on cotton as compared to the rest of the two hosts. The moth emergence was significantly high on groundnut and pigeonpea as compared to cotton. *Helicoverpa* larvae reared on pigeonpea had significantly higher growth index as compared to cotton and groundnut. Valand and Patel (1992) have also found higher larval survival and growth index on pigeonpea than chickpea. The life span was shorter on pigeonpea than cotton. Goyal and Rathod (1988) have also similar observation.

The larval development of *H. armigera* during rabi (Table-1) on tomato and gram was found significantly slower as compared to

cabbage and potato at $21.65 \pm 6.63^{\circ}\text{C}$ and 75.71% R. H. Whereas, the larval survival was significantly higher on potato than tomato, gram and cabbage. The larvae reared on potato had shortest prepupal ($17.55 \pm 4.24^{\circ}\text{C}$ and 71.6% R. H.) and pupal period ($20.25 \pm 2.85^{\circ}\text{C}$ and 71.05% R. H.). The significantly higher growth index was observed on potato followed by gram, cabbage and tomato.

Thus, the larval survival and growth index was found high on pigeonpea and potato as compared to rest of the hosts studied. However, no significant effect was observed of any of the host crops on the fecundity and hatchability of eggs.

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Efficacy of Various Insecticides for the Control of Sugarcane Whitefly (*Aleurelobus Baredensis* Mask)*

C. D. Kunjadia and C. B. Patel**

Department of Entomology Gujarat Agricultural University,
Navsari Campus, Navsari

Sugarcane (*Saccharum officinarum* L.) is one of the most important cash as well as industrial crops in India and is liable to be attacked by insect pests right from planting till harvest. There are about hundreds of species of insects recorded as a pests of sugarcane in different countries of the world. Among them, whitefly, *Aleurelobus barodensis* Mask, is one of the serious pests of sugarcane crop. Several workers have reported control measures of sugarcane whitefly elsewhere in India. Among which Varma (1983) reported that sugarcane crop should be sprayed with 0.05 per cent endosulfan in May and June for the control of whitefly, whereas Avasthy (1977) reported that endosulfan 0.05 per cent should be sprayed with sufficient water in August or September. Chaudhary *et al.* 1985 reported that the greatest mortality of nymphs and pupae occurred in plots treated with dimethoate, domaton-s-methyl and malathion at 7 days after treatment. Sugarcane is widely grown in south Gujarat and is found heavily infested

by the pest recently. Hence efforts were made to fill up the lacuna in research information existing in the area.

The field experiment was conducted at college farm, Gujarat Agricultural University, Navsari, District - Valsad with eleven insecticides viz., endosulfan 35 EC, triazophos 40 EC, acephate 75 SP, quinalphos 25 EC, ethion 50 EC, dimethoate 30 EC, phosphamidon 80 w/w, monocrotophos 36 w/w, methyl-parathion 50 EC and methyl-o-demeton 25 EC, replicated four times in RBD, during *kharif* season of 1986.

Population of eggs, nymphs and puparia of whitefly in 193.5 cm² area on three leaves viz., top, middle and lower portion of five randomly selected canes was recorded in each plot to evaluate the treatments.

The data were subjected to square root transformation and then finally analysed for statistical interpretation. The results in terms of mean population counts are presented in Table 1.

The data in Table 1 indicated that all the insecticidal treatments were significantly superior to untreated control in reducing the mean population of eggs, and nymphs when observation were recorded 24 hours after spraying and mean population of nymphs and puparia when recorded 7 days after spraying.

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** Present address : Assistant Research Scientist, Department of Entomology, Gujarat Agricultural University, Junagadh

TABLE 1

Population of different stages of whitefly in varieties treatments.

| Sr. No. | Treatments | No. of Eggs/193.5
(mean) | | No. of Nymphs/193.5 m ²
(mean) | | No. of Puparia/193.5 m ²
(mean) | |
|---------------------|------------------------|-----------------------------|--|--|--|---|--|
| | | I | | II | | II | |
| 1. Dimethoate | 30 EC @ 0.03 per cent | *6.67 (44.43) ^a | | *18.46 (340.77) ^{ab} | | 7.95 (63.20) ^b | |
| 2. Endosulfan | 35 EC @ 0.1 per cent | 6.70 (44.83) ^a | | 21.29 (453.26) ^{cd} | | 7.59 (57.61) ^{ab} | |
| 3. Triazophos | 40 EC @ 0.1 per cent | 6.38 (40.70) ^a | | 20.08(403.21) ^{bc} | | 4.92(24.21) ^a | |
| 4. Phosphamidone | 85 w/w @ 0.03 per cent | 6.74 (45.43) ^a | | 20.18(407.23) ^{bc} | | 7.03(49.42) ^{ab} | |
| 5. Methyl parathion | 50 EC @ 0.05 per cent | 7.24 (52.42) ^b | | 18.98(360.24) ^{ab} | | 6.53(42.64) ^{ab} | |
| 6. Acephate | 75 SP @ 0.1 per cent | 7.63 (58.22) ^c | | 17.64(311.17) ^a | | 12.81(164.10) ^c | |
| 7. Quinalphos | 25 EC @ 0.1 per cent | 6.40 (40.96) ^a | | 21.38(457.10) ^{cd} | | 7.17(51.41) ^{ab} | |
| 8. Ethion | 25 EC @ 0.1 per cent | 7.50 (56.25) ^{bc} | | 20.42(416.98) ^{bc} | | 14.67(215.21) ^c | |
| 9. Methyl-o-demeton | 25 EC @ 0.075 per cent | 6.73 (45.29) ^a | | 21.52(463.11) ^{cd} | | 9.19 (84.46) ^b | |
| 10. Monocrotophos | 36 w/w @ 0.03 per cent | 7.31(53.44) ^{bc} | | 21.13(446.48) ^c | | 14.74(217.27) ^c | |
| 11. Control | | 8.79(77.26) ^d | | 23.23(539.63) ^d | | 22.89 (523.95) ^d | |
| | Mean | 7.10 | | 20.39 | | 10.50 | |
| | S.E.m. ± | 0.13 | | 0.70 | | 0.99 | |
| | C. D. at 5% | 0.37 | | 2.03 | | 2.85 | |
| | C. V. % | 3.65 | | 6.90 | | 18.78 | |

I 24 hours after spraying

II 7 days after spraying

Figures in parentheses are square root retransformed values.

* Means having same letter are not significantly different at 5% level.

After 24 hours of application, the data of mean population of eggs, indicated that the treatment with triazophos 0.1 per cent was significantly superior to rest of the treatments except the treatments with quinalphos 0.1 per cent, dimethoate 0.03 per cent, endosulfan 0.1 per cent, methyl-o-demeton 0.075 per cent and phosphamidon 0.03 per cent which were at par with triazophos.

On the basis of number of nymphs, the treatment of acephate 0.1 per cent was found at par with the treatment dimethoate 0.03 per cent and methyl parathion 0.05 per cent and was significantly superior to the rest of the treatments, after 24 hours of application.

The treatment of triazophos 0.1 per cent was at par with the treatments of methyl parathion 0.05 per cent, phosphamidon 0.03 per cent, quinalphos 0.1 per cent and endosulfan 0.1 per cent was significantly superior to rest of the treatments by giving lowest i.e. 24.21 number of nymphs, when

observations were recorded 7 days after spraying.

Lower population of puparia was recorded in the treatments of triazophos 0.1 per cent (58.06) and quinalphos 0.1 per cent (60.99), when observations were recorded 7 days after spraying and was at par with treatments endosulfan 0.1 per cent and asephate 0.1 per cent by giving population of puparia 74.99 and 81.50, respectively.

Looking to the above results, it is seen that all the treatments were better than untreated control. Population of all the stages was the lowest in the treatment of triazophos 0.1 per cent. Reddy *et al.*, (1985) reported that triazophos 0.1 per cent sprayed at 5 days interval was moderately effective in controlling the *B. tabaci*, on cotton crop, while triazophos as foliar spray was effective and retained their effectiveness for a satisfactory period against *B. tabaci* on cotton crop as suggested by Malamed Madjar *et al.* (1984).

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**Life History of Sugarcane
Whitefly (*Aleurolobus barodensis*
Mask) under
South Gujarat Condition*
(*Aleyrodidae* : *Homoptera*)**

C. D. Kunjadia, C. B. Patel and M. B. Patel

Department of Entomology, Gujarat Agricultural University,
Navsari Campus, Navsari

Sugarcane is the most important cash crop widely grown in south Gujarat area. Whitefly, (*Aleurolobus barodensis* Mask.) causes enormous losses in tonnage as well as recovery. Preliminary studies on the biology of this pest has been done elsewhere in India (Hamid Mahmood (1955) and Sandhu and Singh (1963). A study was therefore undertaken on detail biology of the pest.

Life history of the pest was studied at Navsari, Gujarat India. The average room temperature and relative humidity during the study was 29.24°C and 89.79 per cent, respectively. Huge culture of the pest was obtained from heavily infested fields and reared on potted plants. The freshly emerged males and females were paired in glass-chimney. The observations on duration and description of all the stages were recorded are reported hereinafter.

The average duration of egg, first, second and third nymphal instar, puparia as well as male and female adult was 8.6 ± 0.51 , 2.43 ± 0.65 , 4.00 ± 0.78 , 4.42 ± 0.51 , 10.67 ± 0.98 , 28.60 ± 2.20 and 32.62 ± 0.65 days, respectively.

The average pre-oviposition, oviposition and post-oviposition periods were 1.15 ± 0.13 , 29.27 ± 0.80 and 2.20 ± 0.25 hours, respectively. Freshly laid eggs were conical, creamy with 0.22 ± 0.02 mm in length and 0.12 ± 0.02 mm in width.

First instar nymph was oval, pale yellow gradually turned to shiny black and 0.34 ± 0.02 mm in length and 0.18 ± 0.02 mm in width. Second instar nymph was creamy yellow subsequently changed to black and 0.57 ± 0.06 mm in length and 0.30 ± 0.03 mm in width. A smoky white fringe could be noticed all around their body. Prominent white waxy fringe could be seen around the body of third nymphal instar. It was 1.20 ± 0.03 mm in length and 0.61 ± 0.03 mm in width. Newly formed puparium was ashy, changed to black and covered with white waxy powder around the body. It measured 2.04 ± 0.39 mm in length and 0.98 ± 0.19 mm in width. The adult was tiny with smoky white wings. The length of female adult was 1.71 ± 0.12 mm and width

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of abdomen was 0.66 ± 0.04 mm. It possessed needle like ovipositor. The male adult was 1.18 ± 0.09 mm in length, with 0.26 ± 0.03 mm broad abdomen and a pair of claspers.

Single female laid 51.0 ± 9.90 eggs. These findings are more or less in confirmation with the results reported by Hamid Mahmood (1955) and Sandhu and Singh (1963).

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***In Vitro* Efficacy of Chemicals Against Cluster Bean Blight Pathogen**

H. G. Vyas and J. G. Patel

Department of Plant Pathology, B. A. College of
Agriculture, Gujarat Agricultural University,
Anand Campus, Anand 388 110

Guar (*Cyamopsis tetragonoloba*) Taub has been used in India since ancient times for forage, vegetables and green manuring.

This crop has assumed industrial importance because of gum content in its seeds. Bacterial blight of guar caused by *Xanthomonas campestris* pv *cyamopsidis* is one of the serious diseases in several states of India. Patel *et al.* (1952) reported this disease for the first time. The widespread growing of susceptible varieties and prevalence of favourable weather conditions in the monsoon season enhance the intensity of the disease resulting into severe yield reduction (Srivastava and Rao, 1963; Bisht *et al.* 1992). Varietal resistance and evaluation of seed dressers against bacterial blight have been reported by several workers (Gandhi *et al.* 1978; Lodha, 1984; Chand, 1985).

This disease appeared in servere form during the *kharif* 1990-91 at Anand (Gujarat)

which necessitated to explore the efficacy of selected antibiotics and chemicals against *Xanthomonas campestris* pv. *cyamopsidis* under Gujarat conditions. Present investigation reports the results of *in vitro* screening of chemicals.

The pathogen was isolated locally from diseased plant of GAUG 34 variety. It was purified and pathogenicity was proved using Koch postulates. The *in vitro* screeing of different chemicals and antibiotics against the pathogen was undertaken on the basis of their efficacy against various bacterial plant pathogens. List of chemicals and antibiotics tested is as under :

- a : Streptocycline (50 ppm),
- b : Streptocycline (50 ppm) + glycerine (1.0%),
- c : streptocycline (50 ppm) + Copper
oxychloride (50 ppm),
- d : Streptomycin sulfate (250 ppm)
- e : Tetracycline (250 ppm),
- f : Terramycin (250 ppm),
- g : Paushamycin (75 ppm),
- h : Copper oxychloride (200 ppm),
- i : Emisan-6/MEMC (3300 ppm) j; Bleaching
powder (200 ppm).

The molten nutrient agar (15 ml) containing the purified *Xanthomonas campestris* pv. *cyamopsidis* culture (10 cells/ml) was poured into sterile petridish, mixed gently and

TABLE 1

Effect of various chemicals and antibiotics on the growth of *Xanthomonas campestris* pv *cyamopsidis* of cluster bean.

| Sr. No. | Treatments | Zone of Inhibition (mm) |
|---------|---|------------------------------|
| 1. | Streptocycline (50 ppm) | 4.7079 ^{AB} (21.66) |
| 2. | Streptocycline (50 ppm) + Glycerine (1.0%) | 5.8803 ^{AB} (23.32) |
| 3. | Streptocycline (50 ppm) + Copper oxychloride (50 ppm) | 4.7079 ^{AB} (21.66) |
| 4. | Streptomycin sulfate (250 ppm) | 5.6419 ^A (31.33) |
| 5. | Tetracycline (250 ppm) | 4.3001 ^B (17.99) |
| 6. | Terramycin (250 ppm) | 3.9787 ^B (15.33) |
| 7. | Paushamycin (75 ppm) | 4.5996 ^B (20.66) |
| 8. | Copper oxychloride (200 ppm) | 1.6499 ^C (02.22) |
| 9. | Emisan-6/ MEMC (3300 ppm) | 4.7079 ^{AB} (21.66) |
| 10. | Bleaching Powder (200 ppm) | 0.7071 ^D (00.00) |
| 11. | Control | 0.7071 ^D (00.00) |
| | SEM | 0.288 |
| | CV % | 13.52 |

NOTE : a. Treatment means with the letter/letters in common are not significant by Duncan's New Multiple Range Test at 5% level of Significance.

b. Figures in parentheses are retransformed values.

allowed to solidify at room temperature. The wells (5 mm) were punched with a sterile cork borer and were sealed from bottom with 0.8% sterilized agar. The chemicals were carefully loaded into wells (50 ul/well) under aseptic conditions. Sterile distilled water (50 ul/well) was kept as control. There were three replications for all the treatments. The plates were incubated at 37 C for 48-72 hrs. For the development of zone of inhibition. The inhibition zones were measured after 72 hrs for each treatment and data were analysed using

Duncan's New Multiple Range Test. The data have been presented in Table-1.

It is evident from Table-1 that, out of ten chemicals screened in the laboratory, streptomycin sulfate (250 ppm) proved best over all other treatments and produced maximum zone of inhibition (31.33 mm). However, streptocycline (50 ppm) alone and in combination with glycerine (1.0%) and copper oxychloride (50 ppm) as well as Emisan-6/ MEMC (3300 ppm) were at par with each other. Bleaching

powder (200 ppm) was least effective and did not inhibit the growth of *Xanthomonas* on nutrient agar plate.

Lodha (1984) has suggested that seed treatment with streptocycline (250 ppm) proved effective in reducing the disease intensity and increase in the yield. However, higher dose of streptocycline (1000 ppm) has been recommended for seed treatment of guar against seed borne pathogens (Sowell, (1965).

It can be seen from Table-1 that streptocycline (50 ppm) was not effective over streptomycin sulfate (250 ppm) in the present

studies. The poor response by streptocycline could be attributed to low dose of antibiotic. However, seed treatment with higher dose can be tried for the control of bacterial blight of cluster bean as suggested by Lodha (1984).

On the basis of *in vitro* screening of various chemicals and antibiotics, streptomycin sulfate (250 ppm) could be used for the seed treatment for the control of bacterial blight.

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Association Studies in Okra (*Abelmoschus esculentus* (L.) Moench)

S. S. Patel, U. G. Kulkarni and Y. S. Nerkar

Genetics and Plant Breeding Department, Marathwada
Agricultural University, Parbhani-431 402

Yield being a polygenic character is very much influenced by environment changes, so selection for yield alone is not effective. Correlation provides the knowledge of relative importance of each of the component character helpful for stressing on specific characters. Therefore, it is essential to know the association of different yield components among themselves and with yield.

Ten Okra inbreds namely Punjab Padmini, Padra 18-6, A.E.-91, Kheda-8, Gujarat Bhendi, Parbhani Kranti, No-100, No.168, Red Line and Vaishali Vadhu were crossed in all possible combinations (excluding reciprocal) at College of Agriculture, M.A.U., Parbhani in Summer 1987. All 55 entries comprising of 10 parental lines and 45 hybrids were grown in randomised block design with three replications in Kharif 1987, spaced 45 x 30 cm. Observations were recorded for pod yield and six yield contributing traits. Data

obtained were analysed as per procedure of Croxton and Cowden (1964).

The genotypic and phenotypic correlation coefficient presented in Table 1 showed that the plant height (0.321 G, 0.313 P) and number of pods per plant (0.860 G, 0.685 P) had significant and positive correlation with green pod yield per plant. Our present results agreed with those reported by Singh and Singh (1978) and Swamy Rao and Kulkarni (1978). These two traits seem to be important for increasing green pod yield per plant. First fruiting node (-0.333 G, -0.327 P) and days to first flowering (-0.331 G, -0.324 P) showed desirable negative and significant correlation with green pod yield per plant. Korja and Rastogi (1978) reported correlation between days to flowering and green pod yield per plant.

Plant height was significantly correlated with first fruiting node (0.469 G, 0.459 P), inter-nodal length (0.634 G, 0.574 P) and days to first flowering (0.494 G, 0.452 P).

It is thus concluded that the characters viz., plant height, number of pods per plant and days to first flowering are the important yield contributing characters. Concentration upon these characters with specific objective while considering selection criterion will help to increase green pod yield in Okra.

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TABLE 1

Genotypic (G) and phenotypic (P) correlation co-efficient in F_1 diallel of Okra.

| | | First
fruiting
node | Inter
nodal
length
(cm) | Days to
first
flowering | Number
of pods/
plant | Pod
weight
(g) | Green pod
yield
plant (g) |
|----------------------------|---|---------------------------|----------------------------------|-------------------------------|-----------------------------|----------------------|---------------------------------|
| Plant height (cm) | G | 0.469** | 0.634** | 0.595** | 0.219 | 0.216 | 0.321* |
| | P | 0.459** | 0.574** | 0.452** | 0.174 | 0.182 | 0.313* |
| First fruiting node | G | | 0.449** | 0.878** | -0.269* | 0.105 | -0.333** |
| | P | | 0.401** | 0.832** | -0.206 | 0.093 | -0.327* |
| Inter-nodal | G | | | 0.387** | 0.315* | -0.278* | -0.167 |
| Length (cm) | P | | | 0.321* | -0.233 | 0.219 | -0.151 |
| Days to first
flowering | G | | | | -0.355** | 0.264 | -0.331* |
| | P | | | | -0.288* | 0.232 | -0.324* |
| Number of pods/
Plant | G | | | | | -0.478** | 0.860** |
| | P | | | | | -0.346** | 0.685** |
| Pod weight (g) | G | | | | | | -0.027 |
| | P | | | | | | -0.021 |

*, ** : Significant at 5% and 1% probability level of significance, respectively.

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Variability Studies in Bunch and Spreading Types of Groundnut at High and Low Fertility Levels

V. D. Pathak, V. J. Patel and K. V. Pethani

Main Oilseeds Research Station, Gujarat Agricultural University, Junagadh - 362 001

Groundnut, *Arachis hypogaea* (L.) is an important source of edible oil and is also rich in protein. The oil percentage and yield of groundnut have reached a plateau so there is urgent need to study genotypic coefficient of variation along with heritability estimate to get the information on genetic advance through selection. The present study was therefore undertaken to findout variability, heritability and genetic advance under high and low fertility levels in bunch and spreading groundnut with respect to yield and its component in the existing germplasm.

Fifteen varieties each of the spreading and bunch groundnut types were sown with two experiments under high (25 kg N & 50 kg P_2O_5 /ha) and low (12.5 kg N & 25 kg P_2O_5 /ha) fertility levels were laid out separately in randomised complete block design with three replications in the *kharif* season of July, 1983 at Main Oilseeds Research Station, Gujarat Agricultural University, Junagadh. Each plot consisted of single row of 5 m in length. The

crop was raised with all recommended agronomical practices. Observations were recorded on 10 randomly selected plants as mentioned in tables.

The value of range showed considerable amount of variation for most of the traits due to the application of higher dose of fertilizer. The characters like height of main axis, number of primary branches, number of pegs, number of pods, number of mature pods, days to maturity and pod yield showed moderately high phenotypic range under high fertility level in both groups, while 100 kernel weight showed high phenotypic range in bunch group (Table-1). Similar results have also been reported by Dixit *et al.* (1970) and Chauhan and Shukla (1985).

The genotypic variances was more or less equal to phenotypic variances for all the traits under high fertility level in both groups which indicated that improvement in these traits can be easily brought by phenotypic selection under high fertility. While high estimates of genotypic variances over error variances indicated that variation due to genetic causes was higher than due to non-genetic factors. In the present study high genotypic co-efficient of variation was observed for pod yield, number of primary branches, number of pegs, number of pods and height of main axis under high fertility level as compared to low fertility level in both groups indicated high degree of genotypic variability in

TABLE 1

Phenotypic range, overall mean with standard error, Genotypic (6^2_g), Phenotypic (5^2_p) and Error (6^2_e) variances of twelve characters for bunch (B) and spreading (S) types of groundnut under high (H) and low (L) fertility levels (FL).

| Character | F.L. | Phenotypic range | Mean $\pm$ S. Em. | Variance components | | | | | | | | | | | |
|---------------------------------------|------------------------------------|--------------------------------|--|---------------------|---|---|---------|-----------------|------------------|------------------|------------------|----------------|----------------|---|---|
| | | | | 6^2_g | | | 6^2_p | | | 6^2_e | | | | | |
| | | | | B | S | B | S | B | S | B | S | B | S | B | S |
| 1. Pod yield (g) per plant | H 4.42 - 9.15
L 5.25 - 8.25 | 7.40 - 14.22
6.32 - 11.15 | 6.56 $\pm$ 0.405
6.68 $\pm$ 0.357 | | | | | 1.739
0.733 | 4.037
2.188 | 2.231
1.073 | 6.012
3.294 | 0.492
0.340 | 1.975
1.106 | | |
| 2. Days to 50% flowering | H 26.00 - 30.00
L 27.33 - 31.33 | 32.67 - 36.67
33.00 - 37.00 | 27.73 $\pm$ 0.440
28.87 $\pm$ 0.452 | | | | | 1.100
1.173 | 1.270
1.162 | 1.680
1.787 | 2.454
2.476 | 0.580
0.616 | 1.184
1.314 | | |
| 3. Height of main axis (cm) | H 20.40 - 30.20
L 20.40 - 28.85 | 25.44 - 46.55
25.30 - 43.12 | 25.33 $\pm$ 0.633
24.65 $\pm$ 0.552 | | | | | 8.933
5.653 | 30.730
24.069 | 10.133
6.566 | 33.650
26.114 | 1.200
0.913 | 2.920
2.045 | | |
| 4. Number of primary branches/plant | H 3.40 - 6.75
L 3.72 - 6.10 | 3.85 - 7.57
3.20 - 6.68 | 5.01 $\pm$ 0.430
4.80 $\pm$ 0.300 | | | | | 0.911
0.300 | 1.094
0.692 | 1.458
0.570 | 1.933
1.262 | 0.547
0.270 | 0.839
0.570 | | |
| 5. Number of secondary branches/plant | H 1.50 - 3.50
L 0.50 - 3.40 | 4.10 - 12.55
4.94 - 13.44 | 2.24 $\pm$ 0.223
2.12 $\pm$ 0.212 | | | | | 0.370
0.440 | 5.287
4.183 | 0.520
0.570 | 6.172
4.856 | 0.149
0.133 | 0.885
0.673 | | |
| 6. Number of pegs/plant | H 13.45 - 27.28
L 12.88 - 24.37 | 17.60 - 31.63
18.56 - 27.47 | 21.80 $\pm$ 0.976
20.65 $\pm$ 0.800 | | | | | 15.787
9.059 | 15.410
6.550 | 18.644
10.976 | 18.390
12.154 | 2.857
1.917 | 2.980
5.604 | | |
| 7. Number of pods/plant | H 7.45 - 14.25
L 7.15 - 14.75 | 9.45 - 19.75
9.20 - 16.34 | 11.65 $\pm$ 0.681
11.40 $\pm$ 0.749 | | | | | 3.335
2.810 | 7.613
4.630 | 4.726
4.492 | 10.959
8.123 | 1.391
1.682 | 3.346
3.493 | | |

| Character | F.I. | Phenotypic range | Mean $\pm$ S. Em. | Variance components | | | | | | | | | | | |
|---------------------------------------|--------------------------------------|--------------------------------|--|--|------------------|------------------|------------------|------------------|----------------|----------------|--------------|---|---|---|---|
| | | | | σ^2_g | | | σ^2_p | | | | σ^2_e | | | | |
| | B | S | B | S | B | S | B | S | B | S | B | S | B | S | S |
| 8. Number of
Mature pods/
plant | H 6.70 - 11.25
L 6.40 - 10.66 | 6.20 - 14.66
6.20 - 11.56 | 8.53 $\pm$ 0.443
7.99 $\pm$ 0.330 | 8.70 $\pm$ 0.807
8.12 $\pm$ 0.838 | 1.290
1.138 | 4.911
2.212 | 1.870
1.452 | 6.813
4.221 | 0.580
0.314 | 1.952
2.109 | | | | | |
| 9. Days to maturity | H 96.00 - 107.33
L 97.33 - 110.00 | 111.00-121.33
112.00-123.63 | 101.04 $\pm$ 0.704
102.69 $\pm$ 0.600 | 116.54 $\pm$ 0.867
117.18 $\pm$ 0.772 | 10.330
13.013 | 9.745
10.676 | 11.820
14.083 | 12.002
12.464 | 1.490
1.070 | 2.257
1.788 | | | | | |
| 10. Shelling
percentage | H 65.30 - 71.80
L 66.60 - 71.50 | 62.36- 70.92
63.55- 71.58 | 68.24 $\pm$ 0.700
68.35 $\pm$ 0.777 | 67.34 $\pm$ 0.840
67.55 $\pm$ 0.631 | 2.768
1.970 | 7.703
6.710 | 4.223
3.780 | 9.801
7.903 | 1.455
1.810 | 2.098
1.193 | | | | | |
| 11. 100 kernel
weight (g) | H 28.68 - 45.72
L 28.85 - 44.40 | 32.57 - 47.70
29.05 - 46.35 | 33.52 $\pm$ 0.527
33.71 $\pm$ 0.690 | 38.76 $\pm$ 0.707
38.90 $\pm$ 0.777 | 19.215
15.210 | 21.070
24.950 | 20.048
16.631 | 22.569
26.759 | 0.833
1.421 | 1.499
1.809 | | | | | |
| 12. Oil percentage | H 46.30 - 50.20
L 46.40 - 50.60 | 46.70 - 50.62
46.50 - 50.45 | 48.28 $\pm$ 0.214
48.33 $\pm$ 0.171 | 48.51 $\pm$ 0.210
48.54 $\pm$ 0.223 | 0.917
0.990 | 0.987
1.046 | 1.055
1.078 | 1.119
1.209 | 0.138
0.088 | 0.132
0.163 | | | | | |

TABLE 2

Genotypic coefficient of variation, heritability, expected genotype advance and genetic advance expressed as percentage of mean of twelve characters for bunch (B) and spreading (S) types of groundnut under high (H) and low (L) fertility levels (FL).

| Sr. No. | Character | F.L. | Genotypic coefficient variation % | | Heritability (B.S.) % | | Expected genetic advance ($K = 2.06$) | | Genetic advance expressed as % of mean % | |
|---------|------------------------------------|------|-----------------------------------|-------|-----------------------|-------|---|-------|--|-------|
| | | | (B) | (S) | (B) | (S) | (B) | (S) | (B) | (S) |
| 1. | Pod yield (g) per plant | H | 20.10 | 20.46 | 77.95 | 67.15 | 2.40 | 3.40 | 36.56 | 34.62 |
| | | L | 12.82 | 18.00 | 68.31 | 66.42 | 1.46 | 2.48 | 21.83 | 30.22 |
| 2. | Days to 50 % flowering | H | 3.78 | 3.24 | 65.48 | 51.75 | 1.75 | 1.67 | 6.37 | 4.80 |
| | | L | 3.75 | 3.07 | 65.64 | 46.93 | 1.81 | 1.52 | 6.26 | 4.33 |
| 3. | Height of main axis (cm) | H | 11.71 | 18.34 | 88.16 | 91.33 | 5.78 | 10.91 | 22.64 | 36.10 |
| | | L | 9.62 | 16.66 | 88.04 | 92.17 | 4.54 | 9.70 | 18.45 | 32.92 |
| 4. | Number of primary branches/plant | H | 19.05 | 18.64 | 62.50 | 56.60 | 1.56 | 1.62 | 31.03 | 28.90 |
| | | L | 11.41 | 15.70 | 62.60 | 54.83 | 0.82 | 1.27 | 17.07 | 23.94 |
| 5. | Number of secondary branches/plant | H | 27.05 | 27.87 | 71.31 | 85.66 | 1.07 | 4.38 | 47.05 | 53.14 |
| | | L | 31.28 | 25.53 | 76.77 | 87.14 | 1.20 | 3.91 | 56.46 | 48.82 |
| 6. | Number of pegs/plant | H | 18.23 | 15.42 | 84.68 | 83.80 | 7.53 | 7.41 | 34.55 | 29.10 |
| | | L | 14.58 | 10.76 | 82.53 | 53.89 | 5.63 | 3.87 | 27.28 | 16.28 |
| 7. | Number of pods/plant | H | 15.68 | 19.49 | 70.57 | 69.47 | 3.16 | 4.74 | 27.13 | 33.46 |
| | | L | 14.70 | 17.64 | 62.56 | 57.00 | 2.73 | 3.35 | 23.96 | 27.43 |
| 8. | Number of mature pods/plant | H | 13.32 | 25.47 | 69.00 | 71.56 | 1.94 | 3.86 | 22.80 | 44.39 |
| | | L | 13.35 | 17.86 | 78.37 | 49.92 | 1.95 | 2.11 | 24.41 | 25.99 |
| 9. | Days to maturity | H | 3.18 | 2.68 | 87.39 | 81.19 | 6.19 | 5.79 | 6.13 | 4.97 |
| | | L | 3.51 | 2.79 | 92.40 | 85.65 | 7.14 | 6.23 | 6.95 | 5.32 |
| 10. | Shelling percentage | H | 2.44 | 4.12 | 65.55 | 78.59 | 2.78 | 5.07 | 4.07 | 7.53 |
| | | L | 1.77 | 3.84 | 44.82 | 84.90 | 1.68 | 4.92 | 2.46 | 7.29 |
| 11. | 100 kernel weight (g) | H | 13.08 | 11.85 | 95.84 | 93.36 | 8.84 | 9.14 | 26.37 | 23.57 |
| | | L | 11.57 | 12.84 | 91.46 | 93.24 | 7.68 | 9.94 | 22.79 | 25.54 |
| 12. | Oil percentage | H | 1.98 | 2.05 | 86.92 | 88.20 | 1.84 | 1.92 | 3.81 | 3.96 |
| | | L | 2.06 | 2.11 | 91.84 | 86.52 | 1.96 | 1.96 | 4.06 | 4.04 |

the above traits. The low genotypic coefficient of variation for oil percentage indicated that for this trait, the variation had reached a plateau. Therefore, there is a need for collecting new materials.

High heritability estimates for pod yield, number of primary branches, number of pegs, number of pods and 100 kernel weight under high fertility level in both groups, indicated that cyclic selection becomes very effective resulting in a faster rate of improvement as the environmental effect is less. Though the oil percentage and days to maturity recorded high heritability, but with low genotypic coefficient of variation, it makes it unsuitable for direct selection for improvement, while 100 kernel weight showed high heritability value indicates possibilities of evolving bold seeded table varieties for export purpose by putting proper selection pressure for a reasonable period of time.

The result of the present study indicated that the direct selection for number of secondary branches (high values of genotypic

coefficient of variation, heritability coupled with high genetic advance expressed as a percentage of mean) could be effective in yield improvement at lower fertility level in bunch group and at high fertility level in spreading group pod yield, number of primary branches, number of pegs, number of pods showed high genotypic coefficient of variation and heritability values coupled with high genetic advance expressed as a percentage of mean under high fertility level in both the groups, suggested that the characters can be improved through direct selection under high fertility level. Chauhan and Shukla (1985) and Swamy Rao T. *et al.* (1988) also reported similar results. Oil percentage showed high heritability and low genetic advance expressed as a percentage of mean under both fertility levels in both the groups which suggested that high heritability was probably due to non-additive gene action. Poor genetic advance indicated that the character is less variable.

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Intercropping in Maize (*Zea mays* (L.) with Pigeon pea under Different Spacing and Fertility Levels

G. J. Patel, G. N. Patel and M. D. Arha

Maize Research Station, Gujarat Agricultural University,
Godhra-389 001

Studies were undertaken at the Maize Research Station, Gujarat Agricultural University, Godhra from 1988 to 1990 on intercropping in maize with pigeon pea to different spacing and fertilizer levels under the rainfed condition. The maize var. Farm Sameri intercropped with pigeon pea (BDN-2) in the ratio of 1:1 with a row spacing of 45 cm and 80 kg N/ha and 40 kg P_2O_5 /ha gave maximum net returns of Rs. 7333/- per ha.

Intercropping has proved to be as effective tool in increasing the production of field crops. Maize is an important food crop in Gujarat. Usually farmers intercrop maize with pigeon pea to minimise risk in *kharif* crop production.

The pattern of maize + pigeon pea intercropping is highly variable and no information is available as what should be the exact pattern for maize + pigeon pea intercropping system for maximum net returns. Row arrangement and intercropping with legumes like pigeon pea has an added advantage over sole cropping. Planting geometry not only help in the maximum

utilization of natural resources like sunlight and aeration but also helps in arranging higher plant population which in turn contributes to higher yields of crops (Willey, 1979). Maize intercropped with pigeon pea (legume) might have been benefitted through nitrogen fixation specifically in the condition when nearly half of the recommended dose of nitrogen was given to the crop (Chauhan and Dunganwal, 1982). Intercropping in maize not only gave higher production but also minimised weed growth (Pandey *et al.* 1981).

The present experiment was conducted to generate information on intercropping in maize with pigeon pea with proper method of sowing, spacing and fertilizer requirement to achieve higher productivity and net profit under rainfed farming in middle Gujarat Agro-climatic zone of Gujarat.

An experiment was conducted during *kharif* 1988, 1989 and 1990 at the Main Maize Research Station, Gujarat Agricultural University, Godhra, in split-plot design with four replications. The two spacings viz. 45 cm and 60 cm and two fertilizer levels viz. 40 kg N : 20 kg P_2O_5 /ha and 80 kg N : 40 kg P_2O_5 /ha were taken as main plot treatments, while four methods of sowing Maize + Tur (1 : 1), Maize + Tur (2 : 1), Maize + Maize and Tur mixture and Mixture of Maize and Tur in every row were taken as sub-plot treatments. The crops were sown with the onset of monsoon and harvested when maturity was attained for each crop.

TABLE 1

Grain yield and maize equivalent of maize and pigeon pea intercropping.

| Treatments | Maize grain (kg/ha) | | | Pigeon-pea (intercrop) (kg/ha) | | | Maize equivalent (kg/ha) | | | | | |
|--------------------------|---------------------|---------|---------|--------------------------------|---------|---------|--------------------------|---------|---------|---------|---------|---------|
| | 1988-89 | 1989-90 | 1990-91 | Average | 1988-89 | 1989-90 | 1990-91 | Average | 1988-89 | 1989-90 | 1990-91 | Average |
| Spacing | | | | | | | | | | | | |
| S ₁ (60 CM.) | 744 | 788 | 740 | 758 | 635 | 98 | 803 | 512 | 2311 | 1111 | 3171 | 2198 |
| S ₂ (60 CM.) | 1020 | 851 | 991 | 956 | 702 | 118 | 929 | 583 | 2777 | 1146 | 3783 | 2568 |
| CD at 5% | 16 | N.S. | 66 | N.S. | N.S. | 19 | 58 | N.S. | 164 | N.S. | 253 | N.S. |
| Fertilizers | | | | | | | | | | | | |
| F ₁ (80:40:0) | 1029 | 938 | 1014 | 994 | 761 | 114 | 1030 | 635 | 2930 | 1221 | 4103 | 2751 |
| F ₂ (40:20:0) | 734 | 701 | 723 | 720 | 577 | 102 | 702 | 460 | 2157 | 1036 | 2851 | 2014 |
| C.D. at 5% | 46 | 194 | 66 | 110 | 67 | N.S. | 58 | N.S. | 164 | N.S. | 253 | N.S. |
| Methods | | | | | | | | | | | | |
| M ₁ | 726 | 980 | 717 | 820 | 762 | 122 | 1007 | 630 | 2619 | 1444 | 3738 | 2600 |
| M ₂ | 929 | 807 | 729 | 888 | 654 | 98 | 899 | 550 | 2565 | 1051 | 3671 | 2429 |
| M ₃ | 1189 | 556 | 1152 | 966 | 547 | 111 | 599 | 419 | 2557 | 832 | 2950 | 2113 |
| M ₄ | 648 | 938 | 676 | 754 | 712 | 101 | 959 | 591 | 2434 | 1187 | 3549 | 2390 |
| C.D. at 5% | 144 | 177 | 136 | N.S. | 63 | N.S. | 69 | N.S. | N.S. | 237 | 280 | N.S. |

The soils of the location is sandy loam to clay loam in texture with PH 7.5 and organic carbon 0.3 per cent. The available soil phosphorus and potash were 61 and 444 kg/ha, respectively. The total output of components of intercropping system (maize and pigeon pea) was converted in to maize equivalent by using the following formula :

$$\text{Maize Equivalent (kg/ha)} = \frac{\text{Weight of grain (kg/ha)} \times \text{Intercrop grain price (Rs/kg)}}{\text{Price of maize grain (Rs/kg)}}$$

In general, grain yield in 1989-90 was poor as compared to those of in the other seasons (Table 1). This may be attributed to uneven distribution and occurrence of high rainfall in the months of July and August 1989 (384.0 and 596.5 mms) that adversely affected plant growth and grain formation.

Maize yield

Maximum reduction in maize yield was recorded when it was intercropped with pigeon pea grown in wider spacing (60 cm) and lower fertility levels (40 : 20 NP kg/ha). Highest grain yield (956 kg/ha) was obtained when intercropped with pigeon pea at closer spacing (45 cm). This may be attributed to higher plant density per unit area. Sawhney *et al.* (1989) also reported similar results. Application of 80 : 40 NP kg/ha gave 38% higher yield as compared to 40 : 20 NP kg/ha. Method of sowing did not contribute significantly in grain yield improvement (Table 1).

Pigeon Pea Yield

Yield data showed that average seed yield of pigeon pea increased in closer spacing (45 cm) and resulted in 13.9% higher yield as

compared to wider spacing (60 cm). As regards the effect of fertilizer levels on the grain yield it increased significantly with the application of higher level (80 : 40 NP kg/ha) in two years (1988-89 and 1990-91). In one year the difference was non-significant (1989-90). Significantly higher seed yield of pigeon pea (635 kg/ha) was obtained in 80 : 40 NP kg/ha when compared to half of the recommended dose. Pooled analysis showed that pigeon pea yield in Maize + Tur in 1:1 row was highest (630 kg/ha) among all the methods of intercropping.

Maize Equivalent

The Maize equivalent was affected by planting geometry during all the three years. Pooled analysis showed that, sowing the crop at closer spacing (45 cm) gave 16.8% higher yield as compared to wider spacing (60 cm) when intercropped with pigeon pea. This may be attributed to nitrogen fixing behaviour of legumes and higher canopy cover resulting in the reduced evapotranspiration (Shah *et al.* 1991). Application of 80 : 40 NP kg/ha recorded 36.6% higher yield as compared to half of the recommended dose of fertilizers i.e. 40 : 20 NP kg/ha. The results clearly indicate that during all the three years maize and pigeon pea sown in the ratio of 1 : 1 always gave higher yield (2600 kg/ha).

Economics

Results (Table-2) indicate that the highest net realization of Rs. 7333/- per ha and CBR (2-93) was recorded with the use of 45 cm spacing, 80 : 40 NP kg/ha and 1 : 1 ratio of Maize + Tur planting. Maize productivity is known to be increased by inter cropping (Mittal *et al.* 1985). These results also confirm the fact that intercropping is a risk covering approach under rainfed conditions (Giri, 1990).

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TABLE 2

Mean data realization as influenced by different treatments.

| Sr. No. | Treatment | Maize grain yield (kg/ha) | Inter crop yield kg/ha | Maize equivalent yield (kg/ha) | *Gross realization (Rs/ha) | Cost of production (Rs/ha) | Net realization (Rs/ha) | CBR |
|---------|--|---------------------------|------------------------|--------------------------------|----------------------------|----------------------------|-------------------------|------|
| 1. | S ₁ F ₁ M ₁ | 783 | 601 | 2477 | 6729 | 2450 | 4279 | 1.75 |
| 2. | S ₁ F ₁ M ₂ | 887 | 645 | 2647 | 7396 | 2242 | 5954 | 2.44 |
| 3. | S ₁ F ₁ M ₃ | 1058 | 468 | 2330 | 6299 | 2438 | 3861 | 1.58 |
| 4. | S ₁ F ₁ M ₄ | 755 | 637 | 2541 | 7056 | 2450 | 4606 | 1.88 |
| 5. | S ₁ F ₂ M ₁ | 607 | 488 | 2057 | 5611 | 1990 | 3621 | 1.82 |
| 6. | S ₁ F ₂ M ₂ | 678 | 496 | 2110 | 5778 | 1982 | 3796 | 1.90 |
| 7. | S ₁ F ₂ M ₃ | 737 | 322 | 1609 | 4347 | 1978 | 2369 | 1.20 |
| 8. | S ₁ F ₂ M ₄ | 592 | 440 | 1803 | 4854 | 1990 | 2864 | 1.44 |
| 9. | S ₂ F ₁ M ₁ | 1259 | 898 | 3656 | 9833 | 2500 | 7333 | 2.93 |
| 10. | S ₂ F ₁ M ₂ | 1067 | 620 | 2773 | 7697 | 2492 | 5205 | 2.08 |
| 11. | S ₂ F ₁ M ₃ | 1245 | 496 | 2624 | 7247 | 2488 | 4759 | 1.99 |
| 12. | S ₂ F ₁ M ₄ | 983 | 609 | 2936 | 8006 | 2500 | 5506 | 2.20 |
| 13. | S ₂ F ₂ M ₁ | 781 | 534 | 2242 | 6049 | 2040 | 4009 | 1.96 |
| 14. | S ₂ F ₂ M ₂ | 913 | 441 | 2315 | 5852 | 2032 | 3820 | 1.88 |
| 15. | S ₂ F ₂ M ₃ | 809 | 389 | 1885 | 5185 | 2028 | 3157 | 1.56 |
| 16. | S ₂ F ₂ M ₄ | 689 | 579 | 2278 | 6259 | 2040 | 4219 | 2.06 |

*Note : Gross realization has been worked out by taking maize grain and pigeon-pea prices as Rs. 2.50 and Rs. 3.75 per kg. of grain respectively.

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A Note on Age and Body Weight at Maturity in Crossbred Sheep Reared Under Confinement

R. R. Shah, D. P. Pandey and P. B. Patel

Livestock Research Station, G.A.U.,
Sardar Krushinagar-385 506

Variation in reproductive performance traits of crossbred sheep arises due to several genetic and non-genetic factors viz. genetic groups, level of exotic inheritance, year and season of birth. Attempt has been made to investigate the effect different levels of exotic inheritance [i.e. 50% (F_1 and F_2 's), 62.5% and 75%] on age and body weight at maturity and lambing in 93 ewe lambs born out of the crossing of Rambouillet and Russian Merino rams with Patanwadi ewes, during 1985-86. Relevant records for analysis were obtained from all India Co-ordinated Research Project on sheep breeding for fine wool, Dantiwada unit.

The average age at first oestrous, first conception and first lambing were 749.28 ± 15.80 (93), 778.30 ± 17.20 (60) and 924.27 ± 16.87 (60) days respectively. Genetic group-wise, mean ages of these traits has been furnished in table-1. Analysis of variance revealed that the genetic group differences were non-significant for all these traits. However DMRT revealed that Rambouillet x Patanwadi F_1 's had significantly lowest age at expression of these traits.

The average body weight of ewe lambs at first oestrous, first conception and at first lambing were 25.64 ± 0.29 (93), 26.68 ± 0.44 (60) and 26.76 ± 0.44 (60) kg respectively. Genetic groupwise body weights have been furnished in table-1. The analysis of variance revealed that the genetic group differences were non-significant for these traits. However DMRT revealed that Rambouillet x Patanwadi F_1 's had significantly lowest body weight at first oestrous and first lambing, while rest of the genetic groups were having above average body weights. Body weights at first conception did not differ from each other in all the genetic groups.

Non-significant effect of genetic groups on age and body weights at first oestrous, conception and lambing, in general observed during present study were in confirmation with the findings reported by Sinha *et al.* (1979) in Muzaffarnagari and its crosses with Dorset and Suffolk and by Singh *et al.* (1985) in Chokala and its crosses with Rambouillet and Russian Merino. The age at first mating and lambing observed in the present study were in corroboration with the findings for these traits in Malpura, Chokala and their 3/4 breds as reported by Kishore *et al.* (1982). They also studied these traits in Avikalin and Avivastra strains developed at Central Sheep and Wool Research Institute, Avikanagar. The present findings were very close to their findings. Slightly lower age and body weight at first lambing in Nali, Russian Merino and their

TABLE 1

Mean and S.E. of age and weight at first oestrus, first conception and first lambing in crosses of Rambouillet and Russian Merino with Patanwadi.

| Breed group | First Oestrus | | First Conception | | First Lambing | |
|----------------------|---|---|---|-----------------------------|---|--|
| | Age (days) | Weight (kg) | Age (days) | Weight (kg) | Age (days) | Weight (kg) |
| Overall | 749.28 ± 15.80
(93,20.34) | 25.64 ± 0.29
(93,11.00) | 778.30 ± 17.20
(60, 17.12) | 26.68 ± 0.44
(60, 12.67) | 924.27 ± 16.87
(60, 14.10) | 26.76 ± 0.44
(60, 12.64) |
| Ramb. × Pat. | | | | | | |
| F ₁ 's | 603.67 + 22.01 ^a
(6,8.93) | 22.30 + 1.03 ^a
(6,11.33) | 677.00 + 55.54 ^a
(5,18.34) | 23.72 + 2.06
(5,19.41) | 825.00 + 55.37 ^a
(5,15.01) | 24.84 + 2.02 ^{ab}
(5,18.19) |
| F ₂ 's | 761.58 + 33.36 ^b
(12,15.18) | 25.28 + 0.49 ^b
(12,6.74) | 764.00 + 38.16 ^b
(9,14.98) | 25.58 + 0.58
(9,6.77) | 913.00 + 38.48 ^b
(9,13.20) | 25.38 + 1.13 ^{ab}
(9,12.08) |
| 5/8th | 790.07 + 41.75 ^b
(15,20.47) | 25.99 + 0.81 ^b
(15,12.04) | 847.89 + 47.69 ^b
(9,16.87) | 27.40 + 1.48
(9,16.19) | 984.44 + 45.17 ^b
(9,15.36) | 26.51 + 1.17 ^{ab}
(11,14.32) |
| 3/4th | 771.00 + 40.76 ^b
(7,13.99) | 25.78 + 1.05 ^b
(7,10.80) | 765.67 + 39.40 ^b
(3,8.91) | 26.40 + 1.73
(3,11.36) | 921.34 + 41.51 ^b
(3,7.88) | 26.94 + 1.62 ^{ab}
(3,10.41) |
| Merino × Pat. | | | | | | |
| F ₁ 's | 784.00 + 44.20 ^b
(10,17.83) | 26.24 + 1.01 ^b
(10,12.18) | 760.43 + 49.18 ^b
(7,17.11) | 26.09 + 1.12
(7,11.31) | 909.57 + 48.59 ^b
(7,14.13) | 28.26 + 1.59 ^a
(7,14.80) |
| F ₂ 's | 773.08 + 37.26 ^b
(12,16.70) | 25.13 + 0.87 ^b
(12,12.03) | 846.00 + 35.61 ^b
(16,8.90) | 26.57 + 0.88
(6,8.28) | 993.34 + 28.80 ^b
(6,7.10) | 26.03 + 0.54 ^{ab}
(6,5.08) |
| 5/8th | 747.94 + 41.83 ^b
(15,21.66) | 26.21 + 0.69 ^b
(15,10.14) | 809.75 + 44.01 ^b
(18,15.37) | 27.30 + 1.32
(8,13.67) | 955.00 + 44.31 ^b
(8,14.54) | 26.95 + 1.48 ^{ab}
(8,15.14) |
| 3/4th | 708.62 + 46.77 ^b
(16,26.41) | 26.25 + 0.66 ^b
(16,10.12) | 740.92 + 45.17 ^b
(13,21.98) | 28.14 + 0.91
(13,11.68) | 888.46 + 44.61 ^b
(13,18.10) | 28.02 + 0.68 ^a
(13,8.72) |

Similar superscript indicates no significant difference in that column. Number of observations and coefficient of variation is given in the bracket.

crossbreds than those observed in present study has been reported by Srivastava *et al.* (1983).

The correlation coefficients between age and body weights at first oestrous, first conception and first lambing were 0.2980, 0.3446, 0.0583 respectively. The positive

association was indicative of increased weights with increased age. Thus to reduce age at maturity one will have to sacrifice for weight to some extent but not below the optimum weight of 22.0 kg. Otherwise with normal management practices, in general the ewe lamb will mature at age of two years for breeding and will deliver the lamb thereafter.

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Effect of Plant Gaps on Growth of Bidi Tobacco (*Nicotiana tabacum* L.) Plant

M. J. Buch and N. M. Patel

Gujarat Agricultural University,
Anand Campus, Anand-388 110

Uniform plant stand in each plot of the experiment is the prime requirement for precised estimates of treatment effect (s). Various procedures for adjusting yield based on plant stand have been used in different crops (Arceneaux and Stocks, 1939; Leng and Finley, 1957 and Crews and Jones, 1962). The method of analysis of covariance provides satisfactory method of adjusting the experimental data as compared to the method of adjustment by way of direct proportion which results in to over estimation of yield (Crews and Jones, 1962 and Buch and Patel, 1978). The decision whether to adjust yield data for plant stand reduction is a difficult one, especially when the reduction in plant stand is more. For this purpose, it is of importance to know the effect of plant gaps on plant growth (yield).

An experiment was conducted at the College Agronomy Farm, GAU, Anand Campus, Anand in split plot design with five replications to study the effect of plant gap(s) on yield of bidi tobacco plant. The treatments comprised of all 20 combinations of period of occurrence of gap (P) and the plant stand(S) are given below :

P : Period of occurrence of gap (main plot treatments)

P1 = 0 day after transplanting

P2 = 30 days after transplanting

P3 = 60 days after transplanting

P4 = 90 days after transplanting

S : Plant stand in net plot of 7.5 m x 1.8 m (sub plot treatments)

S1 = 20 plants (no gap)

S2 = 18 plants (10% gap)

S3 = 16 plants (20% gap)

S4 = 14 plants (30% gap)

S5 = 12 plants (40% gap)

At appropriate time the plants were removed at random to create required gaps in the experimental plots.

The bidi tobacco variety Anand-2 was transplanted at 90 cm x 75 cm spacing. Crop cultivation was done as per the practices in vogue and all plants were uniformly topped leaving twenty leaves per plant.

The results (Table 1) revealed significant influence of number of plant gaps in experimental plot on yield of bidi tobacco. The yield per plot decreased from 3.011 kg (No gap) to 2.411 kg (40 per cent gaps per plot), the difference being significant. The decreasing trend in yield per unit area is akin to the findings reported by Arceneaux and Stokes (1939) and Crews and Jones (1962).

Gaps around the plant provides more space (area) for development by way of low competition between plants for nutrients, moisture, light etc. Bidi tobacco being space planted deep rooted nitrogen loving crop is likely to be influenced by the gaps. The expected yield at

full plant stand $[(\text{actual yield per plot} \times 20) \div \text{actual number of plants per plot}]$ given in Table 1 showed upward bias in treatment estimates. The tobacco yield per plant increased with the increase in number of gaps per unit area. On the basis of "no gap" (S_1), the compensation

TABLE 1

The average tobacco yield (kg/plot) as influenced by the gap(s) and period of occurrence of gaps(p).

| S | P | | | | | Expected yield at full stand |
|------------|-------|-------|--------|--------|-------|------------------------------|
| | P_1 | P_2 | P_3 | P_4 | Av. | |
| S_1 | 3.027 | 3.006 | 3.198 | 2.813 | 3.011 | 3.011 |
| S_2 | 3.032 | 3.022 | 2.974 | 2.745 | 2.943 | 3.270 |
| S_3 | 2.934 | 2.660 | 2.568 | 2.609 | 2.693 | 3.366 |
| S_4 | 2.233 | 3.055 | 2.637 | 2.667 | 2.649 | 3.784 |
| S_5 | 2.289 | 2.446 | 2.561 | 2.346 | 2.411 | 4.018 |
| Av | 2.703 | 2.838 | 2.787 | 2.636 | — | — |
| | | | | | | |
| Effect | | | P | S | P x S | |
| S. Em. | | | 0.084 | 0.072 | 0.199 | |
| C. D. 0.05 | | | NS | 0.202 | NS | |
| C. V. % | | | 15.200 | 11.700 | — | |

(increase in yield) per plant due to gap was 8.6, 11.8, 25.7 and 33.5 per cent for S_2 , S_3 , S_4 and S_5 respectively. The results thus lead to the conclusion that the observed yield of gappy experimental plot is not a normal yield, affecting precision of the estimates (treatment as well as error). This suggest that if random gaps occur

in the experimental plots of bidi tobacco, the results (yield) need to be adjusted for gap effect by proper method like covariance technique.

The period effect as well as interaction effect was not significant for yield.

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Abstracts of Ph. D. Thesis

Incidence Bioefficacy Serology and Genomic Characterization of *Heliothis Baculovirus* Isolates

Submitted to G. B. Pant University of Agriculture & Technology, Pantnagar, Nainital

Student
H. G. Vyas

Major Guide
B. D. Lakhchaura

Department of Plant Pathology, Gujarat Agricultural University Anand Campus, Anand

Heliothis armigera Hubner (Lepidoptera: Noctuidae) is one of the most devastating insect pest among the borers and attacks cotton, tomato, lucerne and many legumes. In Tarai belt of North-Eastern UP, the damage to chickpea has been estimated to be as high as 58%. Attempts to control the pest solely by chemical pesticides creates enormous problems. They destroy the natural biocontrol agents and raise severe ecological problems by environmental pollution and leave the residual contamination in food and fiber. A programme of Integrated Pest Management (IPM) is currently being advocated to fight the pest menace.

The present investigation was undertaken with a view to initiate systematic work on incidence and bioefficacy of microbial agents associated with *Heliothis armigera* in chickpea. No attempt has been made so far on the serological and genotypic relation of various geographic isolates of *Heliothis baculovirus* in India. Conventional serological and modern genetic techniques of restriction analysis have been employed for the comparison of variation in these isolates.

The natural incidence of parasites and pathogens associated with *Heliothis armigera* on chickpea during Feb.-March, 1988 indicated that parasite population was

highest during first week of February and subsequently decreased to zero level by third week of April and showed a negative correlation with temperature. The gross mortality due to pathogens including bacteria, protozoa and viruses did not show any specific trend. The Nuclear Polyhedrosis Virus (NPV) appeared in third week of March and caused as high as 90% mortality during third week of April and showed a positive correlation with field temperature and total mortality.

The efficacy test on chickpea showed that 250 LE/ha NPV (3 rounds) reduced the larval population and pod damage. An increase in mortality due to virus and grain yield was observed in NPV treated plots. However, two applications of 0.07% endosulfan performed slightly better than NPV application. The combination of NPV + insecticides at 50% reduced doses, though, showed significant reduction in pod damage and increase in yield, did not prove better than NPV or insecticide alone.

An attempt was made to study the serological homology amongst various isolates of *Heliothis baculovirus* from five different geographic locations of India. Cross reaction studies indicated that all the isolates are homologous. The attempts with fractionated antigens (alkaline digest containing polyhedron protein, purified polyhedron protein and purified virions) suggested that these isolates had homologous polyhedron matrix, however, virions may be antigenically different.

The genomic characterization revealed that the fragmentation profiles produced by EcoRI, Sall and HindIII digestion had similar patterns, however, minor genotypic variations were observed. FRD and PNT isolates showed identical patterns with HindIII enzyme. Studies of methylated sites on DNA using HpaII and MspI clearly indicated that out five fragments produced by MspI, two fragments corresponded with HpaII digestion products. The three unidentical bands suggested possible methylated sites.

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Role Expectation and Role Performance of Rural Women in Farm Management (a Study in Valsad District of Gujarat State)

Submitted to Gujarat Agricultural University

Student

P. M. Parekh

Major Guide

D. N. Pandya

Department of Extension Education, N. M. College of Agriculture, Gujarat Agricultural University, Navsari Campus, Navsari

The study on rural women's role in farm management was undertaken keeping in view of the increasing importance of involvement of rural women in agricultural production programmes. Studies in this field so far have exhibited a negligible concern for a systematic study on rural women's role in India as well as in Gujarat State. Hence this study was conducted with an objective of ascertaining the role expectations and role performances of rural women in farm management and to elucidate the factors affecting the role performance.

The study was conducted in eight randomly selected villages of Navsari taluka of Valsad district which is considered as rice bowl of Gujarat State. Ex-post-facto research design was adopted with purposive and stratified random sampling procedures. In all 120 rural women (40 from low economic group, 40 from medium economic group, and 40 from high economic group), 120 rural husbands and 60 experts were interviewed for the purpose of the study.

It was found out from the study that four roles, namely, allied agriculture, harvest and post-harvest, inter cultivation and presowing and sowing in order were expected to be performed by rural women in farm

management. Thirty five sub-roles were delineated under these four major roles. These four major roles were considered as role expectations for finding out the actual role performance of the rural women.

There was significant difference regarding perception of role expectation by experts, rural women, and their husbands. The role performance of rural women in farm management was low and average and none recorded high performance, i.e., above 60 per cent. The low economic category of rural women performed more work in farm activities, the medium and high economic categories of rural women performed more work in allied agricultural activities but there was no significant difference in role performance between these categories of rural women when both agricultural and allied agricultural activities were considered together.

Caste, education, land holding, socio-economic status, urban contact and conservatism value were negatively and significantly associated whereas leadership status and family norms were positively and significantly associated with the farm role performance of rural women. The multiple regression fitted with seventeen independent variables have explained variation of 48.17 per cent on the farm role performance of rural women. However, education (negatively) and family size (Positively) emerged as significant variables in predicting the role performance of rural women in farm management.

The time utilization study of rural women revealed that on an average they spend 15.83 per cent of their time for agricultural activities and remaining 84.17 per cent for allied agricultural, household, social and leisure time and resting activities. The medium and high economic categories of rural women spent more time for allied agricultural activities whereas the low economic category of rural women spent more time for agricultural activities.

These findings could be utilized by development agencies for motivating the rural women in order to perform their roles effectively in farm management.

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**Effect of Post Monsoon Irrigation,
Biofertilizer and Nitrogen Levels on
Growth and Yield of Pigeonpea
(*Cajanus cajan* (L.) Millsp.) Var. BDN-2
in Vertisol of South Gujarat**

Submitted to Gujarat Agricultural University

Student

J. R. Patel

Major Guide

Z. G. Patel

Department of Agronomy, N. M. College of Agriculture,
Gujarat Agricultural University, Navsari Campus, Navsari

Field experiment was conducted at College Farm, Gujarat Agricultural University, Navsari during *kharif* seasons of 1989-90 and 1990-91 to study the effect of post monsoon irrigation, biofertilizer and nitrogen levels on yield of pigeonpea in vertisol of South Gujarat. Twenty four treatments comprising four levels of irrigation (no irrigation and scheduling irrigation at 0.25, 0.50 and 0.75 IW/CPE ratio) as main plot and combination of two levels of inoculation (with and without *rhizobium* inoculation) and three levels of nitrogen (0, 10 and 20 kg/ha) as sub plot treatments were employed in split plot design with four replications. The pigeonpea Cv. BDN-2 was used for experimental purpose. Irrigation each of 80 mm depth of water was applied as per schedule after the cessation of monsoon in 0.25, 0.50 and 0.75 IW/CPE ratios which received one, two and four irrigations, respectively. The results showed that although all the IW/CPE ratios did not differ significantly among themselves, produced sig-

nificantly higher grain yield over no irrigation. Most of the growth characters such as plant height, dry matter accumulation, days to maturity, number of leaves, leaf area and LAI as well as yield attributes such as pods per plant, grain weight per plant and 100 grain weight were significantly increased by irrigation. The maturity of crop extended remarkably due to irrigation. Similarly, protein content, protein yield, N uptake by different plant parts and total N uptake from the soil increased considerably by irrigation. The consumptive use of water increased with increase in irrigation levels. However, the WUE decreased with scheduling irrigation at 0.75 IW/CPE ratio. The maximum WUE was recorded with 0.25 IW/CPE ratio, followed by 0.50 IW/CPE ratio.

Rhizobium inoculation failed to exert any significant effect on most of growth and yield attributes. Consequently the yield was not increased upto a significant level. However, the total N uptake increased due to *rhizobium* inoculation.

Most of the growth and yield attributes were significantly increased with increase in N levels. The highest values for all these parameters were recorded under 20 kg N/ha. The protein content, protein yield, N uptake by different plant parts and total N uptake by plant were also remarkably improved with increase in nitrogen application rate.

The results thus indicate that maximum yield of pigeonpea var. BDN-2 could be obtained by irrigating the crop at IW/CPE ratio of 25 after cessation of monsoon with application 20 kg/ha with or without *rhizobium* inoculation in vertisol of South Gujarat.

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Study on Drip Irrigation in Conjunction with Integrated Nitrogen Management on Growth, Yield and Nutrient Uptake in Eggplant

Submitted to Gujarat Agricultural University

Student

K. V. Jadav

Major Advisor

H. M. Mehta

Department of Agronomy, B. A. College of Agriculture,
G.A.U., Anand

Field experiment was carried out at the College Farm, Gujarat Agricultural University, Anand on loamy sand in *rabi* seasons of the year 1989-90 and 1990-91 to study the efficiency of drip irrigation in conjunction with integrated nitrogen management in brinjal. Thirty six treatments comprising of three levels of irrigation viz. drip irrigation at 80% and 60% of CPE and surface flooding at 1.2 IW/CPE ratio as main plot treatment and combinations of three levels of nitrogen (0, 50 and 100 kg/ha), two

levels of dry azolla (0 and 1.43 t/ha equivalent to 50 kg of N/ha) and two levels of inoculation (with and without *Azotobacter* treatments) as a sub plot treatment, were employed in split plot design with four replications. The brinjal Cv. Doli-5 was selected for experimental purpose. The results showed that scheduling irrigation through drip at 80% CPE remarkably increased plant height, LAI, dry matter/plant, flower/ plant, fruits/ plant, stalk yield and total fruit yield as compared to surface flooding irrigation during both the years of study protein content in fruits and the NPK uptake also found higher in drip irrigation.

Application of 100 kg N/ha significantly increased plant height, LAI dry matter/plant, flowers/plant, fruits/plant, size of fruit and total fruit yield over 50 kg N and no nitrogen. Similar trend also noticed with dry azolla (equivalent to 50 kg N/ha) treatment as well as in case of *Azotobacter* treatment. The interactive effect of irrigation x Azolla and Azolla x *Azotobacter* were found significant in respect of total fruit yield and nutrient uptake. The treatment combination involving drip irrigation at 80% CPE application of nitrogen @ 100 kg/ha, dry azolla 1.43 t/ha and *Azotobacter* treatment recorded the highest total fruit yield as well as net as net profit of Rs. 17944/ ha.

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