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Relative Storability of Wheat Seeds as Influenced by Varieties and Seed Treatments During Storage

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ABSTRACT

Sundried seeds of wheat varieties viz., Sonalika, Lok-1, Kalyan Sona and GW 496 having 10 per cent moisture were treated with four seed dressings viz., carbendazim, thiram, methyl parathion and castor oil alongwith control and stored in polythene bags under ambient conditions for twelve months. Seed moisture (%), germination rate and vigour increased with storage upto 5-6 months whereas, germination declined during storage. Variety GW 496 recorded the lowest seed moisture and higher germination, germination rate and vigour throughout the storage suggesting better storability. Seed treatment with thiram helped to record significantly lower seed moisture. While, germination (%), germination rate and vigour index were significantly higher under this treatment.

(Received on 1st March, 1997)

INTRODUCTION

The viability of seed in storage is greatly dependent on the level of moisture content which is closely related to the surrounding relative humidity. An understanding of relationship between moisture content and relative humidity (RH) is useful for developing short or long term safe seed storage practice. The relationship between the storage environment and loss of seed viability has been studied by Singh (1987). In seeds of majority of important crop species, an increase in either temperature or relative humidity of storage environment increase the rate of loss of viability (Roberts, 1972). Due to scarcity of ideal moisture proof storage godowns in Indian conditions, emphasis on

alternatives such as seed treatment is gaining importance. Very little information on such aspects is available in respect of wheat, hence this investigation was taken up.

MATERIALS AND METHODS

Cleaned seeds of four wheat varieties viz. Sonalika, Lok-1, Kalyan Sona and GW 496 were sundried to bring the moisture around 10 per cent (wet weight basis) and divided into the treatment units of 5 kg each. Seed treatment comprised of carbendazim (50%) and thiram (75% WDP) each @ 2 g/kg seed, methyl parathion (2% dust) and castor oil @ 10 g/kg seed and a control (without seed treatment). Treated seeds were stored in polythene bags in the Seed Technology Laboratory at Sardar

Krushinagar under ambient storage conditions for a period of twelve months from May, 1992. Observations on seed moisture, germination, root and shoot length and germination rate were recorded at monthly interval. The germination test was conducted following rolled paper towel method (Anonymous, 1985). Seed moisture was determined following the hot air oven method on wet weight basis by drying 5 g ground seed samples at $110 \pm 1^\circ\text{C}$ for 17 hours (Anonymous, 1985). The germination rate was determined by dividing the number of normal seedlings observed on each day by corresponding days and values obtained at each day from by very first day were summed at the end of germination test as described by Maguire (1962). The vigour index was determined by multiplying the germination (%) with the sum of root and shoot length in cm (Woodstock, 1969). The data obtained were processed on computer following completely randomized design.

RESULTS AND DISCUSSION

The seed moisture (%), germination percentage and rate as well as vigour index differed significantly during the storage (Table 1). Seed moisture fluctuated and followed the pattern of fluctuations of atmospheric relative humidity (Table 3). The highest seed moisture (11.72%) was observed when the seed samples were tested after 5 months of storage. Similarly, the lowest seed moisture (9.73%) was observed after twelve months possibly due to low RH. A similar trend with respect to seed moisture in sorghum was reported by Singh (1986). Continuous decline in seed germination and germination rate was observed during storage. This may be explained by the increased seed respiration and membrane leakage due to increased temperature and relative humidity (Abdul Baki and Anderson, 1972). Singh (1987) reported that decrease in germination was proportional to increasing time of storage.

TABLE 1

Seed moisture (%), germination (%), germination rate and vigour Index as influenced by wheat varieties, storage period and seed treatments.

Treatments	Seed moisture	Germination (%)	Germination rate	Vigour index
Storage Period(s) (in months)				
1	10.16	79.80 (96.59)	15.62	2051
2	10.21	79.32 (96.24)	15.26	2103
3	10.82	79.09 (96.06)	14.87	2161
4	11.28	78.35 (95.75)	14.46	2207
5	11.72	76.71 (94.53)	14.08	2252
6	11.53	75.62 (93.66)	13.65	2253
7	11.28	73.65 (91.92)	13.21	2175
8	11.07	72.46 (90.82)	12.75	2076
9	10.75	71.11 (89.45)	12.32	1965
10	10.39	68.93 (87.35)	11.87	1815
11	9.95	67.63 (85.47)	11.48	1729
12	9.73	67.32 (85.07)	11.07	1644
S. Em. $\pm$	0.009	0.18	0.04	5.74
C. D. (P=0.05)	0.026	0.49	0.12	15.92

1.	2.	3.	4.	5.	6.
Varieties (V)					
Sonalika	10.80	72.75	(90.60)	12.93	2040
Lok-1	10.78	73.39	(91.24)	13.18	1983
Kalyan Sona	10.71	74.61	(92.36)	13.52	1920
GW 496	10.67	75.92	(93.36)	13.92	2202
S. Em. $\pm$	0.008	0.18		0.02	3.32
C. D. ($p=0.05$)	0.023	0.49		0.07	9.19
Seed Treatments (T)					
Carbendazim	10.68	74.88	(92.59)	13.73	2168
Thiram	10.64	76.70	(93.88)	13.97	2233
Methyl Parathion	10.74	73.90	(91.70)	13.32	1986
Castor Oil	10.82	71.34	(89.38)	12.67	1812
Control	10.82	74.01	(91.83)	13.23	1982
S. Em. $\pm$	0.018	0.24		0.03	5.52
C. D. ($p=0.05$)	0.051	0.69		0.08	15.76
Interaction(V x T)					
S. Em. $\pm$	0.019	0.23		0.06	8.92
C. D. ($p=0.05$)	0.052	0.64		0.19	24.73

Note : Figures in the parentheses are untransformed means.

Vigour index increased upto six months and thereafter, it decreased upon further storage. In the initial months of storage, seeds were vigorous which resulted into increased root and shoot lengths leading to higher vigour. The increase in root length and shoot length of seedling upto six months might be attributed to the increase in seed moisture content resulting into increased respiration rate in seed which enhanced enzymatic activity and metabolism in germinating seed and hence increasing the length of seedling (Coleman *et al.* 1928). Singh and Borikar (1985) reported that vigour of sorghum was good upto four months and then there was a gradual decrease.

Significant differences in seed moisture, germination per cent and rate as

well as vigour due to varieties indicated genotypic variation for these characters. GW 496 having hard seed coat recorded significantly lower seed moisture (10.67%). However, the magnitude of difference in seed moisture between GW 496 and Sonalika was very small (0.13%). In contrast to seed moisture, GW 496 recorded significantly higher germination (93.36%), germination rate (13.92) and vigour (2202). The genotypic variation in the present study may, be attributed to the inherent variation in the composition of different wheat varieties. Thus, it revealed that the genetic make-up of GW 496 was superior than other varieties in respect of seed viability, germination rate and vigour index. Present findings are in accordance with the findings of Singh (1986).

The effect of seed treatment was significant. The lowest seed moisture (10.64%) was recorded in the seeds treated with thiram. The beneficial effect of thiram in maintaining lower seed moisture might be attributed to the separation of seeds from the atmospheric relative humidity by forming relatively

impermeable barrier by this fungicide (Vyas and Nene, 1975). The same treatment recorded significantly higher vigour (2233), germination (93.88%) and germination rate (13.97). Beneficial effect of thiram in maintaining seed viability have been reported by Singh *et al.* (1982) and Dakshinamoorthy and Sivaprakasam (1988).

TABLE 2

Interaction effect of varieties and seed treatments on seed moisture (%), per cent germination, germination rate and vigour Index during storage.

Varieties	Seed treatments				
	Carbendazim	Thiram	Methyl Parathion	Castor Oil	Control
Seed Moisture (%)					
Sonalika	10.71	10.66	10.81	10.92	10.93
Lok-I	10.70	10.65	10.77	10.89	10.88
Kalyan Sona	10.67	10.65	10.71	10.75	10.75
GW 496	10.64	10.62	10.67	10.72	10.72
C. D. ($p=0.05$)	0.052				
Germination (%)					
Sonalika	73.72 (92.00)	75.29 (93.00)	73.25 (91.00)	68.06 (86.00)	73.45 (91.00)
Lok-I	74.19 (92.00)	75.70 (93.00)	72.82 (91.00)	71.10 (89.00)	73.12 (91.00)
Kalyan Sona	75.31 (93.00)	76.87 (94.00)	74.46 (92.00)	72.46 (91.00)	74.29 (92.00)
GW 496	76.32 (94.00)	78.93 (96.00)	75.43 (93.00)	73.75 (92.00)	75.17 (93.00)
C. D. ($p=0.05$)	0.64				
Germination rate					
Sonalika	13.38	13.48	12.85	12.13	12.81
Lok-I	13.55	13.67	13.12	12.52	13.04
Kalyan Sona	13.83	13.93	13.55	12.84	13.45
GW 496	14.18	14.81	13.76	13.20	13.63
C. D. ($P=0.05$)	0.19				

1.	2.	3.	4.	5.	6.
Vigour Index					
Sonalika	2118	2155	2035	1856	2035
Lok-1	2054	2119	1946	1846	1947
Kalyan Sona	2032	2093	1928	1627	1919
GW 496	2470	2563	2033	1917	2026
C. D. (p=0.05)	24.73				

Note : Figures in the parentheses are untransformed means.

TABLE 3

Monthly temperature, humidity and rainfall during May, 1992 to April, 1993.

Months	Max. Temp. (C)	Min. Temp. (C)	Relative Humidity (%)	Rainfall (mm)
May	40.4	24.7	45.0	0.0
June	40.5	27.3	52.0	8.0
July	34.2	24.9	71.5	582.9
August	32.0	24.9	74.5	233.3
September	32.5	22.1	67.5	687.0
October	34.6	20.0	52.5	1.0
November	31.2	13.5	53.5	8.0
December	29.6	11.4	53.2	0.0
January	27.2	10.5	50.0	0.0
February	31.3	10.9	46.0	11.0
March	32.9	15.3	41.5	0.0
April	37.9	20.1	41.8	0.0

The interaction effect (Table 2) revealed that V x T interaction was significant for all the characters studied. Seeds of variety GW 496 treated with thiram recorded significantly lower seed moisture (10.62%). But was at par with that recorded by the

seeds of all the varieties treated with thiram. In case of germination per cent and rate as well as vigour, GW 496 treated with thiram recorded significantly higher values as compared to other combinations indicating superiority of thiram in maintaining seed viability.

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Integrated Weed Management in Chickpea

N. M. Sukhadia* B. B. Ramani, M. M. Modhwadia, V. D. Khanpara and K. B. Asodaria

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ABSTRACT

The results of the experiment conducted on Vertisol soils of Junagadh during *rabi* season of 1992-93, 1994-95 and 1995-96 on 'Integrated weed management in chickpea' revealed that maximum yield of grain (1432 kg ha^{-1}) and fodder (1660 kg ha^{-1}) as well as the highest net return (Rs. 15450 ha^{-1}) and additional income over control (Rs. 7508 ha^{-1}) could be obtained by one hand weeding + interculturing at 30-35 days after sowing the crop. However, the integration of herbicides with hand weeding and interculturing was found efficient as far as the weed control efficiency is concerned.

(Received on 29th Dec., 1997)

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is world's important *rabi* pulse crop occupying third position among the grain legumes. In India, where people are predominantly vegetarian, pulses form the main source of protein in daily diet. In Gujarat, it occupies an area of about 0.967 lakh hectares producing 0.551 lakh tonnes of grain annually with productivity of 570 kg ha^{-1} (Anon., 1995). Competition between weeds and crop for moisture becomes aggressive, particularly during early stage of crop growth. The chickpea is generally grown under conserved soil moisture conditions specially in Ghed as well as *Bhal* tracts of Gujarat. But there is a large area of chickpea in Gujarat taken as irrigated crop during *Rabi* season. Due to irrigation, there will be severe competition between crop and weeds for moisture, nutrients and space. The

magnitude in yield losses due to weeds was recorded to the tune of 31-61% under Junagadh conditions (Gediya, 1988). There is always paucity of labour during the peak period of crop growth for hand weeding. For the farmers point of view the labour charges are also too high. The importance of integrated approach is well established instead of only one weed control method (Bhan and Malik, 1983). Considering the fact highlighted above, the present experiment was carried out to find out an efficient and economical weed management system for chickpea crop under South Saurashtra agro-climatic conditions.

MATERIALS AND METHODS

A field experiment was conducted in the research farm of weed control project, Department of Agronomy, Gujarat Agricultural University, Junagadh during *rabi* seasons of

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1992-93, 1994-95 and 1995-96 on Vertisol. The soil was slightly alkaline in reaction (pH 8.2), normal in respect to salt content (Ec 0.28 dSm⁻¹). The soil was low in available nitrogen (216.4 kg ha⁻¹), high in available phosphorus (60.3 kg ha⁻¹) and medium in available potash (268.8 kg ha⁻¹). The experiment comprising of twelve treatments (Table-1) was laid out in a randomized block design with four replications. The crop was fertilized with 20 kg N and 40 kg P₂O₅ ha⁻¹ at the time of sowing. The chickpea var. ICC-4 was sown at 30 cm apart using seed rate of 6 kg ha⁻¹ on 13, 30 and 22 November and harvested on 11, 28 and 6 March in the year 1992-93, 1994-95 and 1995-96, respectively. The number of irrigations given were 6, 6 and 8 in respective years. The crop yield and dry weight of weeds were subjected to statistical analysis and then interpreted with Duncan's New Multiple Range Test accordingly.

RESULTS AND DISCUSSION

WEED STUDIES

A. Weed Flora

The seven weed species viz. *Digera arvensis* (38.33%), *Echinochloa crusgalli* (26.18%), *Indigofera glandulosa* (11.51%), *Eluopus villosus* (4.07%), *Portulaca oleracea* (1.74%), *Physalis minima* (0.54%) and *Chenopodium album* (0.39%) contributed about 82.76% of total weed flora (Table-1). Contributional data of different weeds indicated that the experimental plots were more dominated with broad leaf weeds (52.51%) than the grassy weeds (30.25%). *Digera arvensis* was found the most dominant weed in all the treatments except treatment K where two hand weedings and interculturing were carried out at 20 & 40 days after sowing.

B. Weed Density

Data presented in Table-2 indicated that the lowest weed density of all the 7 weed species were recorded under treatment K where two hand weedings and interculturings were carried out at 20 & 40 days after sowing. In general the treatment weedy check recorded the highest density of *D. arvensis*, *E. crusgalli*, *E. villosus* and *P. oleracea*.

Data further revealed that the application of pendimethalin at lower as well as higher rate with or without HW + IC was found effective for the control of *E. crusgalli*. Likewise the use of fluchloralin was also found beneficial. The higher level of oxyfluorfen was found effective to control the *E. crusgalli*. All the three herbicides at either level were found less effective for the control of *D. arvensis* as compared to *E. crusgalli*.

C. Dry Weed Weight

The critical examination of data (Table-3) showed that the maximum dry weed weight of 778 kg ha⁻¹ was recorded under treatment L where nothing was done. The findings are in accordance with those of Saxena and Ali (1995). Whereas, the lowest dry weed weight of 116 kg ha⁻¹ was registered under treatment I (oxyfluorfen 0.120 kg ha⁻¹, pre emergence + one HW & IC at 30-35 DAS).

The higher rates of all the three herbicides were found effective to reduce the dry weed weight when compared to lower rates of respective herbicides. The data further indicated that when integrated approach is adopted in either herbicides was found most effective to control the weeds as compared to the herbicide used alone either at lower or higher rate.

Per cent composition of different weeds (Mean over three years).

Treatments	Rate kg/ha	<i>D. arvensis</i>	<i>E. crusgalli</i>	<i>I. glandulosa</i>	<i>E. villosus</i>	<i>P. oleracea</i>	<i>P. minima</i>	<i>C. album</i>	Others
A Pendimethalin, Pre	0.600	60.67	16.58	8.33	0	0	0.22	1.89	12.31
B Pendimethalin, Pre	0.900	42.40	28.40	10.14	0.90	0.28	2.25	0.14	15.49
C Pendimethalin, Pre+ 1 HW & IC at 30-35 DAS	0.600	43.58	18.18	16.58	3.65	0.92	1.09	0	16.00
D Fluchloralin, Pre	0.675	49.40	13.71	11.58	5.31	8.33	0.80	0.80	10.07
E Fluchloralin, Pre	0.900	41.12	27.53	8.19	6.03	0.70	0	0.81	15.62
F Fluchloralin, Pre + 1 HW & IC at 30-35 DAS	0.675	34.89	27.79	16.14	2.94	0	0	0	18.24
G Oxyfluorfen, Pre	0.120	41.23	40.25	13.60	0.55	0.76	0	0	3.61
H Oxyfluorfen, Pre	0.180	36.52	32.90	10.97	0.84	0.45	1.02	0.64	16.66
I Oxyfluorfen, Pre + 1 HW & IC at 30-35 DAS	0.120	38.57	32.06	15.70	3.38	1.39	0.93	0	7.97
J 1 HW & IC at 30 & 35 DAS	—	32.68	26.09	12.36	8.37	5.35	0	0	15.15
K 2 HW & IC at 20 & 40 DAS	—	2.75	17.52	5.58	5.41	2.07	0	0	66.67
L Weedy check	—	36.15	33.23	9.00	11.44	0.64	0.11	0.34	9.09
Mean	—	38.33	26.18	11.51	4.07	1.74	0.54	0.39	17.24

Pre = Pre-emergence, HW = Hand weeding, IC = Interculturing, DAS = Days after sowing.

TABLE 2
Specieswise weed density during the crop growth period (mean over three years).

Treatments	No./sq.m.					
	<i>D. arvensis</i>	<i>E. crusgalli</i>	<i>I. glandulosa</i>	<i>E. villosus</i>	<i>P. oleracea</i>	<i>P. minima</i> <i>C. album</i>
A	6.42	2.22	1.43	0	0	0.30
B	5.43	2.86	1.88	0.25	0.10	0.05
C	2.72	1.73	1.18	0.34	0.05	0
D	8.05	1.83	3.16	1.09	0.05	0.20
E	6.27	9.53	1.83	0.74	0.25	0.20
F	4.05	2.67	2.76	0.25	0	0
G	7.61	17.38	2.57	0.36	0.15	0
H	5.14	5.09	1.53	0.20	0.10	0.05
I	3.06	5.38	1.09	0.30	0.15	0
J	3.31	8.64	1.78	1.83	0.30	0
K	0.49	0.25	0.10	0.15	0.05	0
L	10.32	25.88	2.47	5.38	0.39	0.15

TABLE 3

Effect of different treatments on yield of chickpea, dry weed weight, weed control efficiency and economics (Pooled over 3 years).

Treatments	Rate (kg/ha)	Yield (kg/ha)		Dry weed weight kg/ha	W.C.E. (%)	Net return (Rs./ha)	Additional income over control (Rs./ha)
		Grain	Fodder				
A Pendimethalin, Pre	0.600	852 cd	1472 ab	313 bc	59.8	9124	1182
B Pendimethalin, Pre.	0.900	1045 abcd	1566 a	243 bc	68.8	10975	3033
C Pendimethalin, Pre+ 1 HW & IC at 30-35 DAS	0.600	1073 abcd	1458 ab	139 c	82.1	11140	3198
D Fluchloralin, Pre.	0.675	898 bcd	1536 a	425 b	45.4	9799	1857
E Fluchoralin, Pre.	0.900	1005 bcd	1535 a	311 bc	60.0	10826	2884
F Fluchoralin, Pre.+ 1 HW & IC at 30-35 DAS	0.675	1248 abc	1609 a	125 c	83.9	13191	5249
G Oxyfluorfen, Pre	0.120	1090 abcd	1486 ab	248 bc	68.1	11846	3904
H Oxyfluorfen, Pre.	0.180	1068 abcd	1538 a	182 bc	76.6	11369	3427
I Oxyfluorfen, Pre. + 1 HW & IC at 30-35 DAS	0.120	1260 ab	1486 ab	116 c	85.1	13096	5154
J 1 HW & IC at 30-35 DAS	—	1432 a	1660 a	229 bc	70.6	15450	7508
K 2 HW & IC at 20 & 40 DAS	—	1260 ab	1609 a	179 bc	77.0	13243	5301
L Weedy check	—	691 d	1135 b	778 a	—	7942	—
C. V. %	—	10.79	8.51	20.63	—	—	—

Pre = Pre-emergence, HW = Hand weeding, IC = Interculturing, DAS = Day After Sowing.

Note = The same alphabet indicates at par values (by DNMRT) of yield and dry weed weight.

D. Weed Control Efficiency

The highest weed control efficiency of 85.1% was recorded in the treatment I followed by treatment F (83.9%) and C (82.1%) means integration of lower rate of herbicides with one HW & IC was quite efficient in weed control as compared to sole herbicide or other cultural practices.

Effect on Yield

The pooled results presented under Table-3 showed that different weed management treatments exerted their significant effect on grain as well as fodder yield of chickpea. The highest grain yield of 1432 kg ha⁻¹ and fodder yield of 1660 kg ha⁻¹ were produced under the treatment J i.e. one HW & IC at 30-35 DAS. It was closely followed by treatment K (2 HW & IC at 20 & 40 DAS). The lowest grain (691 kg ha⁻¹) and fodder (1135 kg ha⁻¹) yield were recorded under the treatment weedy check. The reduction in yield under treatment weedy check in comparison to treatment J were 52 and 32 per cent in case of grain and fodder yield, respectively. These findings were in agreements with those of Ahuja and Yaduraju(1995) and Saxena and Ali (1995). When compared with lower rate, the higher

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rate of any herbicides was found superior in case of grain yield of chickpea. In comparison to either lower or higher rate of any herbicides, the adoption of integrated approach was found beneficial as far as grain yield of chickpea is concerned.

Economics of Different Treatments

The highest net return of Rs. 15450 ha⁻¹ and maximum additional income over control of Rs. 7508 ha⁻¹ were achieved with the treatment J. The lowest net return of Rs. 7942 ha⁻¹ was observed under the treatment weedy check.

It could be concluded that for effective and profitable weed management in chickpea, one hand weeding with one interculturing at 30-35 days after sowing is worth adoptive for the chickpea growing farmers of South Saurashtra region. However, on the bases of weed control efficiency, it could be concluded that integration of pre-emergence application of either oxyfluorfen, fluchloralin or pendimethalin at lower rates with one hand weeding + interculturing at 30-35 DAS proved efficient to minimise weed problems in chickpea as compared to sole herbicide or sole cultural practice.

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Effect of Irrigation, Methods of Sowing and Levels of Phosphorus on Growth and Yield of Lucerne (*Medicago sativa* L.)

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ABSTRACT

A field experiment was conducted during the *rabi* season of 1992-93 and 1993-94 to study the effect of irrigation, methods of sowing and levels of phosphorus on growth and yield of lucerne. Crop irrigated with 60 mm depth of water at IW/CPE ratio of 1.25 showed its superiority with respect to green and dry fodder yields, plant height, number of tillers/m², green : dry fodder ratio and leaf : stem ratio. Line sowing at 25 cm row spacing gave numerically higher values of yield and yield attributes. Application of 120 kg P₂O₅/ha resulted in significantly highest green and dry fodder yields of 411.2 and 104.1 q/ha which were 18.4 and 33.5 per cent higher over 60 kg P₂O₅/ha, respectively. Yield attributing characters followed the same trend.

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INTRODUCTION

Irrigation water is a costlier input and therefore, its economic and efficient utilization becomes quite imperative. Thus, precise information on water requirement of lucerne is essential and inevitable. Proper scheduling of irrigation is must to maintain the optimum soil moisture level for better root and shoot development. Irrigation not only helps in increasing the green and dry fodder yields but also improves the quality of fodder (Kumar, 1976). Normally, lucerne is raised by broadcasting which is a common practice adopted by farmers. This method does not facilitate the operations like interculturing for loosening of soil, hoeing for weed control etc. Moreover, these operations are labourious and

expensive. Lucerne is known to be a heavy consumer of plant nutrients (Griffith, 1974). Being a leguminous forage, almost in all type of soils, nitrogen is seldom a serious problem, but lucerne responds more to phosphatic fertilizer as compared to nitrogen and potassium fertilizers. Keeping in view the above consideration, comprehensive research work was undertaken to ascertain judicious use of irrigation water, proper method of sowing and phosphorus fertilizer requirement of lucerne.

MATERIALS AND METHODS

The experiment was conducted at the Instructional Farm, C. P. College of Agriculture, Gujarat Agricultural University,

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Sardar Krushinagar during *rabi* season of 1992-93 and 1993-94. The soil was loamy sand in texture, low in total nitrogen (0.018%), medium in available phosphorus (39 kg P_2O_5 /ha) as per Olsen's method (Jackson, 1967) and medium to high in available potash (288 kg K_2O /ha). The average values of field capacity, permanent wilting point, bulk density, pH and EC were 8.73%, 2.80%, 1.58 g/cm³, 7.85 and 0.19 dSm⁻¹, respectively. Treatments consisted of three irrigation schedules based on IW/CPE ratios (I_1 : 0.75 I_2 : 1.00 and I_3 : 1.25) and two sowing methods (M_1 : Broadcast sowing and M_2 : Line sowing at 25 cm) as main plot treatments and four levels of phosphorus (60, 80, 100 and 120 kg P_2O_5 /ha) as sub plot treatments tried in split plot design with four replications. The lucerne cv. Anand-2, was sown on November 25 and 20 in 1992-93 and 1993-94, respectively.

A basal dose of 15 kg N/ha in the form of urea and 40 kg K_2O /ha in the form of muriate of potash and phosphorus as per treatments in the form of single super phosphate was given either before sowing in previously opened furrows or broadcast as per the methods of sowing. Fertilizers were slightly mixed with soil immediately after application. Remaining 15 kg N/ha in the form of urea was applied as top dressing at 30 days after sowing. In broadcast sowing, two hand weedings were carried out, while in line sowing, interculture and hand weeding twice were carried out after 30-35 and 135-140 days after sowing. Except for the irrigation treatments, all other operations were followed as per recommendations. Besides, three common irrigations each of 60 mm depth were given to all the treatment plots, first immediately after sowing, second 5-6 days after sowing and third one 14-15 days after sowing for better germination and establishment of the crop. Five cuts of lucerne were taken during both the years.

RESULTS AND DISCUSSION

Effect of Irrigation

The two years data indicate that the green fodder yield increased progressively with increase in the irrigation levels (Table-1). The number of post sowing irrigations were 14, 19 and 23 in 1992-93 and 12, 17 and 21 during 1993-94 at 0.75, 1.00 and 1.25 IW/CPE ratio, respectively. On pooled basis the maximum green fodder yield was recorded under IW/CPE ratio of 1.25 (430.3 q/ha), followed by ratio of 1.00 (398.3 q/ha) and 0.75 (321.9 q/ha). The percentage increase in the green fodder yield under 1.25 and 1.00 ratios were 33.7 and 23.7 per cent over 0.75 ratio. Similar trend was observed for dry fodder yield. The plots irrigated more frequently with IW/CPE ratio of 1.25 gave considerably higher yields of green and dry fodder (Table-1) owing to taller plants (52.8 cm), maximum number of tillers /m² (98.6), green : dry fodder ratio (4.39) and significantly lowest leaf : stem ratio (1.00) (Table-2). The increase in fodder yield of lucerne under higher moisture content might be due to easy availability of moisture to lucerne within the suction range of 2 to 8 bars during the crop growth season which resulted in better growth and development of the crop (Taylor *et al.*, 1959). Significantly lower yields under IW/CPE ratio of 0.75 (I_1) could be explained on the basis that this treatment received irrigation at longer interval which created adverse effect of moisture stress condition on root development, photosynthesis and other physiological processes resulting in poor growth. Reduction in yield under moisture stress condition was observed by Abu-Shakra *et al.* (1969) and Patel (1992). Green : dry fodder ratio increased with increasing irrigation frequency. Moisture stress condition (IW/CPE ratio 0.75) resulted in significant increase in leaf : stem ratio, while it was lowest in higher

TABLE 1

Total green and dry fodder yields (q/ha) as well as average plant height (cm) as influenced by IW/CPE ratios, sowing methods and phosphorus levels.

Treatment	Green fodder yield (q/ha)			Dry fodder yield (q/ha)			Plant height (cm)		
	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled
IW/CPE ratio									
I ₁ (0.75)	321.9	321.9	321.9	81.1	80.9	81.0	43.3	47.1	45.2
I ₂ (1.00)	396.3	400.4	398.4	92.2	95.5	94.9	46.7	52.4	49.6
I ₃ (1.25)	423.3	436.3	430.3	98.0	100.5	99.2	49.5	56.1	52.8
C. D. (P = 0.05)	11.10	18.02	10.14	3.81	5.63	3.26	1.00	1.52	4.27
Sowing method									
M ₁ Broadcasting	374.1	386.7	377.4	89.0	90.9	90.0	45.7	51.2	48.5
M ₂ Line sowing at 25 cm	387.5	391.8	389.6	93.2	93.7	93.5	47.3	52.5	49.9
C. D. (P = 0.05)	9.07	NS	NS	3.11	NS	NS	0.81	NS	1.01
Phosphorus (kg/ha)									
P ₁ (60)	346.0	348.6	347.3	77.8	78.1	78.0	43.0	48.7	45.8
P ₂ (80)	369.5	376.8	373.2	86.6	88.5	87.5	45.7	51.1	48.4
P ₃ (100)	399.4	405.3	402.3	96.4	98.1	97.2	48.3	53.5	50.9
P ₄ (120)	408.3	414.2	411.2	103.6	104.6	104.1	49.0	54.1	51.5
C. D. (P = 0.05)	5.55	7.65	4.68	1.67	1.98	1.28	0.66	0.66	0.46

TABLE 2

Number of tillers/m², green : dry and leaf : stem ratio as influenced by IW/CPE ratios, sowing methods and phosphorus levels (Average of five cuts).

Treatment	Number of tillers/m ²			Green : dry fodder ratio			Leaf : stem ratio		
	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled
IW/CPE ratio									
I ₁ (0.75)	84.7	90.6	87.6	4.06	4.03	4.05	1.10	1.12	1.11
I ₂ (1.00)	92.9	96.4	94.7	4.24	4.24	4.24	1.02	1.07	1.05
I ₃ (1.25)	97.9	99.4	98.6	4.38	4.40	4.39	0.99	1.01	1.00
C. D. (P = 0.05)	2.34	2.08	6.74	0.13	0.11	0.08	0.04	0.02	0.02
Sowing method									
M ₁ Broadcasting	91.3	94.2	92.8	4.24	4.23	4.23	1.03	1.06	1.05
M ₂ Line sowing at 25 cm	92.3	96.8	94.5	4.21	4.23	4.22	1.04	1.07	1.06
C. D. (P = 0.05)	NS	1.70	NS	NS	NS	NS	NS	NS	NS
Phosphorus (kg/ha)									
P ₁ (60)	86.7	90.8	88.8	4.50	4.49	4.50	0.98	1.01	1.00
P ₂ (80)	90.9	94.4	92.6	4.29	4.29	4.29	1.02	1.04	1.03
P ₃ (100)	93.8	97.2	95.5	4.14	4.15	4.15	1.07	1.08	1.08
P ₄ (120)	95.9	99.5	97.7	3.97	3.98	3.97	1.09	1.12	1.10
C. D. (P = 0.05)	1.67	1.88	1.24	0.09	0.04	0.05	0.02	0.02	0.01

moisture regimes (IW/CPE ratio of 1.25). The increase in leaf : stem ratio under moisture stress condition was probably due to decrease in stem length thereby increasing the leaf portion. Halim *et al.* (1989) reported decrease in percentage of leaves at low moisture stress condition which was associated with taller plants having longer internodes and larger stem diameter.

Effect of Sowing Method

Line sowing method recorded higher green fodder yield of 387.5, 391.8 and 389.6 q/ha and dry fodder yield of 93.2, 93.7 and 93.5 q/ha during 1992-93 and 1993-94 on pooled basis, respectively over broadcast sowing. The more green and dry fodder yields in line sown crop might be due to more availability of soil surface, moisture and solar energy which might have improved the yield attributes viz., plant height, number of tillers / m² leaf : stem ratio and lower green : dry fodder ratio (Table-2) which ultimately resulted in improvement in yield. Vittum *et al.* (1958) also obtained increased green fodder yield of lucerne in line sowing method. Marginally higher dry fodder yield in line (sown) crop as compared to broadcast, though not significant when pooled seemed to be due to more green fodder yield in this treatment. Similar results were also observed by Dev *et al.* (1974).

Effect of Phosphorus

Green and dry fodder yields increased progressively with increase in phosphorus

levels from 60 to 120 kg P₂O₅/ha during both the year and in pooled analysis (Table-1). On pooled data basis, the increase in green fodder yield due to 120, 100 and 80 kg P₂O₅/ha were 18.4, 15.8 and 7.5 per cent, respectively over 60 kg P₂O₅ per hectare. Similar results were also observed in case of dry fodder yield. The remarkable increase in yields with higher levels of phosphorus may be attributed to favourable effect on yield attributing characters. Tomer *et al.* (1974) observed that improvement in yield with the application of phosphorus is mainly due to improved growth, fresh and dry weight and better plant population which might have resulted into increase in cell division, better root development and high microbial activity. The results are in accordance with those reported by Patel (1992).

Increasing the levels of phosphorus from 60 to 120 kg P₂O₅/ha increased leaf : stem ratio whereas a reverse trend was observed in case of green : dry fodder ratio (Table-2). Phosphorus plays crucial role in photosynthesis. It increased the photosynthetic efficiency of leaves and thus increased the availability of photosynthates. Increase in leafiness, dry matter production and succulency with phosphorus fertilization resulted in increased leaf : stem ratio and reduction in green : dry fodder ratio. These findings are in accordance with those reported by Parson and Davis (1960).

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Correlation and Path Analysis in Blackgram

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ABSTRACT

Correlation and path coefficient analysis in 70 diverse genotypes of blackgram (*Vigna mungo* (L.) Hopper) showed a significant positive association of yield per plant with pod clusters per plant, plant height, pods per plant, 100-seed weight and pod length. Days to 50 per cent flowering and days to maturity exhibited significant and positive genotypic correlation with seed yield. Path analysis indicated that pods per plant, plant height and 100-seed weight had direct effect on yield. Thus maximum emphasis for selection of better genotypes should be given to pods per plant, plant height and 100-seed weight.

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INTRODUCTION

Knowledge of correlation and path coefficient analysis helps plant breeder to ascertain the real components of yield and provide an effective basis of selection. Therefore, in the present study, correlation and path coefficient analysis were computed on 70 diverse blackgram genotypes.

MATERIALS AND METHODS

Seventy genotypes of blackgram were grown in a Randomized Block Design with three replications at instructional Farm, College of Agriculture, Gujarat Agricultural University, Junagadh. The sowing was done keeping each plot of one row of four meter length with interrow spacing of 30 cm and plant to plant spacing of 10 cm. The observations were recorded on five

randomly selected plants from each plot for nine characters (Table 1). Path coefficient analysis was done following Dewey and Lu (1959).

RESULTS AND DISCUSSION

The genotypic correlation was in general, higher in magnitude than the corresponding phenotypic correlation (Table 1). In all cases the sign of both phenotypic and genotypic correlations were the same. The near agreement in the magnitude and direction of phenotypic and genotypic correlations indicated great importance of genetic variability with common effects than the environmental variability with common effects.

Seed yield per plant had positive and significant correlation with pod clusters per plant, plant height, pods per plant, 100-seed weight

TABLE 1

Estimate of genotypic (r_g) and phenotypic (r_p) correlation coefficients between different characters in blackgram.

Characters	Day to 50% flowering	Dys to maturity	Plant height	No. of pods per plant	No. of cluster per plant	No. of pods per cluster	No. of seeds per pod	Pod length (cm)	100-seed weight (g)
Seed yield per plant (g)	(r_g) 0.258* (r_p) 0.229	0.238* 0.200	0.486** 0.475**	0.383** 0.373**	0.507** 0.496**	-0.109 -0.106	0.181 0.158	0.296* 0.284*	0.318** 0.288*
Days to 50% flowering	(r_g) (r_p)	0.915** 0.682**	0.550** 0.474**	0.309** 0.264*	0.321** 0.269*	-0.017 -0.010	0.154 0.117	0.276* 0.245*	0.216 0.199
Day to maturity	(r_g) (r_p)		0.642** 0.595**	0.499** 0.432**	0.423** 0.361**	0.111 0.097	0.048 0.026	0.285* 0.236*	0.234 0.210
Plant height (cm)	(r_g) (r_p)			0.624** 0.621**	0.637** 0.632**	0.039 0.036	0.296* 0.268*	0.623** 0.591**	0.426** 0.385**
Number of pod per plant	(r_g) (r_p)				0.669** 0.661**	0.486** 0.480**	0.164 0.144	0.352** 0.327**	0.133 0.113
Number of cluster per plant	(r_g) (r_p)					-0.298** -0.310**	0.131 0.108	0.246* 0.232	0.130 0.111
Number of pods per cluster	(r_g) (r_p)						0.022 0.027	0.143 0.125	-0.002 -0.004
Number of seeds per pod	(r_g) (r_p)							0.576** 0.529**	0.001 0.012
Pod length (cm)	(r_g) (r_p)								0.286* 0.230

* and ** significant at $P = 0.05$ and 0.01 , respectively.

TABLE 2
Direct and indirect effects of different characters on yield in blackgram.

Characters	Day to 50% flowering	Dys to maturity	Plant height (cm)	No. of pods per plant	No. of cluster per plant	No. of pods per cluster	No. of seeds per pod	Pod length (cm)	100-seed weight (g)	Genotypic correlation with seed yield (g)
Days to 50% flowering	0.0486	-0.1158	0.1212	0.1439	-0.0054	0.0036	0.0063	-0.0148	0.0262	0.258*
Days to maturity	0.0331	-0.1312	0.1422	0.1762	-0.0072	-0.0318	0.0015	-0.0144	0.0284	0.238*
Plant height (cm)	0.0229	-0.0941	0.2571	0.2472	-0.0326	-0.0117	0.0139	-0.0357	0.0532	0.486**
Number of pods per plant	0.0127	-0.0733	0.1704	0.4094	-0.0132	-0.1583	0.0075	-0.0195	0.0156	0.383**
Number of clusters per plant	0.0130	-0.0614	0.1624	0.2737	-0.0100	0.1022	0.0056	-0.0140	0.0152	0.507**
Number of pods per cluster	-0.0005	-0.0164	0.0091	0.1966	0.0062	-0.3307	0.0014	-0.0075	-0.0005	-0.109
Number of seeds per pod	0.0059	-0.0048	0.0690	0.0842	-0.0022	0.0088	0.0520	-0.0320	0.0012	0.181
Pod length (cm)	0.0119	-0.0404	0.1318	0.1539	-0.0846	-0.0412	0.0275	-0.0475	0.0315	0.296*
100-seed weight (g)	0.0092	-0.0349	0.1279	0.0461	-0.0022	-0.0012	0.0004	-0.0137	0.1387	0.318**

Residual effect = 0.4322.

* and ** Significant at P = 0.05 and 0.01, respectively
Diagonal underlined figures are direct effect.

and pod length, indicating that these attributes were more influencing the seed yield in blackgram. These results are in agreement with those obtained by Raut *et al.* (1990), Singh *et al.* (1991), Abraham *et al.* (1992) and Parameswarappa *et al.* (1993). Both at genotypic and phenotypic levels, days to 50 per cent flowering was associated with days to maturity. This suggests that flowering time is an important indicator of maturity. Both days to 50 per cent flowering and maturity exhibited significant and positive association with plant height, number of pods per plant, number of clusters per plant and pod length which is in agreement with the findings of Singh *et al.* (1991). Plant height showed significant positive correlation with pods per plant, clusters per plant, seeds per pod, pod length and 100 seed weight at both the levels. Pods per plant had significant and positive correlations with clusters per plant, pods per cluster and pod length. Pod length expressed significant and positive correlations with clusters per plant, seeds per pod and 100-seed weight.

Path coefficient analysis revealed that pods per plant had a strong positive direct effect

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on seed yield followed by plant height and 100-seed weight indicating their relatively high direct contribution to the seed yield. These results are in agreement with findings of Raut *et al.* (1990). Pods per plant showed highly significant positive correlation with seed yield which was mainly due to its high positive direct and indirect effect via plant height. Number of clusters per plant, pod length and days to maturity expressed negative direct effects of low magnitude on seed yield. However, then significant positive correlation with seed yield because of cumulative minor positive indirect effects via rest of the characters. The negative direct effects of low magnitude of these characters was nullified by high positive indirect effects of number of pods per plant and plant height. Days to 50 per cent flowering and positive significant correlation with seed yield, but when partitioned into direct and indirect effects, the direct contribution was very low and indirect effects through pods per plant was relatively high. This suggested that for genetic improvement of blackgram, pods per plant should also be taken into maximum consideration, followed by plant height and 100-seed weight.

Genetic Diversity for Grain Yield and its Components in Soybean (*Glycine max* (L.))*

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ABSTRACT

Thirty four strains of soybean (*Glycine max*) were selected for the study. The D^2 statistic for the strain showed adequate diversity between strains with values ranging from 13.34 to 2095.91. On the basis of D^2 analysis the strains were grouped into 7 clusters with substantial genetic divergence between them. Cluster A and B were very large comprising of 11 strains each C-2 strains, D-4 strains, E-3 strains, F-2 strains and G-single variety cluster.

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INTRODUCTION

In breeding programmes selection of parents for hybridization is largely based on wide adaptation, high yield potential and genetic diversity. Progenies derived from a set of diverse crosses are expected to throw a broad spectrum of genetic variability providing larger scope for isolating high yielding segregants. The present study was undertaken to classify the available variability in different groups giving information which will be helpful in planning the breeding programme.

MATERIALS AND METHODS

For the present study thirty four genotypes of soybean (*Glycine max*) showing variability for different characters were selected from the germplasm collected from

the Maharashtra Association for the cultivation of Science, Pune and presently maintained by the Department of Botany, Konkan Krishi Vidyapeeth, Dapoli. These lines were grown in kharif season of 1992 in a randomised block design with two replications. In each replication, two rows of 2.6 m length for each variety were planted at spacing of 50 cm between and 20 cm within rows. Observations were recorded on five randomly selected plants for days to initiation of flowering, days for 50% flowering, days from anthesis to maturity, days for maturity, plant height, number of branches per plant, number of pods per plant, number of grains per pod, 100-grain weight and grain yield per plant.

The data were subjected to the statistical analysis as suggested by standard method of Mahalanobis (1936). The clustering

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of genotypes was done by Tochers method as described by Rao (1952) and Majumdar and Rao (1958).

comprised of 11 strains, while the cluster D had four strains, cluster E had 3 strains, cluster C and F had 2 strains and G comprised single strain.

RESULTS AND DISCUSSION

The thirty four strains were grouped into seven clusters. The distribution of thirty four strains in different clusters is given in Table-1. Cluster A and B was very large and

The average intra and inter cluster D^2 values are presented in Table 2. The maximum statistical distance appeared between the cluster F and G (1694.291) followed by cluster E and G (1446.31), cluster

TABLE 1

Distribution of 34 strains in various clusters.

Cluster	No.	Strains included
A	11	MACS 27, MACS 392, MACS 243, MACS 239 MACS 124, MACS 321, MACS 375, MACS 381, MACS 396, MACS 329, MACS 338
B	11	Monetta, MACS 394, MACS 267, MACS 365, MACS 410, MACS 57, MACS 201, MACS 390, MACS 366, MACS 360, MACS 378
C	2	MACS 346, MACS 13
D	4	MACS 58, MACS 397, MACS 391, MACS 226
E	3	MACS 348, MACS 349, MACS 205
F	2	MACS 286, MACS 233
G	1	MACS 409

TABLE 2

Inter and Intra cluster divergence (D^2) in soybean.

Cluster	A	B	C	D	E	F	G
A	116.030	366.463	180.167	178.439	183.447	374.574	988.74
B		96.968	226.557	274.922	637.529	855.457	269.10
C			20.280	322.419	432.763	630.778	650.89
D				82.361	223.078	411.190	791.21
E					90.780	272.709	1446.03
F						903.479	1694.291
G							0.000

TABLE 3
Cluster means for 10 characters.

Cluster No.	Day to initiation of flowering	Dys to 50% flowering	Days from anthesis to maturity	Plant height (cm)	No. of branches/plant	No. of pods/plant	No. of grains/pod	100-grain weight (gm)	Seed yield/plant (gm)
A	41.50	44.41	59.36	113.59	66.92	4.74	61.46	13.01	18.71
B	40.04	42.77	49.54	105.73	47.95	4.66	43.76	14.75	13.74
C	43.25	45.00	59.00	116.00	41.95	5.10	35.82	13.72	10.96
D	39.37	43.12	53.25	106.87	80.56	4.71	55.99	13.95	18.48
E	44.33	46.50	60.17	115.00	85.95	6.38	81.90	8.72	17.04
F	43.00	46.25	61.00	114.25	88.22	5.32	67.75	10.22	15.71
G	36.00	37.50	43.00	94.00	29.25	7.45	42.15	16.35	13.91

A and G (988.674). The lowest degree of divergence was noticed in cluster A and D (178.493) followed by cluster A and C (180.167), suggested the close genetic make up among them.

An examination of Table 3 showed that the means for different characters of cluster G varied considerably from those of clusters F

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and E. This indicated that strain in cluster G might have entirely different genetic architecture from the strains cluster in clusters F and E. It is suggested that varieties from diverse clusters and having high yield potential thus might be useful in framing a suitable breeding programme since such crosses are expected to throw superior segregates.

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Genetic Variability for Yield, Fruit Borer Infestation, Little Leaf Incidence and Quality Characters in Brinjal

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ABSTRACT

Information on genetic variance, coefficient of variation, broad sense heritability and genetic advance for yield and quality characters were worked out using data from 41 genotypes of brinjal (*Solanum melongena* L.). The highest genetic coefficient of variation was observed for anthocyanin content followed by glycoalkaloid content. High heritability was observed for all the characters studied for brinjal. Further, anthocyanin content, total phenols, polyphenoloxidase activity, total soluble sugars and reducing sugars had high genetic advance coupled with high heritability, which suggested that these traits are under the control of additive gene action and can be improved through simple selection procedures.

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INTRODUCTION

Fruit yield is the most economical trait in brinjal (*Solanum melongena* L.). However, detailed information on biotic stress and quality characters in brinjal is scanty. The extent of variability available for yield alone with important economic traits and their heritability will be helpful to the breeders to formulate sound breeding programme. Hence, present attempt was made with these objectives in the brinjal crop.

MATERIALS AND METHODS

The experiment comprising 41 diverse genotypes of brinjal was laid out in randomised block design with four replications at Plant Breeding Farm, Gujarat Agricultural University, Anand during *rabi* 1995-96. Each plot had two rows and each row consisted of

10 plants. The inter and intra row spacing was 90 and 60 cm, respectively. Five random plants were selected from each plot for recording the observations on fruit yield per plant (g), fruit borer infested fruits (%) and little leaf incidence (%). Uniformly ripen fruits were collected at random from each plot to determine the chemical composition. The fruits were cut and dry matter was obtained by drying to a constant weight at 105°C for 6 hours. The quality determining traits like polyphenoloxidase activity (Taneja and Sachar, 1974), total phenols (Malik and Singh, 1980), glycoalkaloid content (Currie and Kuc, 1975) and total soluble as well as reducing sugars (Sadasivam and Manickam, 1992) were estimated by using the standard procedures given by various scientists. Anthocyanin content was determined from the peel of the fresh fruit (Ranganna, 1976).

TABLE 1

The estimates of genotypic (σ^2_g) and phenotypic (σ^2_p) variances and other genetic parameters for different characters in brinjal.

Characters	Range	Mean $\pm$ S. Em.	σ^2_g	σ^2_p	GCV (%)	PCV (%)	H^2 (%)	GA (% mean)
Fruit yield/plant (g)	112.66-386.07	253.14 $\pm$ 12.77	4850.62	5503.81	27.51	29.31	88.13	53.21
Fruit borer (%) infestation	13.64 - 32.840	20.36 $\pm$ 0.500	19.03	200.03	21.42	21.97	95.02	43.02
Little leaf (%) incidence	19.55 - 56.070	34.14 $\pm$ 1.150	95.24	100.37	28.58	29.34	94.88	57.35
Dry matter (%)	6.11 - 11.210	7.340 $\pm$ 0.112	0.65	0.71	11.00	11.42	92.89	21.84
Anthocyanin content (mg/100g)	0.00 - 112.16	21.640 $\pm$ 1.580	423.11	433.13	95.67	96.77	97.68	194.78
Polyphenol oxidase activity (D.O.O./min.)	0.345 - 3.468	2.035 $\pm$ 0.145	0.73	0.82	41.62	43.97	89.59	81.15
Total phenols (mg/100 mg drywt.)	0.898 - 4.615	2.026 $\pm$ 0.145	0.85	0.93	44.17	46.30	90.98	86.77
Glycoalkaloid content (O.D.)	0.132 - 1.907	0.781 $\pm$ 0.050	0.18	0.19	54.70	56.18	94.81	109.72
Total soluble sugars (mg/100 mg dry wt.)	10.282 - 61.095	31.980 $\pm$ 1.360	153.67	161.06	38.76	39.12	95.41	77.99
Reducing sugars (mg/100 mg dry wt.)	2.173 - 14.180	7.260 $\pm$ 0.500	8.34	9.34	39.79	42.12	89.24	77.44

The coefficient of variations were estimated according to Burton and Devane (1953). Heritability in broad sense and expected genetic advance were estimated by the methods given by Hanson *et al.* (1956).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among the genotypes for all the characters studied. The range of variation was substantially high for all the characters under study and it was particularly pronounced in anthocyanin content and glycoalkloid content (Table 1). These traits also showed large genotypic variability.

Among all the characters studied, glycoalkloid content was least affected by environmental factors followed by dry matter, total phenols, polyphenoloxidase activity, reducing sugars, total soluble sugars and anthocyanin content. On the other hand, fruit yield per plant, little leaf incidence and fruit borer infested fruits were comparatively more influenced by external factors as evident by their respective estimates of phenotypic and genotypic variances. The estimates of phenotypic coefficient of variation (PCV) were higher than their respective genotypic coefficient of variation (GCV) for all the traits. The GCV was maximum for anthocyanin

content followed by glycoalkloid content. It was comparatively low for dry matter, fruit borer infested fruits, little leaf incidence, fruit yield per plant and moderate for total phenols, polyphenoloxidase activity, total soluble sugars and reducing sugars. Same trend was observed for PCV. Dhankar and Sharma (1986) and Malik *et al.* (1986) reported low GCV for fruit yield per plant and fruit borer infested fruits. The heritability estimates help breeders in selection based on the phenotypic performance. In the present study, high heritability was observed for all the characters, which indicates that selection is effective. But this selection is misleading because Johnson *et al.* (1955) reported that heritability estimate alongwith genetic advance is more useful than the heritability value alone for improving a particular trait. The high heritability combined with genetic advance as per cent of mean was observed for the characters like anthocyanin content, glycoalkloid content, total phenols, polyphenoloxidase activity, total soluble sugars and reducing sugars. This indicated that these characters are under the control of additive gene action (Panse, 1957) and would respond very well to continuous selection. These results are in agreement with the findings of Chadha and Paul (1984), Singh and Kalda (1984), Gautam and Srinavas (1992) and Kapadia (1995).

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Gene Effects in Vegetable Cowpea

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ABSTRACT

The nature of gene effects involved in the inheritance of days to 50 per cent flowering, leaf area, number of branches per plant, plant height, number of pods per plant and pod yield per plant was investigated in vegetable cowpea (*Vigna unguiculata* (L.) Walp.). Graphical analysis revealed the presence of partial dominance for days to 50 per cent flowering near to complete dominance for leaf area and number of branches per plant, whereas overdominance was observed for plant height, number of pods per plant and pod yield per plant. Both additive and non-additive type of gene effects may be simultaneously exploited by recurrent selection for improvement of these traits.

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INTRODUCTION

Vegetable cowpea has a great potential in the Indian vegetable scenario. It plays an important role in Indian diet. Green tender pods form an excellent nutritious vegetable and have got a potential to solve the protein deficiency problem of human diet. Sometimes it is also known as poor man's meat. The success of breeding programme depends upon understanding the genetics of characters in relation to material to be utilized. Information on genetic architecture through graphical analysis in vegetable cowpea is meagre and hence the present investigation was undertaken to know the genetic architecture for pod yield and its associated characters.

MATERIALS AND METHODS

The experimental material comprised of seven diverse lines of vegetable cowpea viz., Line Selection-102, Punjab-263, Pusa Barsati, Gujarat-1, GC-82-7, Arka Garima, In-103 and their 21 F₁s were evaluated in randomized block design with three replications during kharif 1996 at Vegetable Research Station, GAU, Junagadh. Each genotype was grown in 3 meter long single row plot spaced 60 x 30 cm. Data were recorded on five randomly selected plants in each replication except for days to 50 per cent flowering. The mean data were utilized for graphical analysis following Hayman(1954).

RESULTS AND DISCUSSION

The fulfilment of the assumptions underlying diallel analysis was revealed by non-significant t^2 values for all the characters studied. The results are graphically presented for days to 50 per cent flowering leaf area, number of branches per plant, plant height, number of pods per plant and pod yield per plant (Figure 1, 2, 3, 4, 5 and 6 respectively). Perusal of these figures indicated that array points were scattered below the limiting parabola for days to 50 per cent flowering and number of branches per plant. It suggested that these traits were more responsive to environmental effects which could also be supported by large standard error for days to 50 per cent flowering (0.544) and branches per plant (0.720). The environmental influence seems to have caused wobbling of the array points. Consequently neither the presence nor the absence of interallelic interaction could be confirmed. In general, wide scattering of parental array points along regression line in the Vr-Wr graph (1-6) indicated genetic diversity among the parents for all the traits studied.

In the Vr - Wr graph (Fig. 1), the intercept of regression line on Wr axis was above the origin, indicating partial dominance for days to 50 per cent flowering. Similar findings were also reported by Mak and Yap (1980), Zaveri *et al.* (1980) and Buhecha (1981). The parent In - 103 possessed more number of dominant genes, while Gujarat -1 contained more recessive genes. The wide gap between regression line and parabole curve suggested greater influence of environment on the expression of this character with resepct to leaf area the regression line which cut the Wr - axis slightly below the point of origin revealed complete dominance. The array points of GC-82-7 which was the nearest to the point of origin

possessed most of the dominant alleles, while the array point of line Selection-102 was away from the point of origin indicating that it possessed most recessive alleles. Gujarat-1 and Arka Garima had equal proportion of dominant and recessive alleles. Parental point of Punjab-263 fell relatively far below the regression line indicating complementary type of gene interaction.

For number of branches per plant (Fig. 3) the regression line passed through the origin thereby indicating presence of the complete dominance. However, Zaveri (1978) observed overdominance which was at variance with the present finding. The dispersion of parental array points indicated presence of large number of dominant genes in Gujarat-1 and more number of recessive genes in In-103. The wide gap between regression line and parabola curve suggested greater influence of environment on the expression of this character. In case of plant height (Fig. 4) the regression line intercepted Wr-axis below the origin indicating the presence of overdominance. Similar findings were also reported by Sawant (1994). The parent Arka Garima and GC-82-7 whose array points were situated near the point of origin possessed more dominant genes, whereas Punjab-263 falling away from the point of origin possessed maximum number of recessive alleles.

The regression line intercepted the Wr-axis below the origin for number of pods per plant (Fig. 5) indicating overdominance. Results were in agreement with Mak and Yap (1980). The array points of Arka Garima had excess of dominant alleles, whereas Gujarat-1 had maximum number of recessive alleles. The Vr-Wr graph for pod yield per plant indicated the presence of overdominance as Wr-axis was intercepted by regression line below the point of origin. Line selection 102 was more closer and GC-82-7 was farthest from point of origin suggesting the presence of most dominant and recessive alleles, respectively in them.

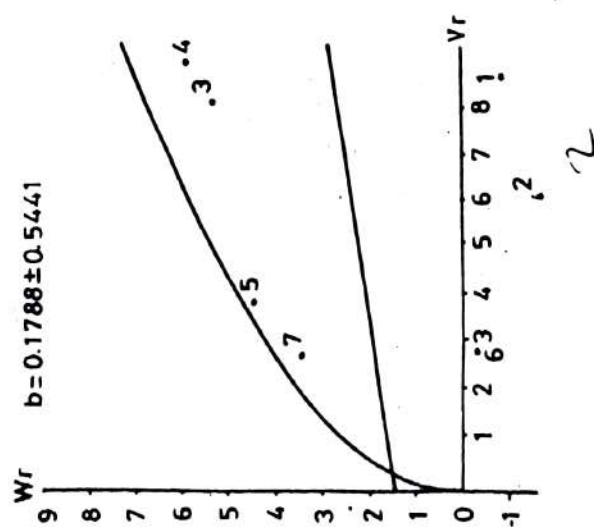


Fig. 1 : Days to 50 per cent flowering

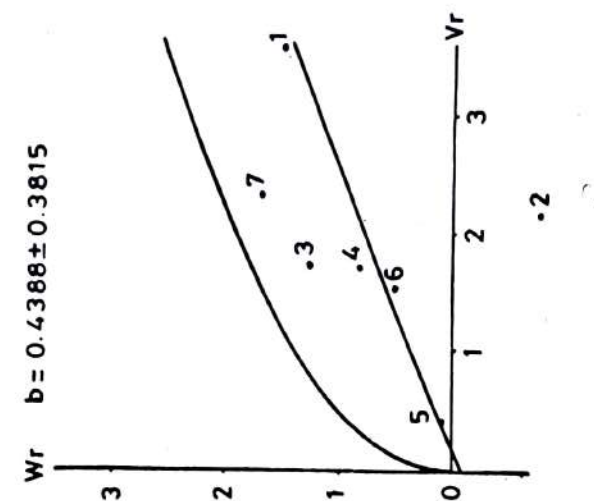


Fig. 2 : Leaf area

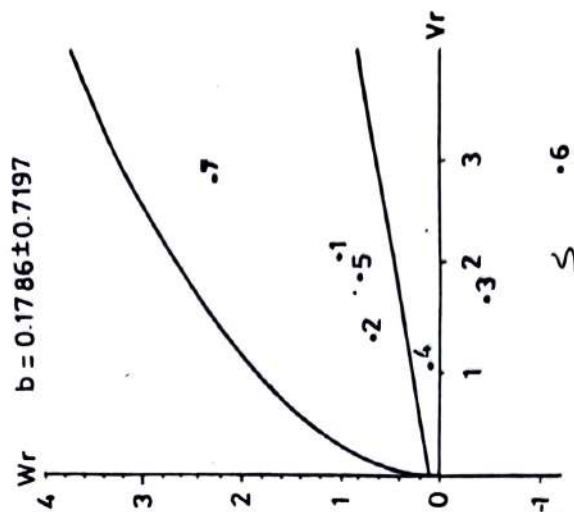


Fig. 3 : Number of branches per plant

1 = Line Selection - 102, 2 = Punjab - 263, 3 = Pusa Barsati, 4 = Gujarat - 1, 5 = GC - 82-7, 6 = Arka Garima, 7 = In - 103

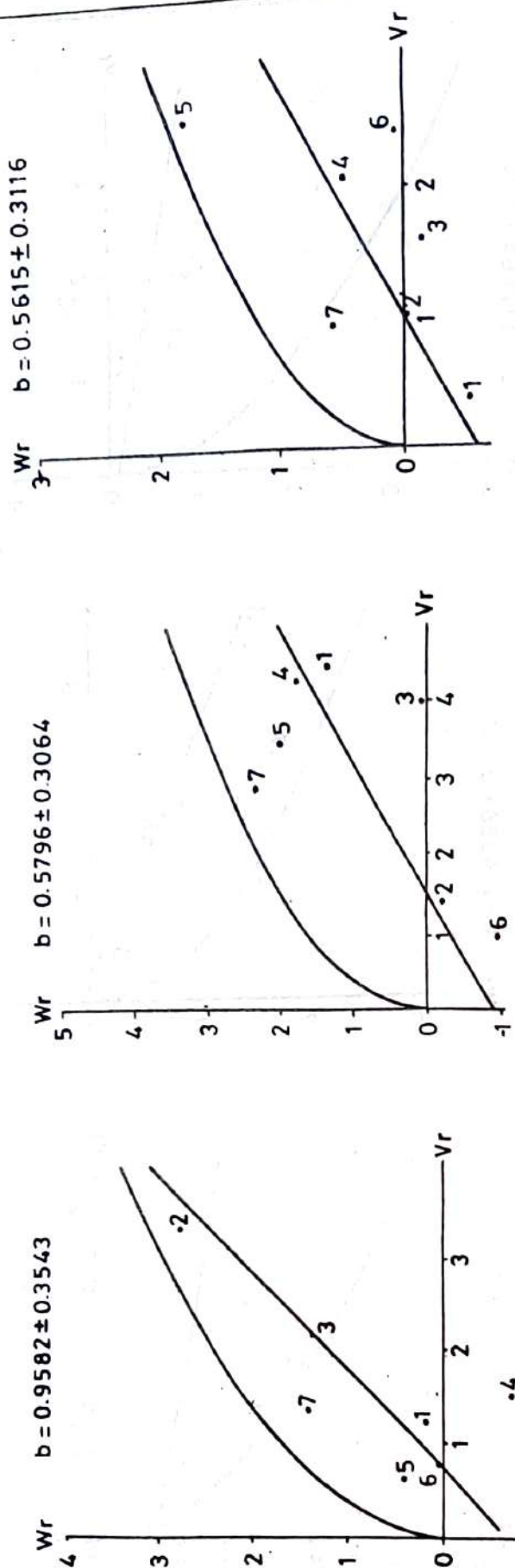


Fig. 4 : Plant height

Fig. 5 : Number of pods per plant

Fig. 6 : Pod yield per plant

It can be ascertained on the basis of graphical analysis that none of the parents had the possible complete set of dominant or recessive genes for all the traits. It would therefore be possible to accumulate desirable alleles in any of the parents by recurrent

selection to achieve high mean performance with high levels of dominance. In the present study Line Selection-102 and Arka Garima could be used in further breeding programme to combine attributes like number of pods per plant and pod yield per plant.

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Heterosis in Indian Bean (*Dolichos lablab* (L.))*

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ABSTRACT

The magnitude of heterosis over better parent was high for seed yield per plant followed by number of pods per plant and number of branches per plant. Significant heterosis effects and high *per se* performance with respect to seed yield per plant was recorded by the cross Red Paria x AKW-9304, Red Paria x NVS-31 and 125-36 x NVS-121. Crosses exhibiting high heterosis for seed yield also depicted high heterosis for one or more yield attributing traits over their better parents.

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INTRODUCTION

The magnitude of heterosis provides a basis for genetic diversity and a guide to the choice of desirable parents for developing superior F_1 hybrids so as to exploit hybrid vigour and/or for building better gene pools to be employed in population improvement. In the recent past, plant breeders have extensively explored and utilised heterosis in boosting up yield in a number of crops. Indian bean is highly self pollinated crop and the scope for exploitation of hybrid vigour will depend on the direction and magnitude of heterosis, biological feasibility and nature of gene action. Study of heterosis will have a direct bearing on the breeding methodology to be employed for varietal improvement. The present investigation was therefore planned to

estimate the extent of heterosis over better parent in Indian bean (*Dolichos lablab* (L.)).

MATERIALS AND METHODS

The experimental materials consisted of 79 entries including 4 females, 15 males and their 60 crosses prepared through line x tester mating design by hand emasculation and pollination at Pulses Research Station, Gujarat Agricultural University, Navsari during rabi 1994. They were grown in randomized block design with three replications in single row plots of 3 m length at three locations viz., Navsari, Vyara and Achhalia of Gujarat Agricultural University during rabi 1995-96. Five competitive plants were selected at random at all the three locations from each row to record data on seed yield/plant.

*Part of Ph. D. thesis submitted to Gujarat Agricultural University, S. K. Nagar.

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TABLE 1

Best heterotic crosses for some related parameters for seed yield per plant in Indian bean in pooled analysis.

Sr. No.	Best heterotic hybrids	Heterotic effects (% heterosis)					
		Mean seed yield (g)	No. of branches/plant	No. of pods/plant	100 seed weight (g)	Days to 50% flowering	Days to maturity
1.	Red Paria x AKW-9304	48.59**	14.52**	31.02*	6.18**	9.90**	12.13**
2.	Red Paria x NVS-31	47.99**	14.73**	28.20*	-18.3**	-14.53**	-9.63**
3.	Red Paria x NVS-102	41.22**	0.67	34.24*	-4.32**	-4.70**	-2.99**
4.	125-36 x NVS-21	34.60**	6.88**	26.39*	0.50	-6.83**	-6.83**
5.	Red Paria x AKW-9305	33.98**	8.49**	11.93*	-9.42**	29.67**	22.90**

TABLE 2

Per se performance for some related parameters for seed yield per plant in Indian bean in pooled analysis.

Sr. No.	Best heterotic hybrids	Per se performance					
		Mean seed yield (g)	No. of branches/plant	No. of pods/plant	100 seed weight (g)	Days to 50% flowering	Days to maturity
1.	Red Paria x AKW-9304	49.08	8.36	52.88	24.04	49.33	95.96
2.	Red Paria x NVS-31	48.88	8.38	51.74	25.29	51.00	97.00
3.	Red Paria x NVS-102	46.65	7.35	54.18	22.12	54.11	101.00
4.	125-36 x NVS-21	47.50	8.38	52.97	23.08	54.56	100.11
5.	Red Paria x AKW-9305	44.26	7.92	45.17	25.34	56.33	102.56

number of branches/plant, number of pods/plant, 100-seed weight, pod length, protein content, plant height, days to 50 per cent flowering and days to maturity. Heterosis was estimated as an increase or decrease of F_1 hybrids over their better parents at all the three locations.

RESULTS AND DISCUSSION

The results revealed that in pooled analysis out of sixty hybrids tested thirty one crosses exhibited significant positive heterosis for seed yield per plant, twelve for number of branches per plant, eighteen for number of pods per plant, twenty-one for 100-seed weight, forty-three for protein content and three hybrids for pod length. While twenty-six hybrids depicted significant negative heterobeltiosis for days to 50 per cent flowering, ten hybrids for plant height and twenty-seven for days to maturity, which indicated considerable amount of heterosis. Deorukhkar (1978) in bengal gram, Chaudhary (1993) in cowpea, Ready *et al.* (1994) in mungbean and Pawar (1983) in field bean have also reported significant heterotic effect for one or more characters, which supported the present findings.

Performance of the five most heterotic crosses (Table 1) for seed yield per plant

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revealed that number of branches per plant were the main contributors towards the seed yield, as all the five crosses depicted highly significant positive heterotic effect for both these characters (except Red Paria x NVS-102 for number of branches). This suggested that heterosis in yield is reflected through heterosis in individual yield component. Grafiours (1959) also pointed out that only some components of yield were important for the final product yield. Expression of heterosis for other yield components like pod length and 100-seed weight does not seem to have direct bearing on heterosis for seed yield though yield is a multiplicative interaction of yield components.

A comparison of *per se* performance of crosses and the heterotic effect for seed yield per plant and its important attributes further revealed that there was close association between heterotic effect of the hybrids and their *per se* performance. For example the first five high yielding hybrids were essentially the most heterotic hybrids for seed yield per plant with slight change in their relative ranking. Similar conclusion can be drawn for other components also. It therefore lead to suggest that heterosis over better parent may also be regarded as the reliable guide for breeding better performing hybrids of Indian bean for commercial exploitation.

Combining Ability in Indian Bean (*Lablab purpureus* (L). Sweet)*

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ABSTRACT

Combining ability and gene actions for six characters including pod yield in Indian bean were studied in a half diallel crosses of seven diverse lines. Analysis of variance revealed significant mean sum of square due to gca as well sca for all the characters. The higher magnitude of gca variance compared to sca variance signified the predominant role of additive type of gene action in the expression of all the characters. It is suggested that breeding for high yielding varieties in Indian bean may become more effective if additive gene action is more appropriately exploited alongwith non-additive gene effects. It could be achieved by selecting desirable segregants from the segregating population by applying progeny selection technique.

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INTRODUCTION

In a crop improvement programme, the success rests upon isolation of valuable gene combinations as determined in the form of lines with high combining ability. The lines which produce good progenies on crossing, are most desired by the plant breeder. The knowledge of gene action and combining ability not only helps in identifying the best combiners which may be hybridized either to exploit heterosis or to accumulate fixable genes through selection but also helps in understanding the inheritance of quantitative characters, so as to choose the proper selection method to be followed in future breeding programmes. There are only a few reports available on these aspects for Indian

bean. With this in view, results on the estimates of combining ability and variances for pod yield and yield contributing characters from 7 x 7 diallel (without reciprocals) experiment are presented here.

MATERIALS AND METHODS

Seven diverse lines of *Lablab purpureus* viz., G. P. L. No. 83, G.P.L. No. 88, JIB (P)-2, G.P.L. No. 36, JDL-79, G.P.L. No. 48 and JIB (P)-6 were crossed in all possible combinations (excluding reciprocals). The 21 F_1 s and 7 parents were grown in a randomized block design with three replications at Vegetable Research Station, Gujarat Agricultural University, Junagadh during rabi 1997-98. Each parent and F_1 was

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planted in one row plot of 7.5 m long with inter and intra-row distance of 0.90 m x 0.75 m. Observations were recorded on five randomly selected plants from each replication, for six traits viz., days to first picking, number of branches per plant, pod length (cm), number of seeds per pod, number of pods per plant and pod yield per plant (g). Mean values were used for statistical analysis. The gca and sca variances and effects were worked out using Model-1, Method-2 of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance for combining ability for different traits (Table 1) was highly significant for all the characters except days to first picking. These suggested the role of both additive and non-additive genetic components in the expression of all the characters. However higher magnitude of gca variance over sca variances for all traits indicated that the additive components of genetic variance were predominantly involved in the expression of yield and its attributing characters. Similar

results were reported by Singh *et al.* (1980) and Singh and Singh (1981). It is evident from these observations that breeding for high yielding varieties in Indian bean may become more effective if additive gene effects are more appropriately exploited along with non-additive gene effects. In Indian bean, it could be achieved by the use of good general combining parents in hybridization and selecting desirable segregants from the segregating generations by adopting progeny selection technique which is meant for exploiting additive genetic variance.

Estimates of gca effects for parents (Table 2) indicated that JIB(P)-2 was the good general combiner for the characters like days to first picking, number of branches per plant and pod yield per plant, G. P. L. No.-88 and G. P. L. No.-48 were good general combiner for pod length, number of seeds per pod. The parent JDL-79 was average combiner for number of branches per plant, pod length and number of seeds per pod. None of the parents was good general combiner for all the traits.

TABLE 1

Analysis of variance for combining ability for different economic traits studied in Indian bean.

Characters d.f.	Mean squares			
	gca 6	sca 21	Error 54	gca/sca
Days to first picking	20.17*	19.34**	6.92	1.04
No. of branches per plant	2.27**	1.14**	0.36	1.99
Pod length	18.05**	1.13**	0.06	15.95
No. of seeds per pod	0.47**	0.05**	0.01	9.10
No. of pods per plant	2718.45**	1072.80**	51.63	2.53
Pod yield per plant	12222.95**	19865.59**	640.01	0.62

*, ** indicates significance at 5 and 1 per cent, respectively.

TABLE 2

General combining ability effects of yield components Indian bean.

Parents	Days to first picking	No. of branches per plant	Pod length (cm)	No. of seeds per pod	No. of pods per plant	Pod yield per plant
G. P. Line No. 83	-2.49*	-0.06	-1.44**	-0.06	16.75**	31.29**
G. P. Line No. 88	-0.20	-0.20	1.56**	0.27**	-15.68**	-32.08**
JIB (P)-2	1.17	-0.75**	-1.63**	-0.32**	26.19**	65.18**
G. P. Line No. 36	1.17	-0.14	0.78**	0.15**	-8.61**	-8.38
JDL-79	0.66	0.91**	0.79**	0.14**	12.68**	3.96
G. P. Line No. 48	-1.57	-0.03	1.32**	0.11	-16.17**	-31.93
JIB (P)-6	1.25	0.27	-1.38**	-0.29**	10.19**	-28.04*
S. E. (gi)	0.88	0.18	0.08	0.04	2.22	7.81
C. D. at 5%	2.16	0.45	0.18	0.08	5.40	19.10
S. E. (gi-gi)	1.24	0.28	0.12	0.05	3.39	11.93
C. D. at 1%	3.03	0.69	0.34	0.13	8.29	29.18

*, ** indicates significance at 5 and 1 per cent, respectively.

No cross combination was consistently good for all the characters (Table 3). The cross combination G.P.L. No.-83 x JIB (P)-2 manifested significant positive effect in desirable direction for pod yield per plant, number of branches per plant, pod length and number of pods per plant. The cross G.P. L. No.-88 x JIB (P)-2 showed significant sca effect in desired direction for number of branches per plant, pod length, number of seeds per pod, number of pods per plant and pod yield per plant. The cross combination JIB (P)-2 x G. P. L. No.-36 exhibited significant sca effect in desired direction for number of branches per plant,

pod length, number of seeds per pod, number of pods per plant and pod yield per plant. The hybrid G. P. L. No.-36 x JDL-79 recorded the highest significant sca effects in desired direction for number of pods per plant. The cross combination JDL-79 x G. P. L. No.-48 had significant sca effects in desired direction for pod length, number of pods per plant and pod yield per plant.

The crosses exhibiting high sca effects for different characters indicate the possibility of improving these characters by selection and hybridization.

TABLE 3

List of crosses showing good specific combining ability effects for yield and its attributes in Indian bean.

Crosses	Days to first picking	No. of branches per plant	Pod length (cm)	No. of seeds per pod	No. of pods per plant	Pod yield per plant (g)
G. P. L. No. 83 x JIB(P)2	-2.94	1.29*	0.85**	0.08	62.70**	104.65**
G. P. L. No. 88 x JIB(P)-2	2.43	-0.50	0.20	0.34**	4.05	177.69**
G. P. L. No. 88 x JIB (P)-6	-0.17	1.52**	0.99**	0.23*	17.01*	104.80*
JIB(P)-2 x G. P. L. No. 36	3.39	2.37**	0.34	0.22*	19.66**	139.65**
G.P.L. No. 36 x JDL-79	-3.76	0.25	0.07	0.11	38.42**	192.54**
JDL-79 x G. P. L. No. 48	-3.35	-0.52	0.50*	0.15	21.01**	144.76**
S. E. (Sij)	2.36	0.54	0.22	0.10	6.45	22.71
C. D. at 5%	4.91	1.12	0.46	0.21	13.41	47.23
S. E. (Sij-Slk)	3.51	0.80	0.33	0.15	9.58	33.73
C. D. at 5%	7.29	1.66	0.69	0.32	19.93	70.16
S.E. (sij-slk)	3.28	0.75	0.98	0.14	8.96	31.55
C. D. at 5%	6.82	1.55	2.04	0.30	18.64	65.63

*, ** indicates significance at 5 and 1 per cent, respectively.

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Knowledge Level of Cash Crop Growers About Pesticides in Guntur District of Andhra Pradesh

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ABSTRACT

The research was conducted on knowledge level of cash crop growers about pesticides used in cash crops (Cotton, Chilli) cultivation in 40 farm families of Guntur district of Andhra Pradesh during the year 1995. Unit of the study was 'whole family'. The results of the study reveal that all the three categories of growers were having medium level of pesticide knowledge. The mean knowledge score was highest in case of off springs followed by their parents (male head and spouse).

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INTRODUCTION

To a considerable extent the yield of cash crops (cotton, chilli) is affected by many pests and diseases. Adoption of timely control measures of pests and diseases by the farmers is therefore, one of the several important ways of increasing the yield. A number of pesticides are available for combining pests and diseases. However, for effective control of pests and diseases it is not enough to know the names of pesticides to be used, but farmers also need to know as to what extent, at what time and which of the pesticide and fungicides should be applied to various pests. The main point is that pesticides (Insecticides, Fungicides and acaricides) can make an effective contribution if they are used in appropriate manner. Thus, healthy plant protection practices farmers should have a strong knowledge about the use

of pesticides (Bhalara *et al.*, 1988). In this direction the present study was taken up with the following objectives :

1. To examine the knowledge level of respondents (male head, spouse and off springs) about pesticides used in cash crops cultivation.
2. To find out relationship between socio-personal, agro-economic and communication characteristics with extent of pesticide knowledge of the cash crop growers.

MATERIALS AND METHODS

The study was conducted in Guntur district of Andhra Pradesh because it is considered as a progressive agricultural belt of the state. Among different mandals of the

district, Guntur mandal was selected for the present study. Among different villages of mandal, four villages were selected based on the cultivable area of cotton and chilli crops. The unit of the study was 'whole family'. A total of 120 respondents were selected from three categories i.e., 40 male heads, 40 spouses and 40 off springs. The data was collected through structured schedule after preliminary testing. Personal interview was followed for data collection. The off springs here refers to eldest son of the family above fifteen years of age. The female off springs of the same category were not interviewed because of their nil response due to some traditional beliefs and other socio-cultural conditions. Based on scores on knowledge items, the respondents were grouped into three categories namely low, medium and high by using mean and standard deviation.

Sim independent variables viz., age, education, size of land holding, farm power and machinery, average annual income and sources of agricultural and pesticide information were selected for the study and their relationship with pesticide knowledge was tested by using correlation coefficient (r).

RESULTS AND DISCUSSION

It is evident from Table 1 that all the three categories of respondents were having medium level of knowledge about pesticide use in cash crop cultivation. The mean knowledge score was highest in case of off springs, followed by male heads and female heads (spouses). The lowest mean score among female heads might be due to their less participation in field activities.

TABLE 1

Distribution of cash crop growers according to their pesticide knowledge level.

N = 120

Case	Category	Number of respondents	Percentage
Male head	Low	3	7.5
	Medium	28	70.0
	High	9	22.5
	N = 4 Mean $\bar{x}$ = 7.597, S. D. = 9.207		
Female head (spouse)	Low	5	12.5
	Medium	25	62.5
	High	10	25.0
	N = 40, Mean $\bar{x}$ = 60.875, S. D. = 6.107		
Off springs	Low	7	17.5
	Medium	24	60.0
	High	9	22.5
	N = 40, Mean $\bar{x}$ = 71.075, S. D. = 5.42		
High = $\bar{x} + S. D.$ Medium = $\bar{x} \pm S. D.$ Low = $\bar{x} - S. D.$			

TABLE 2
Correlation coefficients between independent variables and pesticide knowledge cash crop growers.

Sr. No.	Independent variable	Dependent variable (<i>r</i> - value) pesticide knowledge		
		Male	Female (spouse)	Off- springs
1.	Age	0.594**	0.415**	0.447**
2.	Education	0.793**	0.172 ^{NS}	0.744**
3.	Size of land holding	0.708**	0.161 ^{NS}	0.142 ^{NS}
4.	Farm power and machinery	0.719**	0.632**	0.649**
5.	Average annual income	0.672**	0.748**	0.577**
6.	Sources of agricultural and pesticide information	0.386*	0.280 ^{NS}	0.815**

** Significant at 0.01 level of probability

* Significant at 0.05 level of probability

NS = Non significant.

Findings in the Table 2 depicted that, age, education, size of land holding, farm power and machinery, average annual income and sources of agricultural and pesticides information were positively and significantly related with pesticide knowledge level of male heads. Age, farm power and machinery, average annual income were positively and significantly related with pesticide knowledge level of female heads (spouses). Whereas education, size of land holding, sources of agricultural and pesticides information were non-significantly related with pesticides knowledge level of spouse respondents. This means, age, farm power and machinery and average annual income, exert their influence on the pesticide knowledge level of spouse respondents.

Regarding off springs, except size of land holding all other five independent variables were highly and significantly related with pesticide knowledge level. This means that except size of land holding, all other variables except influence on the pesticide knowledge level of the off springs.

Conclusion

There is a significant difference between the three categories of users of

pesticides within a family. This knowledge difference can be attributed to level of education, extent of outside contact and media use pattern. The study brings out vividly the need for proper understanding of safe handling, packaging, storage and spraying dosage of pesticides at field level.

Recommendations

The villagers belonging to all age groups and sex should be educated well about pesticides. Both formal and informal methods of education should be used. Training of farmers, their wives and off springs be arranged by Agricultural Universities, Krishi Vigyan Kendra Non Governmental organisations in spraying operations as well as storage of pesticides.

Individual, group and mass contact methods of communication should be adopted for safe handling of pesticides information.

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Impact of Poultry Training Organised by Gujarat Agricultural University

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ABSTRACT

Impact of poultry training organised by GAU was assessed through teacher's made questionnaire for selected trainees. Youth with education up to or above Higher Secondary Level took advantage of the training. Majority (61 per cent) of the trainees were from Kaira. Majority of the respondents perceived that all the theoretical as well as practical courses were useful and they acquired important skills required for poultry farming. Majority (78 per cent) of them had positive attitude towards the training. After the training, the trainees were either self-employed (34 per cent), able to run their poultry farm more efficiently (23 per cent) or employed (10 per cent) on poultry farm.

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INTRODUCTION

Poultry production has come-up as an independent occupation and shown a tremendous growth in Surat, Valsad, Kaira, Anand and Ahmedabad districts of Gujarat. For such an important rural occupation, trained man-power is a basic requirement. In order to impart skill oriented vocational training to practicing and prospective poultry farmers, Poultry Training Centre has been established at Anand in 1963-64. During 10 weeks of training, important subjects related to farm poultry production viz., care and management, feeding, housing, marketing etc. are covered and a certificate is given to successful trainees. Work experience for various operations is an integral part of this vocational training to develop confidence and necessary skill in the field of farm poultry production.

Now, the time is mature to measure the effectiveness and practical utility of this training programme. Further, it is also necessary to know the opinions and suggestions of the trainees trained in this programme, so that in future, necessary planning and modifications may be made. In this context, the study was conducted with the following major objectives :

1. To know the personal characteristics of the trainees.
2. To know the sources of information regarding poultry training.
3. To determine the utility of the theoretical and practical course content of the poultry training.

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4. To know the various skills acquired through the poultry training.
5. To know the attitude of the trainees towards the poultry training.
6. To sought opinions of the trainees regarding poultry training.
7. To seek the suggestions of the trainees to improve the poultry programme.

MATERIALS AND METHODS

The trainees who have received the training during the year 1990-91 to 1995-96 at Poultry Training Centre, Gujarat Agricultural University, Anand were the responding population of the present study. Appropriate teacher's made questionnaire was developed for the purpose. The data were collected through mailing questionnaires to the randomly selected 150 trainees, of which 55 trainees responded.

A. Source of Information

Every respondent was asked to indicate the source/sources from which they got the information regarding the poultry training programme. Their frequencies were counted and percentages were worked out.

B. Utility of the Theoretical and Practical Courses of Poultry Training

The utility of various theoretical and practical courses taught during the poultry training was measured with the help of 3 points rating scale 'Most useful, Useful and least useful' with the score value of 3, 2 and 1, respectively. To assign the rank, the mean score for each item was calculated.

C. Attitude Towards Training

Attitude of the respondent towards poultry training was measured by teacher's made attitude scale. The selected '8' statements for final format of the attitude scale were randomly arranged. There were five

TABLE 1
Distribution of the trainees according to their age, education and caste.

Sr. No.	Character	Groups	Number of trainees admitted	Per cent
1.	Age	16 to 20 years	106	23.45
		21 to 30 years	319	70.57
		Above 30 years	27	05.98
2.	Education	Upto 9th Std.	16	03.50
		New S.S.C. passed	57	12.60
		HSC passed	190	42.10
		Above HSC	189	41.80
3.	Caste	Scheduled caste	59	13.05
		Scheduled tribe	38	08.41
		OBC	95	21.02
		Other	260	57.52

response columns representing a 5 point agree-disagree continuum as followed by Likert (1932) in his summated rating technique. The points on the continuum were strongly agree, agree, undecided, disagree and strongly disagree with score weightage of 5, 4, 3, 2 and 1, respectively, for positive and 1, 2, 3, 4 and 5, respectively, for negative statement. Based on the mean and standard deviation, the respondents were classified into three groups as low ($< \text{Mean} - \text{S. D.}$), medium ($> \text{Mean} - \text{S. D.}$ and $< \text{Mean} + \text{S. D.}$) and high ($> \text{Mean} + \text{S. D.}$).

RESULTS AND DISCUSSION

A. Personal characteristics

Profile of age, previous education and caste of trainees admitted during the year 1991-92 to 1995-96 is given in the Table 1.

Data presented in table 1 revealed that nearly 95 per cent of the trainees were below 30 years of age, indicating that youth has got the advantage of the training. It is also

revealed that the majorities (83.90 per cent) of trainees were having HSC and higher education as against minimum requirement of passing seventh standard. This indicates that the minimum requirement for admission in the training may be raised to HSC, if not, at least to New S.S.C. Regarding caste of the trainees admitted, majority (57.52) of the trainees were of general categories against 13.05 per cent from the scheduled caste and 21.02 per cent from the other than backward class.

B. Districtwise distribution of trainees

Majority (61.28 per cent) of the trainees admitted from 1990-91 to 1995-96 were from Kaira District followed by 11.06 per cent from Ahmedabad and 7.52 per cent from Panchmahal district. It is worth noting that practically no trainee was coming from Banaskantha, Kutchh, Junagadh, Amreli, Jamnagar, Surendranagar, Rajkot, Bhavnagar, Bharuch and Dang districts, whereas a limited (less than 4 per cent) trainees were from Mehsana, Sabarkantha, Gandhinagar, Surat

TABLE 2

Distribution of the respondents according to their sources of information regarding poultry training.

Sr. No.	Source of Information	Number	Per cent
1.	Extension worker	13	23
2.	Friends/Neighbour	11	20
3.	Advertisement in Newspaper	25	45
4.	Visit of training centre/letter	07	12
5.	Others	00	00

TABLE 3

Mean utility scores of theoretical courses.

Sr. No.	Areas/subjects	Mean score	Rank
1.	Poultry management and Economics	2.66	III
2.	Poultry, nutrition and feeding	2.67	II
3.	Poultry health care	2.81	I
4.	Anatomy & physiology of poultry	2.14	IV

and Valsad districts. These might be due to remoteness of the training centre from the above districts and/or poor development of poultry farming. It is suggestive that atleast one poultry training centre may be established in South Gujarat which is also a pioneer and good pocket for poultry production.

C. Sources of Information regarding Poultry Training

The respondent trainees had varied sources of information (Table 2) regarding the training on poultry. Important sources for the information were advertisement published in Newspaper (45 per cent) extension worker (23 per cent) and friends/neighbour (20 per cent).

D. Usefulness of theoretical courses

Mean scores worked out for usefulness of the theoretical courses taught during the training as perceived by the respondents are given in Table 3.

It can be seen from the Table 3 that among the four theoretical courses, poultry health care got the highest mean score and secured first rank followed by poultry nutrition and feeding. Majority of the respondents perceived that all the four theoretical courses were useful.

E. Usefulness of practical courses

Mean scores worked out for usefulness of the practical courses contents taught during the training as perceived by the respondents are given in Table 4.

It is revealed from Table 4 that as perceived by the trainees the practicals on housing, brooding and vaccination and health care are the most useful. Majority of the respondents opined that all the practicals were useful.

F. Skills acquired

It is one of the objectives to develop the different skills required in poultry farming. Six important skills were identified to know skills acquired by the trainees.

TABLE 4

Mean utility scores of practical course contents.

Sr. No.	Areas/subjects	Mean Score	Rank
1.	Housing of poultry	2.85	I
2.	Brooding of chicks	2.75	II
3.	Vaccination and health care programme on poultry farm	2.65	III
4.	Records of poultry farm	2.12	VIII
5.	Equipments of poultry farm	2.38	V
6.	Methods for selection of birds	2.46	IV
7.	Hatching of fertile eggs	1.98	X
8.	Poultry feeds	2.37	VI
9.	Judging the quality of eggs	2.02	IX
10.	Anatomy of birds	2.15	VII

TABLE 5

Distribution of the respondents according to the different skills acquired after the poultry training.

<i>Sr. No.</i>	<i>Skills</i>	<i>Number</i>	<i>Per cent</i>
1.	Preparation of poultry feeds	18	40.90
2.	Debeaking	37	90.24
3.	Giving medicine to poultry birds	38	79.16
4.	Vaccination	38	80.85
5.	Brooding of chicks	39	86.66
6.	Maintenance of records	31	73.80

The table 5 indicates that in general majority of the trainees acquired important skills viz., debeaking (90.24 per cent), brooding of chicks (86.66 per cent), vaccination (80.85 per cent), giving medicines (79.16 per cent) and maintenance of records (73.80 per cent) required for poultry farming during the training.

G. Attitude towards training

The distribution of the respondents according to their attitude towards the poultry

training is depicted in Fig. 1. Majority (78.18 per cent) of them and medium to high attitude towards the training.

The attitude score obtained by the respondents varied between 25 to 40 with average value of 31.6 having 4.24 standard deviation and 13.42 co-efficient of variance suggesting that the group was homogenous in this respect.

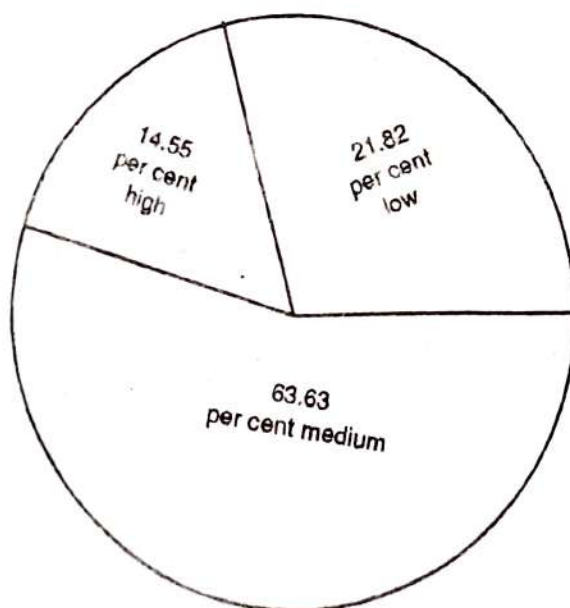


Fig. 1 : Attitude towards poultry training

H. Utility of the poultry training

The utility of the poultry training was found useful in different ways. After the training 34 per cent of the respondent could start their own poultry farms for self-employment, whereas, 23 per cent of the respondents who were already having their poultry farms could do their business more efficiently. About 10 per cent of the respondents could get job on poultry farm. Surprisingly 10 per cent of the respondents opined that though they were not practicing poultry farming, but the training was found useful in their present business.

I. Suggestions of the respondents

To an open question there were suggestions to add following theoretical topics in the training course.

1. Marketing management of poultry produce.
2. Broiler production.
3. Strains breeds of poultry birds.
4. Purchase and maintenance of equipments required on poultry farm.
5. Financial facilities and project preparation for getting finance.

The trainees also suggested that following topics may be included or given more weightage in the practicals during the poultry training.

1. Different parts of eggs and judging egg quality.
2. Vaccination and health care.
3. Cares in preparation of poultry feed.
4. Detail study of important poultry diseases.
5. Post mortem of poultry birds.
6. Sanitation and disinfecting of poultry farm.

While giving their suggestions they opined that the duration of the training may be extended and more time may be allotted for practicals or work experience on farm. The certificate for the successfully completing the training should be given at the earliest.

From the study it can be concluded that the poultry training is very useful and well oriented. However following suggestions are to improve the training :

1. Syllabus for the poultry training may be revised looking to the suggestions of the respondents and development in the science. If necessary, the duration of the training may be increased.
2. A poultry training centre may be established in South Gujarat.
3. Minimum requirements for admission in the training may be raised to S.S.C. Exam. passed.

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Constraints Faced by Mango Growers in Adoption of Drip Irrigation System

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ABSTRACT

The present study was conducted in six talukas of Junagadh district to analyse the constraints faced by mango orchard growers in adoption of drip irrigation system. The data collected from the same respondents by arranging personal interview with randomly selected 175 mango orchard growers of the twenty four selected villages with the help of interview schedule. The results of the research revealed that the most important economic constraints faced by mango orchard growers in adoption of drip irrigation sets were ; high cost of spare parts, heavy initial expenses for installation of drip irrigation system and lack of capital for covering entire area under drip irrigation system. It is also reflected that the major technological constraints faced by the users of drip sets were : frequent clogging of drippers and microtubes, requires time to time attention for minor repairs, damage caused to the system by rodents and jackals, lack of technical know-how, lack of awareness among the farmers, regarding benefits of drip irrigation system and difficult to keep proper water pressure.

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INTRODUCTION

Saurashtra region is considered as a dry farming area, where the availability of water for irrigation in wells is extremely source and irregular. Hence, it is necessary to economize the use of water for agriculture to bring more area under irrigation. Therefore, the farmers of this region have been attracted towards the modern method of irrigation and they have introduced drip irrigation system with the hope of making the judicious and scientific use of irrigation water and thereby overcoming the various problems of labour, money and water management. But it is well

known fact that if there is introduction of any technology, more or less problems will be there considering this it is high time to analyse the constraints faced by mango orchard growers in adoption of drip irrigation systems and seek suggestions to overcome them when a few years have already been passed in introduction at drip system.

MATERIALS AND METHODS

The present study was conducted in six talukas of Junagadh district namely Talala, Malia, Una, Medarada, Vanthli and Visavadar. These talukas were the first six talukas in the

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district which were having maximum number of orchards. From each of the selected talukas, four villages having maximum numbers of drip sets installed in mango orchards were selected. The mango orchard growers, those who had installed and used drip irrigation system in their mango orchards for successively more than three years, were chosen at random from each identified village in such a manner that there would be proportional to total size of mango orchard growers in respective village fell under each of the six talukas. Thus, the sample consisted of 175 respondents for the study which constituted 24 per cent of the total size of drip sets under mango orchards in the district. The data were collected by arranging personal interview with 175 mango orchard in the district. The data were collected by arranging personal interview with 175 mango orchard growers of the twenty four selected villages with the help of interview schedule.

Constraints in adoption of drip irrigation system

It was operationalised as the items of difficulties faced by the mango orchard growers in adoption of drip irrigation system. With a view to identify the inhibitors of drip irrigation system use, a list of 45 specific constraint item was prepared initially based on literature available, discussions with the scientists and field extension functionaries and informal interview with a group of about 50 Ms adopter farmers other than the respondents of the study. These constraints were grouped into four categories viz., economic, technological, administrative and personal and socio-psychological constraints. Thereafter, the constraints were got rated by the respondents on a four-point continuum by asking them to indicate the extent to which each constraint was perceived as hindering the adoption of DIS.

The four response categories provided against each constraint were 'very much', 'much', 'not so much', and 'not at all' with

scores of 3, 2, 1 and 0 respectively. The total weighted score for each constraint was computed by summing the frequencies of respondents in different response categories. The mean weighted score was calculated by dividing the total weighted score with the number of respondents. The constraints were ranked on the basis of mean weighted scores.

Suggestions for promoting the use of drip irrigation system

An attempt was also made to know the suggestions of the mango orchard growers to overcome the constraints and thereby promoting the use of DIS. The respondents' suggestions were elicited through a simple open-ended question. They were asked to suggest possible solution(s) in form of their suggestions to overcome the constraints associated with adoption of DIS and thereby promoting the use of drip irrigation system. Number of respondents making the same suggestion(s) were counted in frequency and then percentage of the respondents making the same suggestion(s) was calculated.

RESULTS AND DISCUSSION

The most important economic constraints faced by the mango orchard growers in adoption of drip irrigation system were : high cost of spare parts, heavy initial expenses for installation of drip irrigation system and lack of capital for covering entire area under drip irrigation system (Table 1).

The major technological constraints faced by the adopters in drip irrigation were : frequent clogging of drippers and microtubes, requires time to time attention for minor repairs, damage caused to the system by rodents and jackals, lack of technical know-how, lack of awareness among the farmers regarding benefits of drip irrigation system and difficult to keep proper water pressure (Table 1).

TABLE 1

Constraints faced by the mango orchard growers in adoption of drip irrigation system.

Sr. No.	Constraints	Mean weighted score	Rank order
I. Economic Constraints			
1.	High cost of spare parts used in DIS	2.714	I
2.	Heavy initial expenses for installation of DIS	2.697	II
3.	Lack of capital for covering entire area under DIS	1.571	III
4.	Lack of credit facilities to farmers	0.394	IV
5.	Additional tank required to get proper pressure	0.080	V
II. Technological Constraints			
1.	Frequent clogging of drippers and microtubes	2.491	I
2.	Requires time to time attention for minor repairs	2.023	II
3.	Damage caused to the system by rodents and jackals	2.006	III
4.	Lack of technical know-how	1.246	IV
5.	Lack of awareness among the farmers regarding benefits of DIS	1.040	V
6.	Difficult to keep proper water pressure	0.949	VI
7.	Improper pressure hinders discharge rate	0.949	VII
8.	Difficulty in weeding within the rows	0.914	VIII
9.	Problems of water leakages	0.886	IX
10.	Difficulty in interculturing	0.817	X
11.	Lack of recommendation of the system in major fruit crops	0.787	XI
12.	Faulty installation	0.446	XII
13.	Uprooting of plants due to shallow rooting	0.486	XIII
14.	Technologically complicated	0.246	XIV
III. Administrative Constraints			
1.	Inadequacy and uncertainty in power supply	2.623	I
2.	Lack of after sale services from the company dealers	2.366	II
3.	Non-availability of spare parts at proper time with reasonable rates	2.349	III
4.	Lack of proper training	2.223	IV
5.	Non-availability of repairing facilities in the village	2.069	V
6.	Non-availability of quality material of DIS	1.897	VI
7.	Non-availability of technical guidance in time	1.549	VII
8.	lack of advice and guidance from extension workers	1.337	VIII

1.	2.	3.	4.
9. Lack of supervision by the block officials		1.154	IX
10. Low frequency of visits of extension workers		1.137	X
11. Clumsy procedure for getting loan/subsidy		0.400	XI
12. Delay in sanction of loan/subsidy		0.297	XII
13. Lack of credibility of extension workers		0.263	XIII
IV. Personal and socio-psychological constraints			
1. Lack of spirit among the farmers regarding DIS		1.960	I
2. Frustration due to failure of DIS in work		0.851	II
3. Resistance from family members		0.229	III
4. Lack of motivation		0.086	IV

The important administrative constraints being faced by the respondents were : inadequacy and uncertainty in power supply, lack of after sale services from the company dealers, non-availability of spare parts at proper time with reasonable rates, lack of proper training, non-availability of repairing facilities in the village, non-availability of quality material of drip irrigation system and non-availability of technical guidance in time. (Table 1).

The major personal and socio-psychological constraints experienced by the drip irrigation system adopter farmers were : lack of spirit among the farmers regarding drip irrigation system, frustration due to failure of drip irrigation system in work, resistance from family members and lack of motivation (Table 1).

These findings go to corroborate the observations of Rodge *et al.* (1988), Ingle (1989), Tilekar (1989), Ingle and Sagane (1992), Phadtare *et al.* (1992), Puranik (1992), Kalasariya *et al.* (1993), Chaudhari (1995) and Shiyani and Kuchhadiya (1997).

The major suggestions offered by the mango orchard growers to overcome the constraints associated with adoption of drip irrigation system and thereby promoting the use of drip irrigation system in sequential order were : provisions should be made to purchase drip irrigation sets directly from open market, training should be imparted along with drip irrigation sets for betterment of knowledge and skills, at least five years guarantee be provided by company agents for drip irrigation system, drip sets be supervised by company agents regularly, subsidy be paid directly to the farmers, regular guidance and free services be sought from company agents, quality material be provided for drip sets and wide publicity of drip irrigation system be made through mass media approaches. In addition to this, the respondents also felt that the amount of subsidy on drip irrigation system be increased, propaganda about drip irrigation system be made through shibirs and film shows and multipurpose sub-means should be designed so as to use in different crops (Table 2).

TABLE 2

Suggestions expressed by the mango orchard growers for promoting the use of drip irrigation system.

Sr. No.	Suggestions	Frequency	Per cent
1.	Provisions should be made to purchase DIS sets directly from open market	173	98.86
2.	Training should be organised along with DIS sets for betterment of knowledge and skills	167	95.43
3.	At least five years guarantee against DIS sets should be provided by company agents	163	93.14
4.	Provisions of regular supervision by company agents	160	91.43
5.	Subsidy be paid directly to the farmers	156	89.14
6.	Provisions of regular guidance on maintenance and free services from company agents.	140	80.00
7.	Quality material be provided for drip sets.	137	78.29
8.	Wide publicity of DIS through mass media approaches.	115	65.71
9.	Amount of subsidy should be increased and loan be provided for remaining cost.	100	57.14
10.	Propaganda about drip irrigation should be made through shibirs and film shows	53	30.29
11.	Multipurpose sub-mains should be designed so as to use in different cross	43	24.57

The findings are similar to the views expressed by Madalia (1990), Ingle and Sagane (1992), Phadtare *et al.* (1992),

Puranik *et al.* (1992), Kalasaria *et al.* (1993), Chaudhari (1995) and Shiyani and Kuchhadiya (1997).

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Evaluation of Some Dust Formulations of Insecticides Against Safflower Aphid *Uroleucon compositae* Theobald

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ABSTRACT

Field experiment was conducted during *rabi* 1991-92 to 1993-94 at Gujarat Agricultural University, Campus Anand to find out the effective and economical insecticide dust formulation against aphid, *Uroleucon compositae* Theobald infesting safflower. Two need base dusting of methyl parathion 2% dust at 15 or more aphids per 100 cm long safflower twig gave effective control of aphid and recorded highest (1 : 5.48) cost : benefit ratio for management of safflower aphids.

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INTRODUCTION

Safflower, *Carthamus tinctorius* (Linn.) is one of the major rainfed *rabi* oilseed crops cultivated in India on an area of 8.60 lakh hectares with an annual production of 4.91 lakh tonnes (Anonymous, 1991). Among the various factors affecting the yields, insects are the major bottle neck. The safflower aphid, *U. compositae* is the most serious pest amongst twenty two pests recorded in India (Rai, 1976). Nymphs and adults suck cell sap from tender shoots and leaves and impair vitality of plant and causing an yield loss from 36.05 to 67.72 per cent (Bhumnavar and Thontadarya, 1979; Basavanagoud *et al.*, 1981). In India various E.C. formulations of insecticides have been tested for their bio-efficacy against *U. compositae* by various workers, but no information on bio-efficacy of

new dust formulations is available, keeping this in view the present study was carried out.

MATERIALS AND METHODS

A field experiment was conducted at Anand in *rabi* 1991-92 to 1993-94 to evaluate the bio-efficacy and economics of five dust formulation of insecticides against safflower aphid, *U. compositae* (Table 1) with four replications. The gross and net plot size was 5.0 x 4.5 m and 4.0 x 3.6 m respectively. A distance of 45 cm between the rows and 10 cm between the plants was maintained.

The aphid population was recorded regularly at weekly interval from the appearance of aphid on randomly selected 10 apical twigs of 10 cm length in each plot. The first dusting of each of the insecticides was

alone @ 25 kg/ha when aphid, *U. compositae* population reached 15 or more aphids per 10 cm twig (Rathore and Pathak, 1982). The post treatment aphid populations were recorded after 24th, 48th, 72th and two weeks of dusting. Second dusting of all the dusts was done after three weeks of first dusting. The data obtained on aphid population after square root transformation and yield were analysed statistically.

RESULTS AND DISCUSSION

The significant effectiveness of all the dust formulations against safflower aphid, *U. compositae* was observed till two weeks after

first and second dusting over the untreated control. However, after first dusting no significant difference was observed in any of the dust formulations except endosulfan 2% dust which remained least effective after 24th of application. Methyl Parathion 2% dust proved more effective against aphid than endosulfan 2% dust after 48 and 72h of dusting. Fenvalerate 0.4% dust remained equally effective as endosulfan 4% dust upto one week, whereas after two weeks fenvalerate 0.4% dust was found less effective and high aphid population was observed on safflower crop in comparison to endosulfan 4% dust. Carbaryl 5% dust, methyl parathion

TABLE 1
Effect of various dust formulations on safflower aphid, *U. compositae* at different time interval and their ICBR (Pooled 1991-92 to 1993-94).

Treatments	Before dusting	Av. no. of aphids per 10 cm long twig.				
		After first dusting				
		24h	48h	72h	One week	Two week
Carbaryl 5% dust	6.07* (38.93)	1.60 (2.53)	1.38 (1.75)	1.52 (2.36)	2.00 (4.56)	3.26 (10.27)
Endosulfan 2% dust	6.44 (43.13)	3.40 (15.72)	2.11 (6.68)	1.83 (3.79)	1.63 (0.61)	2.59 (10.92)
Endosulfan 4% dust	6.40 (43.36)	1.59 (2.54)	0.91 (0.58)	0.93 (0.38)	1.30 (2.17)	2.44 (8.48)
Methyl Parathion 2% dust	6.38 (42.76)	0.79 (0.13)	0.71 (0.01)	0.86 (0.25)	1.38 (3.1)	2.61 (9.97)
Fenvalerate 0.4% dust	6.50 (44.23)	0.95 (0.51)	0.91 (0.45)	0.86 (0.28)	1.59 (2.71)	4.24 (20.82)
Control	6.65 (46.66)	8.44 (63.77)	9.34 (87.22)	9.16 (84.01)	9.42 (73.16)	9.08 (93.87)
S. Em.	0.18	0.50	0.44	0.27	0.22	0.53
C. D. at 5%	NS	1.56	1.39	0.83	0.70	1.66
C. V. %	5.56	24.88	19.85	16.02	14.76	23.67

* $\sqrt{X + 0.5}$ transformed values.
Figures in the parentheses are original values.

TABLE 2

Effect of various dust formulations on safflower aphid, *U. compositae* and their ICBR at different time interval (Pooled 1991-92 to 1993-94).

Treatments	Av. no. of aphids per 10 cm long twig.						Yield (kg/ha) Pooled	ICBR
	After second dusting							
	24h	48h	72h	One week	Two week			
Carbaryl 5% dust	1.48 (2.02)	0.80 (0.13)	1.01 (0.37)	0.89 (0.33)	1.10 (0.55)	799	1 : 1.19	
Endosulfan 2% dust	3.00 (14.39)	1.00 (0.20)	0.86 (0.30)	0.87 (0.10)	0.82 (0.12)	712	1 : 0.99	
Endosulfan 4% dust	1.65 (3.30)	0.79 (0.13)	0.74 (0.08)	0.80 (0.16)	0.78 (0.12)	781	1 : 1.17	
Methyl Parathion 2% dust	0.88 (0.29)	0.75 (0.08)	0.76 (0.11)	0.80 (0.16)	0.83 (0.21)	1033	1 : 5.48	
Fenvalerate 0.4% dust	1.13 (1.04)	0.80 (0.14)	0.86 (0.26)	0.92 (0.36)	1.13 (1.12)	738	1 : 0.81	
Control	7.01 (64.71)	7.05 (59.93)	7.57 (64.31)	7.67 (69.97)	6.45 (68.18)	608		
S. Em.	0.58	0.41	0.22	0.39	0.53	28.66		
C. D. at 5%	1.83	1.29	0.68	1.24	1.66	81.89		
C. V. %	34.85	14.84	15.77	15.35	51.94	10.07		

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

Figures in the parentheses are original values.

2% dust and endosulfan 2% dust showed equally persistancy against *U. compositae* as endosulfan 4% dust and fenvalerate 0.4% dust till two weeks of their applications.

Methyl parathion 2% dust and fenvalerate 0.4% dust treated safflower crop had considerably lower *U. compositae* population than endosulfan 2% dust after 24h

of their application. Ghorpade *et al.*, (1994) have also reported the effectiveness of methyl parathion 2% dust against safflower aphid. Carbaryl 5% dust and endosulfan 4% dust showed equal aphicidal property as methyl parathion 2% dust, fenvalerate 0.4% and endosulfan 2% dust. After 48h none of the dust formulations could show superiority to each other till two weeks of their applications.

Thus, all the five tested insecticide formulations were found effective against *U. compositae*.

Among the insecticides safflower dusted with methyl parathion 2% dust yielded considerably higher yield than fenvalerate

0.4% and endosulfan 2% dusted crop. Carbaryl 5% dusted crop had higher yield than endosulfan 2% dusted crop. Considering the cost of protection and benefit obtained, methyl parathion 2% dust showed highest ICBR (1 : 5.48) followed by carbaryl 5% (1 : 1.19) and endosulfan 4% (1 : 1.17).

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Population Dynamics of Gram Pod Borer, *Helicoverpa armigera* (Hubner) Hardwick on Cotton, Pigeonpea and Chickpea*

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ABSTRACT

The present study on population dynamics of *Helicoverpa (Heliopsis) armigera* (Hubner) Hardwick was carried out at the College Farm, College of Agriculture, GAU, Junagadh (Gujarat) on cotton, pigeonpea and chickpea during the year 1993-94. The study clearly revealed that the pest commenced its activity in the last week of July and remained active up to the end of October in cotton crop. During this period its population showed violent fluctuations with 3 different peaks in the first week of September, first week of October and third week of October, respectively. This was due to increasing trend of minimum temperature, rainfall, vapour pressure and relative humidity in the morning and evening. In pigeonpea crop the pest was active from first week of October to last week of November but the maximum population was recorded during the last week of October. Among the different physical factors of environment, significant effect in causing such fluctuation. The pest incidence on chickpea crop started third week of November and reached at in third week of December, when the crop was at podding stage. In this crop, the pest was active from November to February. Among the various factors, maximum and minimum temperature as well as vapour pressure showed decreasing trend which helped in causing the population fluctuation.

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INTRODUCTION

The gram podborer, *Helicoverpa armigera* (Hubner) Hardwick, previously considered as *Heliopsis armigera* Hb. (Vaishampayan, 1977) is a major pest of chickpea, cotton, pigeonpea and hybrid sorghum in India (Singh and Singh, 1974, Saharia and Dutta, 1975 and Srivastava and Singh, 1973). This insect causes 50 to 60 per cent damage to chickpea crop, which is the most preferred host of the insect. Distribution and abundance of animals are determined by combined effect of different components of the

environment. Weather factors influence the most (Andrewartha and Birch, 1954). Present paper reports the result of effect of weather factors on population fluctuation of *H. armigera* larvae on cotton, pigeonpea and chickpea during 1993-94 at Junagadh.

MATERIALS AND METHODS

The activity of pest in field on chickpea, cotton and pigeonpea was monitored during the year 1993-94 at College Farm, College of

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Agriculture, Junagadh. Twenty quadrates were fixed in each crop and larval population was recorded from 10 randomly selected plants at weekly interval from each quadrate. The observations were taken continuously till the harvesting of the crops. The data on population obtained were correlated with weather parameters viz., minimum and maximum temperature, rainfall, morning and evening vapour pressure and relative humidity by using correlation regression analysis to know the instantaneous effect of weather parameters on population fluctuation of *H. armigera*.

RESULTS AND DISCUSSION

The results on activity of *H. armigera* and role of physical factors of environment in fluctuation of the population was determined and data obtained are summarized in Table 1 and Fig. 1.

The data on larval population of this noctuid revealed that the pest was active from last week of July to the end of October in cotton crop. During this period, it showed violent fluctuations with 3 peaks of population. The pest incidence initiated in last week of July and increased from 5.0 to 8.0 larvae per 10 plants during first week of August. It has been surprisingly decreased during second and third week of August, but again increased and attained a peak (14.8 larvae per 10 plants) in first week of September. During September, the pest population showed fluctuating trend, however, the second peak of the population was observed in first week of October (17.00 larvae/10 plants). The highest population (24.3 larvae/10 plants) was recorded in third week of this month but thereafter it showed decreasing trend during next two weeks. Thus, three population peaks were observed in cotton crop during the season.

In pigeonpea crop, larval population of *H. armigera* observed from first week of

October to last week of November and fluctuated from 1.5 to 5.2 larvae per 10 plants (Fig. 1). The population gradually increased and the highest population (5.2 larvae/10 plants) was recorded during last week of October. It gradually declined in first week of November (3.1 larvae/10 plants) and thereafter remained almost static (1.5 to 1.7 larvae per 10 plants) upto the end of November. The lowest larval population (1.5 larval per 10 plants) was recorded during last week of this month and disappeared from the crop in the first week of December.

The data presented in Table 1 clearly indicate that the pest incidence in chickpea crop commenced during third week of November which gradually increased. Its highest intensity (6.3 larvae/10 plants) was recorded in third week of December and then gradually decreased. The lowest population (0.3 larvae/10 plants) was recorded in last week of February, when the crop was at maturity stage. Thus, the data clearly indicated that the pest was active from November to February in the crop.

Results on role of different physical factors of environment in causing the fluctuations of *Heliothis* population in chickpea, cotton and pigeonpea are given in Table 2.

The correlation study in cotton crop revealed that minimum temperature, rainfall, vapour pressure and relative humidity in the morning and evening were positively correlated with the population build up of this pest. Thus, it is clear that increase in minimum temperature, rainfall, vapour pressure and relative humidity in the morning and evening resulted in increase of population.

The correlation study in chickpea clearly showed that among the various physical factors of environment, minimum and maximum temperature as well as vapour

TABLE 1

Effect of weather parameters on the incidence of *H. armigera* on chickpea, pigeonpea and cotton during the year 1993-94.

Stan- dard week	Date of observation	Average larval population per 10 plants		Average temperature °C		Average relative humidity		Rainfall mm	Vapour pressure	
		Chickpea	Pigeonpea Cotton	Maximum	Minimum	Morning	Evening		Morning	Evening
31	03-08-93	—	—	5.0	29.3	25.1	87	58	0.0	23.3 16.4
32	09-08-93	—	—	8.0	31.8	25.3	88	65	1.4	23.2 21.8
33	16-08-93	—	—	4.7	33.4	21.2	87	56	0.5	22.4 21.3
34	24-08-93	—	—	4.5	32.5	24.7	87	58	1.8	22.8 19.6
35	30-08-93	—	—	32.5	33.8	24.2	83	53	0.0	21.9 20.1
36	06-09-93	—	—	14.8	33.2	24.0	86	54	1.3	22.3 19.9
37	13-09-93	—	—	12.5	34.1	23.8	84	48	0.0	21.5 18.8
38	20-09-93	—	—	15.0	34.5	23.4	85	50	21.9	20.7 19.6
39	27-09-93	—	—	12.0	32.2	23.1	94	76	41.1	22.7 24.1
40	04-10-93	—	3.3	17.0	35.2	23.5	87	49	0.0	21.8 20.3
41	11-10-93	—	3.5	14.5	37.8	24.0	70	39	1.7	19.4 17.3
42	18-10-93	—	4.0	24.3	32.5	23.5	94	68	59.7	22.8 22.9
43	25-10-93	—	4.6	10.5	32.9	21.8	92	61	96.4	21.8 20.8
44	01-11-93	—	5.2	5.5	33.5	17.4	86	42	0.0	16.4 16.0
45	08-11-93	—	3.1	0.0	33.5	15.2	74	31	0.0	13.7 11.8
46	15-11-93	—	1.6	—	33.0	21.8	75	51	3.0	17.4 17.7
47	22-11-93	1.6	1.7	—	33.7	15.6	77	27	0.0	14.0 10.6
48	29-11-93	1.7	1.5	—	33.9	10.0	70	19	0.0	8.3 7.6
49	06-12-93	2.1	—	—	33.2	13.2	73	29	0.0	11.5 10.8
50	13-12-93	2.5	—	—	32.9	12.1	74	27	0.0	9.9 10.0

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
51	20-12-93	6.3	—	—	31.8	9.7	78	21	0.0	8.4	7.7
52	27-12-93	6.3	—	—	29.7	8.5	73	42	0.0	7.6	12.5
01	03-01-94	5.9	—	—	31.7	9.9	77	34	0.0	7.9	11.9
02	10-01-94	4.4	—	—	30.1	12.7	85	37	0.5	10.7	11.2
03	17-01-94	2.9	—	—	27.5	8.8	77	37	0.0	7.5	10.2
04	24-01-94	2.1	—	—	33.3	14.6	79	36	0.0	12.0	20.7
05	31-01-94	2.4	—	—	30.7	10.5	63	29	0.0	7.9	9.2
06	07-02-94	1.5	—	—	31.4	14.6	75	33	0.0	11.1	10.8
07	14-02-94	2.0	—	—	31.6	13.5	78	44	0.0	12.2	15.3
08	21-02-94	1.8	—	—	31.0	11.5	74	58	0.0	9.6	18.6
09	28-02-94	0.3	—	—	35.9	16.5	69	27	0.0	11.8	11.7

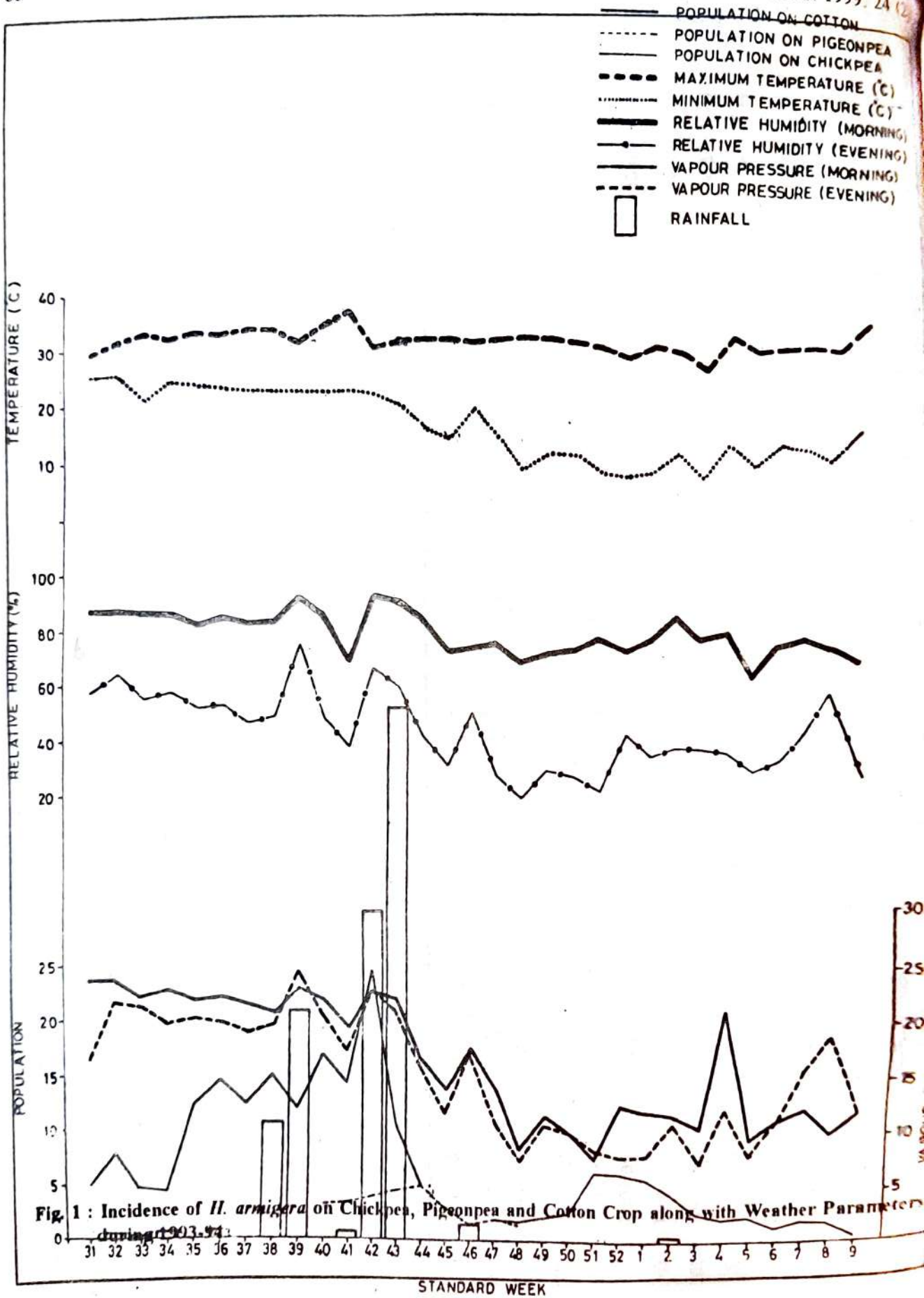


TABLE 2

Correlation of larval population of *H. armigera* in different crops with weather parameters (1993-94).

Crop	Weather parameters						
	Temperature(°C)		Rain-fall mm	Vapour pressure		Relative humidity	
	Maxi-mum	Mini-mum		Morn-ing	Even-ing	Morn-ing	Even-ing
Chickpea	-0.58*	-0.81*	-0.17	-0.71*	-0.55*	-0.11	-0.20
Pigeonpea	-0.03	-0.06	0.22	0.09	0.03	0.11	0.06
Cotton	-0.16	0.41*	0.53*	0.49*	0.51*	0.52*	0.68

* Significant at 5% level.

pressure in the morning and evening were negatively correlated with population build up of this pest indicating that fall in this factors caused rise in population, whereas other factors could not showed any market effect on the fluctuation of the pest population. However, none of the factors showed such effect in population build up of this pest in

pigeonpea. Balasubramanian *et al.* (1981) in Tamil Nadu and Bapodra (1988) in Gujarat also observed significant, negative correlation between the larval population and the manimum temperature on cotton and chickpea, respectively. Thus, the present findings are in conformity of the earlier reports.

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Evaluation of Some New Insecticides Against Major Paddy Pests

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ABSTRACT

Results of the field experiments carried-out during *kharif* 1993-94 to 1996-97 at Main Rice Research Station, Nawagam, Gujarat revealed that among the treatments evaluated least (2.72 to 3.73 hoppers/hill) number of white backed plant hopper *Sogatella furcifera* (Horv.) were observed in the treatment of buprofezin 25 WP (0.5 kg a.i./ha) followed by acephate 75 sp. (0.75 kg a.i./ha). Relatively low (3.91%) incidence of leaf folder, *Cnaphalocrocis medinalis* Guen, was found in the plot treated with monocrotophos 36 = WSC (0.75 kg a.i./ha), acephate 75 sp (4.38%) and trizophos 40 EC (5.03 %) as against 9.30% in untreated check. Minimum incidence (120.67 white earheads/plot of 27.6 m²) of stem borer *Scirpophaga incertulas* (Walker) was registered in trizophos 40 EC (0.50 kg a.i./ha) treatment. Highest (2625 kg/ha) grain yield was obtained from the plots treated with buprofezin followed by acephate (2618 kg/ha) carbofuran 3G (2572 kg/ha) and monocrotophos (2499 kg/ha). Highest Cost Benefit Ratio was found in acephate (1 : 7.73) followed by trizophos (1 : 4.99) and buprofezin (1 : 4.71).

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INTRODUCTION

Paddy, the important cereal crop of Gujarat is cultivated in about 6.5 to 7.5 lakh hectares of land occupying about 5% of the gross cropped area of the state. The crop is attacked by number of insect pests causing yield reduction to the extent of about 30 to 40%. With the introduction of high yielding and fertilizer responsive improved cultivars of paddy in the intensive multicropping system, the problem of insect pests is becoming alarming day by day. The loss caused by insect pests attacking paddy crop in Gujarat is estimated about Rs. 15.6 crores (Patel and Patel, 1983). Large number of new chemicals

are being evaluated against paddy pests elsewhere in the country. Information about their efficacy against paddy pests is completely lacking in this region. It was therefore felt necessary to evaluate some of the newer products alongwith presently recommended insecticides against major paddy pests in the state. With this in view, the present study was carried out during *kharif* seasons from 1993 to 1996. The results obtained are presented here under.

MATERIALS AND METHODS

Field experiments were conducted during 1993-94 to 1996-97 at the Main Rice Research Station, Gujarat Agricultural

University, Nawagam, Gujarat. During 1994-95 pest pressure was below desired level and hence the data were not considered. The experiment was laid-out in Randomized Block Design with 3 replications. Gross and net plot size was 6.9 x 4.0 m and 5.7 x 2.8 m., respectively. The seedlings of the susceptible paddy cultivar (GR-11) were transplanted with a spacing of 20 x 15 cm. There were seven treatments including check to avoid intermixing of treatments, about 20 to 30 cm thick mud boundaries were prepared all around the plots having the treatment of granular insecticides. Two recommended granular insecticides (carbofuran 3 G and phorate 10 g) and monocrotophos 36 WSC were kept as standard checks for comparison. The carbofuran and phorate were used 20.75 and 1.00 kg a.i./ha, respectively. The granules were mixed with little quantity of dry sand and broadcasted in respective plots having 3 to 4 cm. standing water. Three newer insecticides i.e. acephate 75 SP, buprofezin 25 WP and trizophos 40 EC @ 0.50 kg a.i./ha and monocrotophos 36 WSC at @ 0.75 kg a.i./ha, were tested as foliar sprays. Spray applications were made by using knapsack sprayer with hollow cone nozzle @ 500-600 litres spray fluid per hectare depending on crop growth stages. Drifting from one plot to other was avoided by using plastic sheet at the time of spraying.

The insecticide applications were made whenever the pest population crossed the threshold level (Anon. 1993). All the recommended agronomic practices were followed for raising the crop. Incidence of white backed plant hopper (WHPH), *Sogatella furcifera* (Horv.) was found during *kharif* 1993-94 and 1996-97. Similarly, leaf folder (LF), *Cnaphalocrocis medinalis* Guen. damage was noticed during 1995-96 and 1996-97, whereas the incidence of stem borer (SB), *Scirpophaga incertulas* (Walker) appeared very late (at heading stage) during *kharif*, 1995 season. The WHPH populations present on 10 randomly selected hills in a net plot area were

recorded at 3 and 7 days after treatment (DAT). Similarly, the LF incidence was assessed by counting total and LF damaged leaves on 10 hills from net plot. Incidence of SB was assessed by counting total number of white earheads per plot (27.6 sq.m.).

Grain and fodder yields were recorded separately from net plot area of each treatment. Economics of insecticide applications was computed on the basis of economic returns from grain and fodder yields and cost of insecticidal treatments. The Cost Benefit Ratios (CBR) thus calculated were used for judging the economics of treatments.

RESULTS AND DISCUSSION

All the six insecticides tested were found to be significantly superior to untreated control in reducing WHPH population. The number of hoppers per hill ranged from 3.72 to 5.33 in treated plots as against 41.39 in untreated plots at 3 DAT. The corresponding values on 7 DAT were 2.72 to 8.63 and 33.08 hoppers/hill, respectively (Table 1). Statistically, all the insecticidal treatments were on par in suppressing the hopper incidence. However, least number of hoppers were found in the plots sprayed with buprofezin followed by acephate. Our results confirm with the reports of Satapathy and Anjaneyulu (1989) who also reported the effectiveness of acephate in reducing tungro disease infection in rice crop transmitted by the hopper vector.

Leaf folder incidence recorded during 1995-96 season indicated non significant impact of the treatments, however the data of 1996-97 season revealed significant variation among different treatments. During second year of experimentation, monocrotophos exhibited significantly less (3.11%) incidence of the pest followed by acephate (3.42%) and trizophos (3.76%). Pooled results did not show statistical difference among the treatments.

Sr. No.	Treatments	Dose (kg- a.i./ha)	Av. No. of WBPB/Hill on different days							LFDL (%)			No. of WE/Plot	
			3 DAT			7 DAT				Pooled	1995-96	1996-97		Pooled
			1993-94	1996-97	Pooled	1993-94	1996-97	Pooled						
1.	Carbofuran 3 G	0.75	1.97	5.73	3.85	1.05	8.87	4.96	6.47	4.66	5.57	131.00		
2.	Phorate 10 G	1.00	2.48	7.40	4.94	1.78	15.47	8.63	5.32	6.89	6.11	138.33		
3.	Accephate 75 SP	0.50	2.02	5.67	3.84	1.03	4.73	2.88	5.25	3.42	4.33	155.67		
4.	Buprofezin 25 WP	0.50	2.53	4.93	3.73	1.07	4.37	2.72	5.41	5.37	5.93	169.00		
5.	Trizophos 40 EC	0.50	3.40	7.27	5.33	1.57	7.07	4.32	6.29	3.76	5.03	120.67		
6.	Monocrotophos													
	36 WSC	0.75	2.12	6.03	4.07	0.88	5.13	3.01	4.71	3.11	3.91	190.00		
7.	Control	—	45.05	37.73	41.39	22.32	43.83	33.08	6.86	11.75	9.30	191.67		
	S. Em. =	Treat.	0.35	0.80	2.12	0.40	0.82	3.38	0.48	0.61	1.32	10.50		
	Year		—	—	0.23	—	—	0.25	—	—	0.21	—		
	T x Y		—	—	0.62	—	—	0.65	—	—	0.55	—		
	C. D. at 5%	Treat.	1.08	2.46	7.35	1.22	2.54	11.69	NS	1.89	NS	32.36		
	Year		—	—	—	—	—	—	—	—	—	—		
	T x Y		—	—	1.80	—	—	1.89	—	—	1.60	—		
	C. D. (%)		7.13	12.92	11.11	16.22	11.18	13.17	14.31	19.13	16.81	11.61		

LF = Leaf folder WE = White earheads

TABLE 2

Effect of various insecticides on yield of paddy and its economics.

Sr. No.	Treatments	Mean yield (kg/ha)*		Gross income Rs/ha	Cost of treatment Rs/ha	Net gain Rs/ha	Net profit over control Rs/ha	CBR
		Grain	Fodder					
1.	Carbofuran 3 G @ 0.75 kg a.i./ha	2572	4567	17716	2228	15488	5794	1 : 2.60
2.	Phorate 10 G @ 1.0 kg a.i./ha	1782	4313	12849	845	12004	2310	1 : 2.73
3.	Acephate 75 Sp @ 0.5 kg a.i./ha	2618	4504	17960	947	17013	7319	1 : 7.73
4.	Buprofezin 25 WP @ 0.5 kg a.i./ha	2625	4407	17954	1447	16507	6813	1 : 4.71
5.	Trizophos 40 EC @ 0.5 kg a.i./ha	2405	4358	16609	1154	15455	5761	1 : 4.99
6.	Monocrotophos 36 WSC @ 0.75 kg a.i./ha	2499	4560	17274	1502	15772	6078	1 : 4.05
7.	Control	1316	3596	9694	—	9694	—	—
S. Em. ±								
C. D. at 5%		229.18	255.91					
C. V. %		706.21	NS					
		12.22	6.18					
Price								
Paddy grain		Rs. 120/20 kg	Market price					
Paddy straw		Rs. 10/20 kg	Carbofuran 3 G					
Labour Charge		Rs. 34/day	Phorate 10 G					
			Acephate 75 SP					
			Buprofezin 25 WP					
			Trizophos 40 EC					
			Monocrotophos 36 WSC					
			Rs. 52.80/ka.					
			Rs. 49.00/kg.					
			Rs. 750/kg.					
			Rs. 400/kg.					
			Rs. 500/lit.					
			Rs. 400/lit.					

*Pooled data of 3 seasons.

However, relatively low damage of the pest was registered in the plots treated with monocrotophos, acephate and trizophos. Effectiveness of acephate and trizophos @ 0.75 kg a.i./ha against *C. medinalis* has been reported by Rao *et al.* (1983) and Rao *et al.* (1984), respectively. According to Anon. (1995 and 1996), spray application of trizophos and acephate proved to be more effective in controlling leaf folder in paddy. As observed in the present study, Anon. (1981, 1982, 1983, 1984 and 1985) also concluded that trizophos (Hostathion) and monocrotophos were the most effective insecticides both for controlling insect pests of paddy and in increasing yields.

Stem borer incidence observed during 1995-96 season only, was minimum (120.67 WE/plot). In plots treated with trizophos (Table 1) and differed significantly from other foliar sprays. Low incidence of stem borer at heading stage in plots treated with trizophos @ 0.5 kg a.i./ha has been recorded by Anon. (1983, 1984 and 1985). According to Murugesan and Chelliah (1984) one application of trizophos @ 0.75 kg a.i./ha significantly reduced the incidence of *S.*

incertulas. Similarly, Heinrichs *et al.* (1986) also reported that trizophos as a foliar spray effectively controlled the stem borer. All these reports support the present findings.

The highest (2625 kg/ha) grain yield was obtained from the plots treated with buprofezin followed by acephate (2618 kg/ha), carbofuran (2572 kg/ha) and monocrotophos (2499 kg/ha) (Table 2). These treatments were significantly superior over the untreated control and phorate. Impact of insecticides on fodder yield was found to be significant in individual years, whereas the pooled data failed to show its significant effect. However, comparatively higher (4407 to 4567 kg/ha) fodder yield was harvested from the same treatments which produce significantly higher grain yield.

Highest (1 : 7.73) Cost Benefit Ratio (C.B.R.) was found in the case of acephate followed by trizophos (1 : 4.99) and buprofezin (1 : 4.71) (Table 2). In spite of high yields obtained in the case of carbofuran, it showed the lowest (1 : 2.60) CBR value due to its high cost. In contrast to this, low cost of application of acephate gave the highest C.B.R. value.

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Effect of Naphthalene Acetic Acid (NAA) and Different Mulches on Yield of Okra var. GOH-1

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ABSTRACT

A field experiment was conducted during summer season of 1995 and 1996 to examine the effect of naphthalene acetic acid (NAA) and different mulches on yield of okra var. GOH-1. The experiment was conducted on the farm of main Irrigation Research Station, Gujarat Agricultural University, Navsari. Fifteen treatment combinations comprising of NAA (25 and 50 mg/l) and mulches (black, green yellow plastic mulch and sugarcane straw mulch) alongwith their respective controls were tried. All twenty three pickings of green pods were possible in all the treatments. Among NAA, the NAA sprayed at 50 mg/l registered highest yield which was 19.61% higher than the control. Among mulches, black plastic mulch enhanced maximum green pod yield with 12.04% increase over the control. Interaction effect between NAA and mulch was significant and NAA 50 mg/l with black plastic mulch recorded highest green pod yield. The results were consistent during both the years. The net realization went up from Rs. 1.05 lacs/ha in the control to Rs. 4.57 lacs/ha with 50 mg/l NAA application registering cost benefit ratio of 1 : 12.81 and ICBR of 1 : 135.60 black plastic mulch treatment also registered net realization of Rs. 1.44 lacs/ha interaction effect between NAA and mulch was synergistic and registered highest net realization and higher additional yield as compared to NAA or mulch alone.

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INTRODUCTION

Research efforts are in progress in the country as well as in the world to improve the level of production to keep pace with the ever increasing demands. Growth regulators help in efficient utilization of metabolites and thereby improve the yielding potential. Naphthalene Acetic Acid (NAA) is one such growth promoter which is being used beneficially on large scale in a number of fruits, vegetables and flowering crops. Working with three different Okra varieties, Bhatt and Shah (1990) observed increase in yield and growth of the plant by NAA application.

Mulching is also known to influence crop growth and development. Mulching being a precious input especially during summer season, its judicious use alongwith NAA would certainly be of great help in better utilization and saving in available irrigation water resources. Since very little work has been done to examine the effect of mulching with growth regulators, the present study has been undertaken to examine the effect of NAA and or mulching on yield of Okra (*Abelmoschus esculentus* (L.) Moench) var. GOH-1.

MATERIALS AND METHODS

A field experiment was conducted during summer season (Feb. to May) of the year 1995 and 1996 at the Soil and Water Management, Main Irrigation Centre, Gujarat Agricultural University, Navsari. It was laid out in factorial randomized block design with three replications. The treatments consisted of combination of 3 levels of NAA (G_0 - 0, G_1 - 25 and G_2 - 50 mg/l) and 5 different mulchings (M_0 - no mulch, M_1 - sugarcane trash, M_2 - black, M_3 - green and M_4 - yellow plastic mulches). For the sowing, furrows were opened manually at a distance of 60 cm. Healthy seeds (@ 8 kg/ha) of okra, var. GOH-1 were sown at a depth of 2-3 cm in the soil at a distance of 30 cm within the row. The gross and net plot size was 3.00 m x 4.50 m and 1.80 x 3.30 m, respectively. The fertilizers were applied as per recommended dose of 150-50-50 kg N, P and K/ha, respectively. Irrigation were applied to each plot as per recommended IW/CPE ratio of 1.0 with water depth 60 mm as per daily pan evaporation. All the recommended agronomic practices were followed, including plant protection measures for raising the healthy crop.

The NAA was sprayed at two growth stages, i.e. 15 ml/plant just before flowering (25 days after sowing) and 20 ml/plant just before first picking of green pods (45 days after sowing). Mulching was done 25 days after sowing using 10 tonnes/ha sugarcane trash (M_1) and 50 M black (M_2), green (M_3) or yellow (M_4) colour plastics keeping okra plants open.

RESULTS AND DISCUSSION

Fresh Pod Yield

There were total of twenty-three pickings of fresh marketable pods. Total combined 23 pickings marketable yield as influenced by NAA and different mulching treatments are presented in Table 1.

Effect of NAA

There was considerable significant increase in fresh pod yield with both the NAA treatments over the control during both the years; NAA at 50 mg/l was better than 25 mg/l. In the year 1995, NAA at 50 mg/l registered 21.75 t/ha fresh pod yield as against 17.92 t/ha in control. The 17.60% higher yield over the control was recorded with this treatment. In the year 1996, this increase was 21.62%. NAA at 25 mg/l also recorded 10.96 and 13.12% increase in pod yield over the control during the year 1995 and 1996, respectively. The increase in pod yield over the control in pooled mean data was 13.65 and 24.33% with 25 mg/l and 50 mg/l NAA treatments, respectively.

Effect of Mulching

Different mulches significantly influenced fresh pod yield in both the years and also in pooled data. In the year 1995, black plastic mulch treatment recorded 24.10 t/ha pod yield which was 24.21% higher than the control. Similarly, in the year 1996, this treatment registered 27.66% more yield than the control. Overall, in pooled data 26.03% more fresh pod yield was obtained as compared to control. Only yellow plastic mulch treatment was found to be not effective in increasing yield.

The interaction effect between NAA x mulching treatments was significant with NAA 50 mg/l in combination with black plastic mulch recording highest fresh pod yield. This treatment registered 42.82%, 46.03% and 44.42% higher yield than the control in the year 1995, 1996 and in pooled data, respectively.

Our results with NAA are not without precedence. Singh and Upadhyay (1967) observed significant increase in yield of okra var. Pusa Sawani with NAA sprays. Reddy (1968) and Bhatt (1987) obtained similar results in different okra varieties with NAA

TABLE 1

Influence of foliar application of growth regulator (NAA) and different mulches on yield of fresh pods t/ha okra var. GOH-1.

Treatments	Yield of fresh pods (t/ha)		
	1995	1996	Pooled
G ₀ M ₀	15.47	13.85	14.66
G ₀ M ₁	18.70	16.84	17.77
G ₀ M ₂	20.62	19.70	20.16
G ₀ M ₃	17.83	16.02	16.93
G ₀ M ₄	16.98	15.12	16.05
G ₁ M ₀	17.57	15.62	16.59
G ₁ M ₁	20.44	19.93	20.18
G ₁ M ₂	24.63	23.69	24.16
G ₁ M ₃	20.02	17.97	18.99
G ₁ M ₄	17.98	16.66	17.32
G ₂ M ₀	21.76	20.48	21.12
G ₂ M ₁	20.93	20.69	20.77
G ₂ M ₂	27.06	25.67	26.37
G ₂ M ₃	20.35	19.58	19.94
G ₂ M ₄	18.71	17.68	18.20
Growth regulator			
G ₀	17.92	16.31	17.11
G ₁	20.13	18.77	19.45
G ₂	21.75	20.81	21.28
S.E.m. $\pm$	1.95	2.05	1.41
C. D. at 5%	5.67	5.95	4.02
Mulches			
M ₀	18.27	16.65	17.46
M ₁	20.02	19.13	19.58
M ₂	24.10	23.01	23.56
M ₃	19.38	17.86	18.62
M ₄	17.89	16.49	17.19
S.E.m. $\pm$	2.53	2.65	1.83
C. D. at 5%	7.32	7.69	5.19
Interaction			
S.E.m. $\pm$	4.38	4.59	3.17
C. D. at 5%	12.69	13.31	8.99
C. V. %	3.80	4.27	4.03

Economics of okra var. GOH-1 as affected by growth regulator (NAA) and different mulch treatment.

Sr. Treatment	Fresh pod yield (t/ha)	Incremental pod yield (t/ha)	Gross realization (lacs/ha)	Total cost of cultivation (Rs/ha)	Net realization (lacs/ha)	Incremental cost of treatments (Rs)	Value of additional yield (Rs)	Cost benefit ratio	ICBR
1. G ₀ M ₀	14.66	—	1.17	11915	1.05	60	—	1 : 8.84	—
2. G ₀ M ₁	17.77	3.11	1.42	12565	1.30	650	24840	1 : 10.32	1 : 38.21
3. G ₀ M ₂	20.16	5.50	1.61	17615	1.44	5700	43984	1 : 8.16	1 : 7.72
4. G ₀ M ₃	16.93	2.27	1.35	17615	1.18	5700	18136	1 : 6.69	1 : 3.18
5. G ₀ M ₄	16.05	1.39	1.28	17615	1.11	5700	11080	1 : 6.29	1 : 1.94
6. G ₁ M ₀	16.59	1.93	1.33	12076	1.29	221	15440	1 : 10.07	1 : 69.86
7. G ₁ M ₁	20.18	5.52	1.61	12726	1.49	871	44176	1 : 11.69	1 : 50.72
8. G ₁ M ₂	24.15	9.49	1.93	17776	1.75	5921	75936	1 : 9.87	1 : 12.82
9. G ₁ M ₃	18.99	4.33	1.52	17776	1.34	5921	34656	1 : 7.55	1 : 5.85
10. G ₁ M ₄	17.32	2.66	1.39	17776	1.21	5921	21272	1 : 6.80	1 : 3.59
11. G ₂ M ₀	21.12	6.56	1.69	12336	1.57	381	51664	1 : 12.70	1 : 134.60
12. G ₂ M ₁	20.77	6.11	1.66	12886	1.53	1681	48872	1 : 11.90	1 : 29.07
13. G ₂ M ₂	26.37	11.70	2.11	17936	1.93	6081	93624	1 : 10.76	1 : 15.40
14. G ₂ M ₃	19.94	5.28	1.60	17936	1.42	6081	42208	1 : 7.89	1 : 6.94
15. G ₂ M ₄	18.20	3.54	1.46	17936	1.28	6081	28280	1 : 7.12	1 : 4.65

* Average price of okra fresh pods/kg = Rs. 8.00.

application. These workers and Patel *et al.* (1997) reported that beneficial effect of NAA on yield in okra may be because of effective manipulation of yield attributing parameters by foliar application of NAA.

The appropriate relationship between source and their capacity leads to higher productivity of the crops. Application of growth regulators is known to increase the sink capacity. To meet the demand of sink capacity, the soil must not be deprived of water and nutrients. Mulching treatments are known to prevent evaporation and thereby maintain moisture level of soil for longer period. Moreover, mulching also reduced weed growth whereby decreased competition for nutrients. In light of this, the synergistic effect of NAA and mulching is obvious. The combination of NAA and mulching resulted in maximum yield increase by way of better utilization of source and effective manipulation of sink.

ECONOMICS

Effect of NAA : The net realization went up from Rs. 1.05 lacs/ha in the control (only water spray) to Rs. 1.21 lacs/ha with 25 mg/l NAA and Rs. 1.57 lacs/ha with 50 mg/l NAA sprays indicating an increase of 15.45 and 48.73 per cent in net realization, respectively. The cost benefit ratio was 1 : 10.07 with 25 mg/l and 1 : 12.81 with 50 mg/l NAA treatments as compared to 1 : 8.84 in the control. Similarly, gross ICBR was maximum (1 : 135.60) in 50 mg/l NAA treatment.

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Effect of Mulches : Mulching gave higher net return over no mulch treatment. The net realization recorded with black plastic mulch was the highest (Rs. 1.44 lacs/ha) followed by sugarcane trash mulch (Rs. 1.31 lacs/ha) as compared to Rs. 1.05 lacs/ha in the control (no mulch). As compared to black plastic mulch and sugarcane trash mulch, net realization with green and yellow plastic mulches were less. The cost benefit ratio was higher in sugarcane trash treatment (1 : 10.32) than the black plastic mulch treatment (1 : 8.16). Except sugarcane trash mulch, CBR was lower than the no mulch treatment.

Interaction Effect : Interaction of growth regulator (NAA) and mulches was very clear and the effect was synergistic. The NAA and mulch treatment combinations recorded higher net realization and higher additional yield as compared to NAA or mulching treatment alone, except in case of yellow plastic mulch treatment in combination with NAA (G_2M_3) where both net realization and additional yield were being less than either NAA or mulch treatments alone. Similarly, all the $G \times M$ combinations registered less CBR as compared to CBR recorded in G_2M_0 (NAA alone) treatment.

Economics consideration clearly suggested that the combination treatment of NAA (50 mg/l) with black plastic mulch recorded maximum realization.

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Pre-Harvest Forecast Models for Mango (Var. Kesar) Yield Using Weather Variables

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ABSTRACT

Data on mango (var. Kesar) tree yield along with age of the tree and weather variables such as minimum of minimum temperature during October, December, February and rainfall during whole year were collected from Regional Fruit Research Station and Observatory situated at the College Farm of Gujarat Agricultural University, Navsari for the past 13 years. Regression models for all possible subsets were fitted and Mallow's Cp criterion R^2 Adj R^2 & mean square error were utilised to select the best fit. Two models, one at flowering stage and the other at fruit setting stage were developed with $R^2 = 0.808$ and $R^2 = 0.928$ respectively. The last variable i.e. age of the tree helps to provide age-wise prediction of a tree which is necessary for a perennial tree crop.

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INTRODUCTION

In forecast modelling, the knowledge of yield contributing factors is essential. In India weather variables play an important role in deciding the yield of a crop. Regression type prediction models have been developed by many workers to predict the yield of a crop using weather variables. Gangopadhyaya and Sarkar (1964), Thompson (1969) and Brown and Venderlip (1969) while studying the effect of weather factors on yield of different crops, agreed that the weather data when included for specific growth periods are better than monthly data to explain variation in the crop yield. LeDuc *et al.* (1980) described climatic crop relationship yield model in an operational

system and recognised location-wise regression type yield prediction model. Huda *et al.* (1985) used step-wise regression technique and Mallow's Cp criterion to develop a model for predicting sorghum yield using environmental factors with 73% yield variation. But Hamaker and Oosterhaff in the book 'Fitting Equations to Data' written by Cuthbert Daniel and Fred S. Wood (1980) showed that the step-wise regression can lead to confusing results, when the independent variables are highly correlated. In the present paper, an attempt has been made to develop a regression type mango (var. Kesar) yield prediction model based on weather variables and age of the tree collected from past records of Regional Fruit Research Station and

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observatory situated at the college farm of Gujarat Agricultural University Campus Navsari by employing a most comprehensive approach of variable selection.

MATERIALS AND METHODS

Data for this study were taken from two sources. The yield of 10 mango (var. Kesar) trees of the same age, randomly selected with same set of trees over years and its age (calculated from the data of planting) for the past 13 years for the period from 1981 to 1993 were obtained from Regional Fruit Research Station situated at the college farm of Gujarat Agricultural University Campus, Navsari whereas, the weather data such as month-wise minimum of minimum temperature for October, December & February and the annual rainfall were obtained from the observatory situated at the college farm of Gujarat Agricultural University Campus, Navsari. The average yield based on 10 randomly selected trees is considered as dependent variable in the model. The data for the period 1981-1991 (11 years) were used to develop the model and the data for the period 1992 & 1993 were used to forecast/validate

the yield. The crucial stages identified were panicle initiation stage in the month of October, flowering stage in the month of December and fruit setting and development stage in the month of February. As low temperature enhances the flowering and fruit setting of mango, the minimum of the minimum temperature can be regarded as the instrumental variable in forecasting the yield. Thus variables included, were minimum of minimum temperature during the month of October, December & February, the annual rainfall and the age of the tree.

RESULTS AND DISCUSSION

Proposed Model-I

The all possible multiple regression analysis was carried out with above 5 variables and the 11 observations. The results obtained with $R^2 = 0.928$, Adjusted $R^2 = 0.86$, Cp = 6 and mean square error = 1379.64 and the significance of all variables except minimum of minimum temperature during fruit setting stage. However, the non-significant variables (X_3) was found to be very close to significant value.

$$Y = -1579.34 + 30.3^* X_1 + 35.9^* X_2 + 35.9 X_3 + 0.2^* X_4 + 16.9^* X_5$$

(6.45) (6.71) (12.46) (0.035) (2.95)

Where, Y = Yield (in kg.) of mango (var. Kesar) tree.

X_1 = Minimum of Minimum temperature ($^{\circ}\text{C}$) in the month of October.

X_2 = Minimum of minimum temperature ($^{\circ}\text{C}$) in the month of December.

X_3 = Minimum of minimum temperature ($^{\circ}\text{C}$) in the month of February.

X_4 = Annual rainfall (in mm)

X_5 = Age of the tree (in years)

Figures in the brackets denotes the standard error of the estimates.

Asterisk denotes the significance of regression coefficient at 5%.

Proposed Model-II

A subset above variables was obtained using Mallows's C_p criterion, R^2 adjusted R^2 and error mean square so as to get the forecast model for earlier prediction i.e., in the month of December. The C_p criterion is defined as $C_p = [RSS/s^2 - (N-2p)]$; where RSS stands for residual sum of squares for the best subset being tested; 'p' stands for the number of variables in the subset (including the intercept); s^2 stands for residual mean square based on regression using all independent variables and 'N' stands for the number of observations. Netter and

Wasserman (1974) described that the model which has the smallest C_p value, should be selected as best fit. Removing the main set from the set of all possible subset, we get the smallest value of $C_p = 12.32$ for the subset (X_1, X_2, X_4, X_5) as shown in the table 1 in bold printing. The subsets for the single variable were removed from the analysis as they appeared to be unwanted and the C_p values were also higher. Also the model has Maximum R^2 , Maximum Adjusted R^2 , minimum mean square error and minimum C_p value after removing the main set in Table 1. Thus the model given below was selected with $R^2 = 0.808$.

$$Y = -823.115 + 16.9^* X_1 + 24.8^* X_2 + 0.142^* X_3 + 15.03^* X_4$$

(6.68) (8.19) (0.0142) (4.28)

Where,

- Y = Yield (in kg.) of mango (var. Kesar) tree.
- X_1 = Minimum of minimum temperature ($^{\circ}\text{C}$) in the month of October.
- X_2 = Minimum of minimum temperature ($^{\circ}\text{C}$) in the month of December.
- X_3 = Annual rainfall (in mm).
- X_4 = Age of the tree (in years).

Figures in the brackets denotes the standard error of the estimates.

Asterisk denotes the significance of regression coefficient at 5%.

Neter and Wasserman (1974) showed that the model having little bias component tend to fall near the line $C_p = p$. This can be verified in our present study with the help of Table 1.

The model I was selected as it has $C_p = p$ for the complete set of subsets of variables selected. It has Maximum R^2 , Maximum Adjusted R^2 , Minimum root mean square error and Minimum C_p value and there is no other subset of this set, where $C_p = p$ can be attained. The model II is one of the subset with second Maximum R^2 & Adjusted R^2 and second Minimum root mean square

error & C_p value. Although for model II C_p 'is not equal' to p for the subset selected, it may be seen that C_p is more close to p as shown in the table 1 with bold printing. This explains that model II is the second-best-fit with the advantage of predicting mango (var. Kesar) yield, two months earlier than model I.

On the basis of proposed model I & II the yield was forecasted and compared with the actual average yield obtained during the year 1992 and 1993, the years which were not included in the model formulation, as shown in Table 2.

TABLE 1

Subset showing the values of R^2 , Adjusted R^2 , p , C_p , RMSE.

Serial No.	Subset Combination	R^2	Adjusted R^2	p	C_p	RMSE
1	1,2	0.132	0.085	3	55.32	10402.78
2	1,3	0.123	0.096	3	55.79	10514.10
3	1,4	0.282	0.103	3	44.94	8611.17
4	1,5	0.287	0.109	3	44.58	8550.75
5	2,3	0.128	-0.090	3	55.62	10453.47
6	2,4	0.308	0.140	3	43.11	8296.05
7	2,5	0.261	0.070	3	46.36	88574.00
8	3,4	0.250	0.060	3	47.14	8991.90
9	3,5	0.317	0.150	3	42.45	8182.70
10	4,5	0.419	0.270	3	35.36	6959.97
11	1,2,3	0.153	-0.210	4	55.86	11599.97
12	1,2,4	0.451	0.210	4	37.68	8017.19
13	1,2,5	0.445	0.210	4	35.59	7606.12
14	1,3,4	0.283	-0.020	4	46.85	9825.53
15	1,3,5	0.339	0.050	4	42.92	9050.41
16	1,4,5	0.516	0.310	4	30.62	6625.79
17	2,3,4	0.316	0.020	4	44.54	9370.44
18	2,3,5	0.371	0.100	4	40.69	8611.74
19	2,4,5	0.603	0.430	4	24.57	5433.65
20	3,4,5	0.460	0.230	4	34.51	7392.76
21	1, 2, 3, 4	0.453	0.080	5	37.04	8747.99
22	1, 2, 3, 5	0.451	0.080	5	37.28	8769.14
23	1, 2, 4, 5	0.808	0.680	5	12.32	3063.40
24	1, 3, 4, 5	0.571	0.280	5	32.56	7718.59
25	2, 3, 4, 5	0.611	0.350	5	26.07	6224.57
26	1, 2, 3, 4, 5	0.928	0.860	6	6.00	1379.64

TABLE 2

Comparision of forecasted model based on proposed model I & II with observed yield based on average of 10 randomly selected trees of same set.

		Year 1992	Year 1993
Observed yield (kg/tree)		162	143
Forecasted yield	Model I	158.8	128.8
	Model II	127.6	105.5
Difference for	Model I	3.15	14.14
	Model II	34.4	37.46
Per cent different from observed yield	Model I	1.9	9.8
	Model II	21.2	26.2

The per cent different of forecasted yield based on model I from observed average yield of mango per tree is 1.9% and 9.8% for the year 1992 and 1993 respectively, indicated the satisfactory fit of the data. Again per cent difference of forecasted yield based on model II for the year 1992 and 1993 were 21.2% and 26.2%, indicated more deviation in comparison to model I (Table 2). Since model II includes temperature parameter only up to the month of December, it was regarded as earlier forecast model in comparison to model I.

The conclusions emerging from the study are : (1) Out of the two models developed in this study the model I ($Y = -1579.34 + 30.3 X_1 + 35.9 X_2 + 35.9 X_3 + 0.2 X_4 + 16.9 X_5$) that requires minimum of minimum temperature in the month of October (X_1), December (X_2), & February (X_3), the annual rainfall (X_4) and the age of the tree

(X_5), is suitable for prediction at fruit setting stage and model II ($Y = -823.155 + 16.9 X_1 + 24.8 X_2 + 0.142 X_3 + 15.03 X_4$) that requires minimum of minimum temperature in the month of October (X_1), & December (X_2), the annual rainfall (X_3) and the age of the tree (X_4), is suitable for yield prediction flowering stage i.e., in the month of December. Thus an early forecast of yield by two month can be given using model II. (2) Since age of the tree is one of the significant variable in both the models, the age wise prediction will be more useful in planning the future needs in perennial plantation crops.

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Ergonomic Aspects of Tractor Operator Seat Design

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ABSTRACT

The design aspects of tractor-operator seat are described from an ergonomic viewpoint. The design parameters of the seat have been determined using anthropometric data of Indian users. The existing dimensions of the tractor seat widely varies which indicates the need of anthropometric dimensions. The tractor seat should be designed to accommodate the size and shape of at least 90% of tractor operator's population, based on anthropometric data.

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INTRODUCTION

In India a wide choice of competitive tractor models, in the range of 18 to 75 pto HP is now available to the farmers. But the design changes in these tractors are not adequate enough due to economic reasons. However, the existing Indian tractors have yet to fall in line with world trends regarding operator workplace - a fact which primarily arises from the use of relatively older models which are under manufacture (Anonymous, 1990). Most of the Indian tractors are manufactured to suit the anthropometric measurements applicable to the countries where the tractor is designed. Opposite to highly sophisticated designs in Europe, North America and Japan (in saturated market), the two biggest nations of the world, China and India, could become important with their tractor productions using 'medium technology'

and units of low power level achieving annual growth in domestic sales (Renius, 1994).

The ergonomic design of tractor operator seat and workplaces is an effective method for improving operator comfort (Lehmann, 1958 and Pheasant, 1986). The seat design characteristics comprise of static and dynamic characteristics. The static characteristic of the tractor seat refers to the relation of comfort to seat construction type, and its geometric parameters and the physiological features. Therefore, there is need to design the tractor seat considering anthropometric data of tractor operators in India.

THEORETICAL CONSIDERATIONS

There are three primary aspects of maintaining a seated posture. First, the orthopedic considerations, which relate to a

possible damage to the operators health caused by poor design. Second, muscular aspects and third, the behavioral and biomechanical aspects of the operator who may be viewed as a 'comfort seeker' or as a 'discomfort' (Oborne, 1982).

Orthopedic Aspect of Seating

The primarily support structure of the body in seated posture is the spine. It consists of 33 vertebrae joined together by multiple ligaments and intervertebral discs. The vertebrae are divided into four categories. These are the topmost seven cervical, then twelve thoracic and five lumbar vertebrae followed by five fused sacral and four fused coccygeal vertebrae. From the point of view of the seat design, the orientation of the lumbar and sacral vertebral are important, since it is these vertebrae and their respective discs and muscles which take most of the spinal load of a seated operator (Oborne, 1982).

Keegan and Radke's (1964) data suggested that sitting posture which produces the nearest approximation to the 'normal' lumbar shape is one in which the trunk-thigh angle about 115° and the lumbar position of the spine is supported. As the back moves from an upright to a hunched position the pelvis makes a corresponding backward rotation, because it is attached to the sacral area. Grandjean (1973, 1988) suggests, that seats should be designed so that in both the forward and backward sitting postures they provide support to the upper edge of the pelvis in an assist this trend to rotate. In order to accommodate tractor operators ranging from 5th to 95th percentile, it is easier to adjust seat than adjusting controls, however there must be few compromises between hand and foot controls. The height of the seat can not be changed greatly as for a small person, a higher seat would result in worsened foot pedal relationship. The horizontal adjustment of the seat is required to accommodate tractor operator between 5th

and 95th percentile stature. It is easy to provide horizontal adjustment in seat with little design efforts.

Muscular Aspects of Seating

The muscles and tendons keep vertebrae in position. Any alteration to a 'natural' spinal shape will produce corresponding stresses in muscle activity which can be demonstrated and measured. A study was carried out by Floyd and Ward (1969) in which they recorded the activity of four groups of muscles (in the neck, on the collarbone, on the back just below the shoulder blades, and in the lumbar region), when sitter adopted various positions. Their results concluded that 'sitting-up-straight' without any backrest produce a fair degree of activity in the lumbar-region-presumably because this posture attempts to straighten the lumbar curve. However the activity ceased as soon as a backrest was provided.

Biomechanical Aspect of Seating

Muscular fatigue and spinal deformation reduce comfort and increase the stress of the operator which in turn could reduce performance. Sitting behaviour, therefore, can be characterized by regular movements or fidgeting which help to relieve pressure maldistributions on parts of the spine. The hip portion of the body in sitting posture acts like an inverted pyramid. In physiological terms, compression fatigue is the reduction in blood circulation through the capillaries, which affects the local nerve endings and results in sensations of ache, numbness and pain.

On the one hand operator needs to vary his posture to relieve pressure maldistribution while on the other hand he needs to maintain and actively seeks stability. An efficient and comfortable tractor seat, therefore, needs to be able to accommodate these homeostatic requirements and allow the operator stability and flexibility.

TRACTOR SEAT DESIGN

It is generally recognized that to minimize discomfort, fatigue and the possibility of damage to the back whilst seated, the spinal column should maintain its normal curvature as found in the standing position (Keegan and Radke, 1964). The main body support is provided by the seat pan, taking between 65 and 75% of the body weight (Branton, 1969), which is transferred via the ischial tuberosities and to a lesser extent the surrounding tissues. The linear dimensions of tractor seat must fit those of the most likely user population. This by now is axiomatic. Therefore, seat characteristics such as seatpan length, width and tilt, backrest height, angle and slope need to be designed considering anthropometric data of most likely user population of tractor operators. A number of principles are followed for a seat design.

- (i) The type and dimensions of the seat are related to the reason for sitting.
- (ii) The dimensions of the seat should fit the appropriate anthropometric dimensions of the sitter.
- (iii) The seat should be designed to provide support and stability for the operator.
- (iv) The seat should be designed to allow the operator to vary his posture, but the fabric needs to resist slipping when there is fidgeting.
- (v) Backrests, particularly prominent in the lumbar region, will reduce the stress on this part of the spinal column.
- (vi) the seat pan needs sufficient padding and firmness to help to distribute the body weight pressures from the ischial tuberosities.

The dimensions of seat, location of controls and access/exit provisions are the parameters where anthropometric data can provide help in matching the workplace according to the user's capabilities. Anthropometric data like buttock-popliteal

length, popliteal height and hip breadth (sitting) are very useful for the seat design. Anthropometrically, seat height should be from 40.0 to 45.0 cms which is based on Indian population. The weight range of corresponding percentile is 45.0, 73.0 kg. Therefore, European data related to seat design and workplace may not be suitable for Indian operators.

Seat Height

The seat height is adjusted correctly when the thighs of the operator are horizontal, the lower legs are vertical and the feet are flat on the floor.

Seat height from foot rest level is based on typical link-joint biomechanical model (Oborne, 1982) and expressed as follows :

Front edge

$$H_p = \cos(\theta_k + \theta_{sp} - \pi/2) \quad \text{--- (1)}$$

Rear edge

$$H_p = \cos(\theta_k + \theta_{sp} - \pi/2) - L_p \cdot \sin(\theta_{sp}) \quad \text{--- (2)}$$

H_p = Popliteal height, cm

L_p = Buttock popliteal length, cm

θ_k = Knee angle for foot resting on foot rest, degree

θ_{sp} = Thigh angle with horizontal, degree

Seat Depth

In order to assure driver comfort and convenient posture change, the seat width should be wider than the buttock width. The limiting case should be the upper range of the operator.

Seat Depth

For tractor seat it is recommended that the seat depth accommodate even shorter people, since the only consequence of a taller member sitting in such a seat will be that his knee will protrude slightly at the front.

Seat depth < (Buttock-popliteal length of 5th percentile operator).

Seatpan Angle

In a tractor seat, operators requirements are to be positioned for easy access to his work in front of him.

Backrest Height and Width

In order that the sacrum and fleshy parts of the buttocks which protrude behind the operator can be accommodated, while at the same time allowing the lumbar region to fit firmly into the backrest. Osborne (1982) suggested that a space of at least 12.5 to 20 cm is required to accommodate the buttock.

A high back rest prevents mobility of the arms and shoulders in rear viewing and hydraulic control lever operation. Therefore a small backrest which supports the lumbar region only is suitable for a tractor seat. The proposed dimensions of the backrest relate quite simply, to distance from the upper lumbar region to the upper side of the buttock (height) and to the shoulder width (width).

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Backrest Angle

Like an angled seat pan, the angle of the backrest serves two purposes. First, it prevents the occupant from slipping forwards and second, it causes him to lean against the backrest with the lower (lumbar) part of his back supported. The backrest angle larger than 105° provided in a easy chair is not suitable for tractor seat as it creates inconvenience in rear viewing and in operating hydraulic control levers.

CONCLUSIONS

Sitting is often considered to a natural posture, relieving the operator of the need to maintain an upright position. A tractor seat which requires the operator to adopt certain postures can create at the least muscular fatigue due to the static loads placed on the spinal and other muscles. In most of the Indian tractors, manufacturers are using suspended seat now a days but it should be designed to accommodate the size and shape of at least 90% the tractor operator's population, based on anthropometric data.

Short Communications

Performance of Chickpea Varieties Under Different Dates of Sowing

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In the middle Gujarat Agroclimatic Zone AES-III, rice is the major rainy – season crop. Chickpea after rice is becoming popular as it is highly remunerative under rainfed lowland conditions requiring low inputs. Farmers start the sowing of chickpea after harvesting of rice from the end of October to early December. Normally a prolonged winter helps to farmers to get reasonably good yield. The data of sowing of new genotypes is one of the most important factor influencing yield and disease and insect pest incidence. Therefore an experiment was conducted with a view to determine the optimum time for sowing of chickpea varieties in the AES-III.

Field experiment was conducted during winter season 1994-95. The experimental site was sandy loam in texture and neutral in soil reaction. It was low in nitrogen and medium in phosphorus and potash. The treatments consisting of four dates of sowing (30th October, 15th & 30th November and 15th December) in main plots and three varieties (ICCC-4, Pusa-G-209 and Dahod yellow) as sub plots were arranged in split plot design

with four replications. A uniform dose of 20 kg/ha and 40 kg P_2O_5 /ha was applied at the time of sowing. The seed was sown in furrows, 30 cm apart using a seed rate of 60 kg/ha and thereafter plants were thinned to an intra row spacing of 10 cm. The crop was irrigated at branching (30 DAS) flowering (45 DAS) and pod filling (65 DAS) stages.

Seed yield was significantly influenced by dates of sowing (Table 1). The highest seed yield of 3588 kg/ha was obtained when the crop was sown on 15th November. The seed yield in 30th October and 15th November sowing did not differ significantly.

This might be due to favourable temperature effect prevailing at the time of flowering and pod filling stages in case of sowing carried out on 15th November, which ultimately was responsible for increased number of pods plant and test weight. Our results are in agreement with those reported by Arvadia and Patel (1988) and Balyan *et al.* (1989) who obtained reduced yield by 21 and 49 per cent when sowing was delayed or carried out after 15th November and stated that drought condition, high temperature as well as incidence of pod borer prevailed at the time of flowering and pod filling stages were responsible for low yield. The linear decrease in yield was also observed by Dahiya *et al.* (1988) and Paikaray and Misra (1992) in case of sowing performed between 30th October to 15th December. Among the varieties tested, Dehod yellow yielded the highest

TABLE I
Effect of sowing date and varieties on yield attributes and yield of chickpea.

Treatments	No. of branches/ plant	No. of developed pods/plants	No. of seeds/ pod	Plant height (cm)	Seed grain yield (kg/ha)	Fodder yield (kg/ha)	Plant stand	Test weight (g) (100 seeds)
Date of sowing								
D1—30th October	10.1	64.6	1.5	71.0	3356	2551	272.2	16.58
D2—15th November	10.4	68.5	1.5	65.7	3588	2400	270.8	15.29
D3—30th November	10.1	63.1	1.6	61.8	2828	2209	264.4	14.42
D4—15th December	10.7	60.9	1.5	61.7	1837	2199	267.2	14.50
S. Em.	0.2	2.1	0.03	2.8	120.3	72.3	2.43	0.17
C. D. at 5%	0.6	5.4	NS	7.2	385.5	231.2	NS	0.45
C.V. %	14.2	13.0	15.5	17.2	16.2	14.0	8.2	10.7
Varieties								
V1—ICCC-4	10.8	70.8	1.5	68.0	2676	2249	270.2	15.31
V2—Pusa G.209	10.0	62.1	1.6	64.1	2978	2245	269.9	14.34
V3—Dahod yellow	10.1	60.0	1.5	66.8	3072	2325	265.9	15.94
S. Em.	0.3	2.7	0.03	1.3	117.3	81.7	2.7	0.15
C. D. at 5%	0.7	6.5	0.08	3.2	283.4	NS	NS	0.36
C. V. %	8.0	11.1	8.5	14.6	15.0	10.7	3.14	3.94
Sig. Int.	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 2

Interaction effect of sowing dates varieties.

Varieties	Date of Sowing		V1 ICC-4	V2 Pusa-G-209	V3 Dahod yellow
D-1	30th	October	3246	3593	3231
D-2	15th	November	3170	3654	3940
D-3	30th	November	2626	2868	2989
D-4	15th	December	1660	1797	2129

S. Em. 236

C. D. at 5% NS

seed yield (3072 kg/ha) followed by Pusa G. 209 (2988 kg/ha), while ICC-4 gave the lowest seed yield (2676 kg/ha). However the interaction effect of dates of sowing and varieties was not significant, the higher yields were obtained when the sowing was performed between 30th October and 15th November than the sowing carried out after 15th November in case at all the varieties tested.

Thus, results of this experiment clearly indicated that to obtain higher seed yield of chickpea in the conditions prevailing in middle Gujarat Agroclimatic Zone-AES III the sowing of chickpea should be performed between 30th October and 15th November.

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Integrated Weed Management in Fenugreek (*Trigonella foenum-graecum* L.)

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In Fenugreek (*Trigonella foenum-graecum* L.) weed menace is one of the important factors responsible for decreased in yield (Mali and Suwalka, 1987). No systematic research work has so far been done to evaluate integrated weed management approach in fenugreek for the south Saurashtra region of Gujarat. Therefore, the present investigation was initiated to evolve a suitable cultural-cum-chemical approach to manage weeds in fenugreek.

The field experiment was conducted at the Instructional Farm, Gujarat Agricultural University, Junagadh during the winter (rabi) season of 1994-95. The soil of the experimental field was clayey in texture and slightly alkaline in reaction (pH 7.7) with normal E.C. (0.31 dS/m), low in available nitrogen (225 kg/ha), medium in available phosphorus (29 kg/ha) and high in available potassium (254 kg/ha). There were 12 treatments comprised of hand weeding and interculturing in combination of herbicides (Table 1) arranged in randomised block design

with 4 replications. Pre-planting incorporation (PPI) of herbicides was done one day before sowing, pre-emergence (Preem) application was done two days after sowing (DAS) and herbigation was done immediately after sowing through irrigation. The fenugreek variety IC-9955 fertilized with 30 kg N + 60 kg P_2O_5 /ha was sown on November 10, 1994, keeping 30 cm row spacing. The crop was thinned 15 DAS to maintain plant-to-plant distance of 10 cm.

The weed flora of the experimental site included monocots, viz., *Cynodon dactylon*, *Brachiaria* spp., *Echinochloa crusgalli* and *Dactyloctenium aegyptium*, sedge viz., *Cyperus rotundus* and dicots, viz., *Indigofera glandulosa*, *Digera arvensis*, *Acanthospermum hispidum*, *Portulaca oleracea*, *Phaseolus terrestris*, *Tridax procumbens*, *Chenopodium album*, *Amaranthus viridis*, *Leucas aspera*, *Launea nudicaulis*, *Celosia argentea*, *Euphorbia hirta* and *Asphodelus tenuifolius*. Maximum dry weight of weeds (62.0 q/ha) at harvest was recorded in weedy plot (T_1). Application of fluchloralin @ 0.90 kg/ha coupled with 1 hand weeding 30 DAS (T_2) was 98.87% efficient in reducing the dry weight of weeds, whereas application of pendimethalin @ 0.60 kg/ha + 1 hand weeding 30 DAS (T_3) and 2 hand weedings 20 and 40 DAS (T_4) were respectively 98.55 and 96.94% efficient in this regard. This might be due to effective control of weeds under herbicidal treatments and subsequent

TABLE 1

Dry weight of weeds, weed control efficiency, seed and straw yields and weed index as influenced by integrated weed management treatments.

Treatments	Rate (kg a.i./ha)	Time of application	Dry weight of weeds (q/ha)	Weed control efficiency (%)	Yield (q/ha)		Increase in seed yield over control
					Seed	Straw	
T1 Unweeded control	—	—	62.0	—	9.80	20.06	—
T2 2 hand weedings	—	20, 40 DAS	1.90	96.94	16.50	30.20	68.36
T3 1 hand weeding + 1 interculturing	—	20 DAS	3.90	93.71	13.40	27.00	36.73
T4 Fluchloralin	0.90	PPI	2.50	95.97	14.20	26.80	44.90
T5 Fluchloralin + 1 hand weeding	0.90	PPI + 30 DAS	0.70	98.87	16.15	26.78	64.79
T6 Fluchloralin	0.90	PE-HRG	7.00	88.71	12.20	24.40	24.49
T7 Pendimethalin	0.90	PE	3.00	95.16	13.80	26.25	40.82
T8 Pendimethalin + 1 hand weeding	0.60	PE + 30 DAS	0.90	98.55	15.95	27.10	62.96
T9 Pendimethalin	0.90	PE-HRG	8.20	86.77	11.70	24.18	19.39
T10 Oxyfluorfen	0.12	PE	2.70	95.48	12.90	24.70	31.63
T11 Oxyfluorfen + 1 hand weeding	0.06	PE + 30 DAS	2.40	96.29	14.15	25.10	44.38
T12 Oxyfluorfen	0.12	PE + HRG	9.50	84.67	11.30	22.93	15.31
C. D. (P = 0.05)			1.94	2.50	1.91	3.69	5.82

DAS = days after sowing, PPI = Pre-plant incorporation, PE-Pre emergence, HRG-Herbigation

removal of weeds by manual weeding. These treatments (T_2 , T_3 and T_4) proved superior to weedy control in respect of seed and straw yields with 68.36, 64.79 and 62.96%, respectively, higher seed yield over control. The lowest yields in unweeded control (T_1)

was due to severe crop-weed competition. These results are in confirmity with those reported by Mali and Suwalka (1987) in fenugreek, Patel and Mehta (1989) in cumin and Kothari *et al.* (1989) in coriander crop.

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Feasibility of Drip in Cotton Under Clayey Soil of Narmada Command

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Cotton is grown in 24 per cent of total cultivated area of region I of Narmada Command. Earlier study showed that the cotton responds to irrigation and economically higher yield was obtained with 5 irrigation of 80 mm depth after lessation of monsoon (Annual Report, 1993-94). With this view, an experiment was planned to work out economic feasibility of drip in cotton variety Hybrid 8.

An investigation was carried out during monsoon season (*kharif*) of 1992-93 to 1994-95 at Narmada Irrigation Research Project, Khandha, Gujarat to test the economic feasibility of drip irrigation method in cotton, variety Hybrid 8. The soil of experimental plot is typic chromusterts (order-vertisol and haldar series) having 0.033% total N, 18.7 kg/ha Olsen's P_2O_5 and 1219 kg/ha available K_2O . The treatments comprising four levels of irrigation viz., 0.3, 0.5, 0.7 and 0.9 fraction of pan evaporation through drip and surface method (flood) irrigation of 80 mm depth of water. The experiment was laid out in RBD with four replications.

Irrigation was applied at the interval of 20 to 25 days with 80 mm depth in surface method as per farmer's practice. In drip irrigation method, the irrigation was applied alternate day on the basis of Fraction of Pan evaporation (FPE). If Fraction of Pan evaporation is 1 mm then 0.3, 0.5, 0.7 and 0.9 fraction of pan evaporation (1.0 mm) were applied in respective treatments i.e. irrigation was applied @ 30 (0.3 FPE), 50 (0.5 FPE), 70 (0.7 FPE) and 90 (0.9 FPE) per cent of cumulative two days pan evaporation. Crop was fertilized with 240 kg N/ha in four splits. No phosphorus and potash were applied. Sowing was done in middle of June during 1992-93 and 1994-95 while in first week of August during 1993-94 using 4 kg/ha seed and keeping inter and intra row spacing of 120 cm and 45 cm respectively. The lateral pipelines were laid out in plot at 120 cm distance. The drippers were fitted on lateral line at the distance of 90 cm. The on line type of emitters were used with 4 liter per hour discharge of dripper.

Irrigation scheduled at different fractions of Pan evaporation (FPE) i.e. 0.3, 0.5, 0.7 and 0.9 gave significantly higher yield than surface irrigation of 80 mm depth (table 1). Amongst different fractions of pan evaporation 0.7 FPE gave significantly higher yield over 0.3 and 0.9 FPE but at par with 0.5 FPE. The higher yield obtained under 0.5 and 0.7 FPE might be due to better soil water regime. The results corroborated the statement of Goldberg *et al.* (1976).

TABLE 1

Effect of treatments on seed cotton yield, water saving, water use efficiency (WUE) and net realization.

Treatments	Seed cotton yield, kg/ha			Average	Percentage increase in yield over control	Total qty. of water used, mm	Water saving %	WUE kg/ha mm	Net realization Rs/ha
	1992-93	1993-94	1994-95						
Drip method of irrigation at									
0.3 FPE	3437	2518	2149	2701	14	155	67.8	17.4	82800
0.5 FPE	3621	2939	2426	2995	27	227	52.7	13.2	68770
0.7 FPE	3719	3192	2546	3152	33	299	37.7	10.5	56520
0.9 FPE	3541	2697	2338	2858	21	371	22.7	7.7	39520
Surface (flood) irrigation	2958	2131	2004	2364	—	480	—	4.9	33280
S. Em. =	125	154	120	75	—	—	—	—	—
C. D. 0.05	384	474	NS	215	—	—	—	—	—
C. V. %	7.2	11.4	10.5	9.5	—	—	—	—	—

The results further revealed that there was saving of water from 23 to 68 per cent under different fractions and highest was with the lowest fraction of 0.3 (Table 1). The water use efficiency (kg/ha-mm) was higher (i.e. 17.4) with 0.3 FPE and decreased with increase in the fraction of pan evaporation. This might be due to better utilization of irrigation water at lower fraction, whereas in higher fraction, the rate of water loss as evapotranspiration might be high and relative increase in yield was not proportional to the increase in water applied. These results are in close agreement with the findings of Malik *et al.* (1994) in pea and Patel *et al.* (1997) in castor crop.

The net realization was higher with drip method of irrigation applied at 0.3 fraction of

pan evaporation followed by 0.5 FPE.

The above study revealed that the irrigation scheduling under drip method of irrigation may be followed at 0.5 FPE to get about 27 per cent increase in cotton yield and cotton crop can be grown successfully with 30 cm of water through drip after cessation of monsoon on typic chromusterts (order-vertisol, series-Haldar). Under extreme constraints of irrigation water, the crop can be irrigated at 0.3 FPE through drip.

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Heterosis and Genetic Architecture for Oil Content in Indian Mustard*

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Adopting line x tester (11 x 6) mating design (Kempthorne, 1957) heterosis for oil content in Indian Mustard (*Brassica juncea* (L.) Czern & Coss) was conducted. The 66 F_1 s and 17 parents were grown in a R.B.D. with 3 replications at three locations in Gujarat (Sardar Krushinagar, Talod and Surat) and one location in Rajasthan (Udaipur) in *rabi* 1993-94. Each entry represented a single row of 3 m length. The inter and intra row spacing were 45 and 15 cm, respectively. The per cent oil content was estimated by using Nuclear Magnetic Resonance Technique (Tiwari *et al.*, 1974). Heterosis over better parent (Fonseca and Patterson, 1968) and over standard check (Varuna) was calculated.

Mean squares due to genotypes were significant at all the four locations as well as pooled over locations. Likewise, mean squares due to parents vs hybrids were significant at all the locations, indicating presence of heterosis for oil content in Indian mustard.

However, this trait was highly influenced by the environmental differences as evidenced by significant mean squares due to locations.

There was no appreciable increase in oil content due to hybridization (mean oil content of parents 34.68% and hybrids 35.66%). These results confirm the findings of Prasad and Singh (1985). The heterobeltiosis on pooled basis varied from -8.75 (RSK 28 x Kranti) to 10.61 per cent (RSK 77 x Vardan). The hybrid which followed positive heterobeltiosis on pooled basis were RSK 77 x Vardan and RSK 76 x Vardan (Table 1). Both the hybrids also showed significant heterobeltiosis at all the locations. It was noticed that the cross Lalpur 17 x RLC 1359 which had highest oil content, involved two parents having comparatively low oil content than the best parent (RSK 28). This might be due to the presence of different genes or gene complexes, separately in both the parents and when they were brought together they nicked well and gave higher oil content. This can also be due to the presence of nonallelic interactions. The standard heterosis on pooled basis ranged from -6.96 (RSK 76 x Varuna) to 7.93 per cent (Lalpur 17 x RLC 1359). Only two hybrids viz., Lalpur 17 x RLC 1359 and RSK 28 x RLC 1359 (Table 1) recorded significant positive and consistent performance at all the four locations, in both these hybrids RLC 1359 was a common male parent.

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TABLE 1

Estimate of heterosis crosses over better parent and standard check (Varuna), GCA and SCA effects on pooled basis for oil content of 31 selected crosses of Indian mustard.

Sr. No.	Cross		Mean oil content %	Heterosis % over		GCA effect of		SCA effects of crosses
				Better parent	Standard Check (Varuna)	Female Parent	Male Parent	
1.	RSK 16	% GM 1	36.40	2.03**	1.68**	0.18**	0.13**	0.43**
2.	RSK 16	% PM 67	35.40	4.04**	-1.12*	0.18**	-0.11**	-0.33**
3.	RSK 16	% Kranti	35.97	5.19**	0.47	0.18**	-0.83**	0.96**
4.	RSK 16	% Vardan	35.27	4.78**	-1.48**	0.18**	0.16**	-0.74**
5.	RSK 28	% PM 67	37.05	-4.45**	3.49**	0.92**	-0.11**	0.59**
6.	RSK 28	% RLC 1359	37.98	-2.04**	6.9**	0.92**	0.73**	0.68**
7.	RSK28	% Vardan	37.53	-3.20**	4.83**	0.92**	0.16**	0.80**
8.	RSK 69	% GM1	37.30	1.57**	4.19**	0.44**	0.13**	1.08**
9.	RSK 69	% PM 67	36.95	0.57	3.21**	0.44**	-0.11**	0.96**
10.	RSK 69	% Vardan	37.45	1.93**	4.61**	0.44**	0.16**	1.19**
11.	RSK 76	% GM 1	36.68	2.83**	2.46**	-0.28**	0.13**	1.18**
12.	RSK 76	% Kranti	36.25	6.02**	1.26*	-0.28**	-0.83**	1.71**
13.	RSK 76	% Vardan	36.47	10.53**	1.87**	-0.28**	0.16**	0.73**
14.	RSK 77	% PM 67	35.58	4.58**	-0.61	-0.32**	-0.11**	0.36**
15.	RSK 77	% Kranti	35.32	3.29**	-1.34*	-0.32**	-0.83**	0.82**
16.	RSK 77	% Vardan	35.54	10.61**	-0.73	-0.32**	0.16**	0.05
17.	RSK 78	% GM1	36.36	1.92**	1.56**	0.20**	0.13**	0.38**
18.	RSK 78	% PM 67	35.67	3.56**	-0.36	0.20**	-0.11**	-0.08
19.	RSK 78	% RLC 1359	36.79	-2.62**	2.77**	0.20**	0.73**	0.20*
20.	RSK 78	% Vardan	36.59	6.24**	2.21**	0.20**	0.16**	0.57**
21.	Lalpur 17	% GM1	36.68	2.83**	2.46**	0.58**	0.13**	0.32**
22.	Lalpur 17	% Varuna	38.22	6.75**	6.76**	0.58**	-0.08*	2.05**
23.	Lalpur 17	% RLC 1359	38.64	2.27**	7.93**	0.58**	0.73**	1.67**
24.	RJ 9	% Varuna	36.92	3.24**	3.13**	-0.13*	-0.08*	1.48**
25.	CSR 164	% PM 67	35.61	2.35**	-0.5	-0.35**	-0.11**	0.41**
26.	CSR 164	% Kranti	35.33	1.56**	-1.31*	-0.35**	-0.83**	0.86**
27.	BID 902	% PM 67	36.33	6.76**	1.48**	-0.39**	-0.11**	1.17**
28.	BID 902	% Vardan	35.73	5.13**	-0.20	-0.39**	0.16**	0.30**
29.	RH 7513	% PM 67	35.06	3.01**	-2.07**	-0.85**	-0.11**	0.36**
30.	RH 7513	% RLC 1359	36.66	-2.98**	2.40**	-0.85**	0.73**	1.12**
31.	RH 7513	% Vardan	34.83	7.12**	-2.71**	-0.85**	0.16**	-0.14
S.E.				0.19	0.19	0.05	0.03	0.10
Crosses significant			54	48				
Positive significant			25	19				
Negative significant			29	29				
Range (Min.)			-8.75	-6.96				
(Max.)			10.61	7.93				

* and **, Significant at $P = 0.05$ and $P = 0.01$ levels, respectively.

The results of pooled analysis of variance for combining ability revealed that variation due to locations was highly significant. The mean squares due to males were significant. The interaction mean squares due to line x location, line x tester x location were significant. This trend indicated that the estimates of GCA and SCA variances were influenced by the environment. The variance components due to males (σ^2_m) were higher than that of female (σ^2_f), which indicated greater contribution of males for oil content. The ratio $\sigma^2_{gca}/\sigma^2_{sca}$ being less than unity, suggested greater role of non-additive genetic system in the inheritance of oil content. These results are in accordance with the findings of Hari Singh and Yashpal (1991) and Prakash Kumar *et al.*, (1994).

Male parent RLC 1359 exhibited significant and positive GCA effect at all the

four locations as well as over the locations and was a good general combiner for this quality character of economic importance. Five parental lines viz., RSK 28, Lalpur 17, RSK 69, RSK 78 and RSK16, expressed positive significant GCA effects for this trait in pooled analysis (Table 1). Therefore, it would be worthwhile to use these parental lines in exploitation of hybrid vigour.

The best crosses at all locations as well as across locations were RSK 77 x Vardan and RSK 76 x Vardan over better parents over the better parents and Lalpur 17 x RLC 1359 and RSK 28 x RLC 1359 over the standard check 'Varuna' RLC 1359 was the best general combiner and proposed for exploitation in breeding researches of Indian Mustard.

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G x E Interaction for Grain Yield and its Components in Durum Wheat (*Triticum durum* Desf.)

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The potential of newly developed genotypes and stability of their performance can be judged by multi environment testing. A precise knowledge of genotype x environment interaction is very important to evaluate the stability of grain yield and its components. The present study is an attempt to identify stable genotypes for grain yield and its components in durum wheat under different sowing times in specific climatic condition.

The 48 genotypes of durum wheat, consisting of 43 advanced generation lines and 5 cultivated check varieties were grown in a randomized block design with three replications at Wheat Research Station, Junagadh during *rabi* 1995-96. The environments were created by sowing the crop on three different dates, i.e. early sowing (29th Oct., '95) as Environment-1 (E_1), timely sowing (15th Nov., '95) as environment-2 (E_2)

and late sowing (2nd Dec., '95) as environment-3 (E_3). The data were analysed for stability parameters according to Eberhart and Russell (1996) for days to flowering, tillers per plant, grains per spike and grain yield per plant (g).

The mean, regression co-efficient ($\bar{b}_i$) and deviation from regression ($\bar{S}^2_{di}$) are presented in table 1. High heterogeneity between the slopes of linear regression was observed making it difficult to decide the criteria for selection. A genotype having high mean, unit regression and least deviation from regression is considered to be superior. The different genotypes used in this study, however, did not exhibit uniform stability and responsiveness patterns for all the characters. The stability and responsiveness appeared to be specific for specific characters within a single genotype.

It was also observed that generally, the genotypes with relatively high yield exhibited low stability, indicating that mean performance and stability are two different components genetically controlled in different manner. The genotypes JDB 95-11 and MACS 1967 had high mean performance for grains per spike and grain yield per plant, respectively.

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TABLE 1
Stability parameters for grain yield and its components in 48 genotypes of durum wheat.

Genotypes	Days to flowering			Tillers per plant			Grains per spike			Grain yield per plant		
	$\bar{X}$	bi	$\bar{S}^2 di$	$\bar{X}$	bi	$\bar{S}^2 di$	$\bar{X}$	bi	$\bar{S}^2 di$	$\bar{X}$	bi	$\bar{S}^2 di$
JDB 95-1	58.58	0.49	9.62**	5.00	0.68**	-0.52	44.16	-1.15**	-4.40	7.67	0.25**	-1.04
JDB 95-2	64.89	2.73**	-0.77	5.06	1.35**	-0.52	49.97	3.09	19.29*	9.78	1.49**	-1.14
JDB 95-3	57.67	-1.08**	0.14	4.38	-0.23**	-0.47	42.58	0.37	0.01	7.11	0.27**	-0.80
JDB 95-4	58.00	-0.41	1.52	4.64	0.63**	-0.53	43.73	-1.22**	-4.98	6.12	0.17**	-1.09
JDB 95-5	62.00	1.53	0.22	6.07	1.08	1.02	43.58	-0.44**	-3.76	8.14	1.09	1.26
JDB 95-6	58.22	1.70	-0.56	5.96	1.06	-0.29	45.82	0.98	-2.96	6.43	1.22	-0.72
JDB 95-7	63.33	1.83	0.72	4.69	1.49**	-0.48	40.82	2.67	9.77	7.11	1.45**	-1.14
JDB 95-8	58.11	-0.50**	-0.19	4.53	0.28**	-0.46	46.23	0.76	-4.31	6.69	0.20	-0.95
JDB 95-9	65.56	2.10	-0.01	7.22	0.90	4.76**	39.31	1.47	6.23	9.33	0.20	13.36**
JDB 95-10	59.67	0.11**	-0.74	5.91	2.47**	-0.24	43.01	2.41	-4.06	9.15	1.84**	-0.89
JDB 95-11	59.56	1.64	-0.52	4.37	1.12**	-0.03	54.24	2.09**	-4.84	7.83	1.26**	-1.17
JDB 95-12	59.11	-0.73	3.27*	6.84	-0.16*	4.04**	41.16	-0.37*	-4.36	7.21	0.57**	-1.03
JDB 95-13	64.44	1.16**	-0.93	6.69	0.43	2.40*	43.84	-0.20**	-4.74	8.69	0.92	6.31*
JDB 95-14	58.22	0.09*	-0.44	6.86	0.71	-0.43	39.32	1.03	-5.11	8.44	0.90*	-1.15
JDB 95-15	61.33	1.37	0.27	6.27	1.23	0.39	44.51	-0.34*	-3.42	8.81	1.14	1.04
JDB 95-16	59.33	1.60**	-0.92	5.22	0.15	-0.54	47.40	0.45	-3.50	8.84	0.49	2.44
JDB 95-17	60.67	0.75	4.45*	5.73	0.05**	-0.47	48.16	-0.55**	-5.02	8.90	0.06**	-1.12
JDB 95-18	55.56	-1.23	7.54	4.93	0.46**	-0.29	37.73	2.46	33.07**	7.82	0.13	0.52
JDB 95-19	57.33	-1.09**	0.11	5.06	1.01	-0.19	46.14	-0.13**	-3.86	8.92	1.14	-0.93
JDB 95-20	59.44	1.17	3.48*	5.71	1.76	-0.53	39.13	-0.56**	-5.11	7.95	1.30	-0.81
JDB 95-21	61.33	-0.34	0.76	4.44	1.12	1.96*	42.93	2.69	25.40*	8.42	1.21	-0.91
JDB 95-22	59.78	1.51	-0.29	4.49	0.19	-0.52	41.13	1.71	-3.87	7.52	0.28	7.28**
JDB 95-23	60.78	-0.32	1.54	4.11	-0.01**	-0.27	49.13	1.88	0.91	6.96	0.48**	-1.12
JDB 95-24	58.22	0.78	0.63	5.58	0.11*	-0.49	47.29	0.28	0.05	9.03	0.72	-0.98

Table 1 (Contd.)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
JDB 95-25	61.22	2.16	2.20	6.78	1.70**	-0.04	45.07	1.91	1.25	8.71	1.19**	-1.16
JDB 95-26	65.44	3.80**	-0.80	6.82	2.39**	-0.04	46.07	2.80	8.20	10.29	2.91**	-0.99
JDB 95-27	62.56	0.84	1.68	5.31	-0.19	0.32	39.46	1.52	-4.08	7.37	0.34	2.45
JDB 95-28	61.33	-0.23*	-0.18	5.13	1.83**	-0.48	47.42	2.46	6.30	7.35	1.03	-1.07
JDB 95-29	63.56	2.24	-0.07	6.67	2.46**	-0.09	40.58	0.38	-4.26	8.51	0.77	0.12
JDB 95-30	59.67	1.66	0.39	5.76	0.57	-0.40	46.20	-1.11	17.74*	8.67	0.26	2.43
JDB 95-31	64.56	2.61**	-0.92	7.27	2.24**	-0.19	41.33	0.80	-0.72	9.79	0.66	-0.09
JDB 95-32	58.22	-0.65**	0.01	5.73	1.31	0.76	50.27	2.34**	-0.92	9.22	1.56**	-1.11
JDB 95-33	56.33	-1.78**	-0.71	5.21	0.98	-0.25	43.36	-1.49**	-2.84	9.25	1.71	-0.26
JDB 95-34	56.67	1.43*	-0.85	4.51	1.72**	-0.41	50.58	1.36**	-5.10	7.69	0.95	-1.08
JDB 95-35	60.56	0.78	-0.28	4.93	0.38**	-0.51	43.11	2.05*	-4.02	7.03	0.56**	-1.10
JDB 95-36	57.22	-0.37*	0.12	4.32	0.56	0.09	42.12	3.01	3.43	6.92	0.25	0.97
JDB 95-37	60.22	-0.13	3.99*	6.39	0.35	1.45	43.36	0.08	8.43	8.45	0.86	-0.93
JDB 95-38	62.00	2.52**	-0.38	5.24	0.81	-0.25	43.66	1.13	14.24	8.85	0.38	1.36
JDB 95-39	60.22	0.44**	-0.93	5.58	2.13**	-0.41	38.49	2.38	-1.13	8.64	1.94**	-1.16
JDB 95-40	57.44	0.70**	-0.85	5.07	0.14**	-0.52	50.62	1.73	-0.65	8.38	0.85	1.45
JDB 95-41	61.67	1.38	0.80	4.98	1.15	-0.37	48.11	1.63	-3.58	9.13	1.49**	-0.99
JDB 95-42	63.22	1.47**	-0.86	4.73	0.85	-0.27	46.96	2.59	-0.53	8.56	0.86	-0.88
JDB 95-43	58.22	-0.03	4.48*	5.0	1.26*	-0.52	47.67	1.18	-2.68	8.97	1.83*	-0.29
Raj 1555	62.33	0.69	1.35	5.80	0.87	-0.47	51.26	0.44	-1.69	9.09	0.72	-0.61
HI 8381	75.00	5.37**	2.62	5.67	1.36	1.16	48.84	-0.44	16.15*	8.48	1.66	6.55*
HD 4530	60.78	-1.84**	1.08	6.63	1.29**	-0.54	41.34	0.40	-3.25	6.89	0.95	-0.48
PBw 34	79.11	8.60**	-0.51	6.12	1.58	3.31**	50.92	0.17	57.71**	9.97	2.69	15.70**
MACS 1967	63.11	2.25*	0.06	6.02	2.41**	0.21	43.44	2.54	1.48	12.21	2.82	7.02**
Mean	61.10			5.56			44.83			8.34		
S. Em. ±	0.96			0.74			2.26			1.73		
C. D.	2.66			2.05			6.26			4.79		

Optimum Temperature for Germination Test of Isabgol (*Plantago ovata* Forsk)

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Isabgol is an irrigated *rabi* crop grown in Mehsana and Banaskantha districts of Gujarat State in an area of about 36,000 ha (Anon., 1995-96). It is an important commercial crop, which earns sizeable foreign exchange. It is grown in the month of November and harvested in the month of March. In case of seed production programmes it is necessary to test its

germination in the month of April-May so as to finish the formalities of certification. It being cold loving crop desired germination is difficult to attain even at 25 x C in the germination chamber. Therefore, present experiment was planned to find out optimum temperature for germination test.

Seeds were supplied by the Gujarat State Seed Corporation, Gandhinagar for germination test. Seeds were kept in a freezer (5 q 1 x C), seed germinator at 15 and 25 x C and at an ambient temperature in the laboratory (30 q 2 x C). Observations on germination count, root and shoot length and fresh wt. of 10 days oil seedlings were recorded. The data are presented in Table 1.

TABLE 1

Germination of Isabgol seeds and root and shoot length of seedlings as Influenced by temperature.

Temperature (°C)	Germination (%)	Length (cm)		Fresh wt. of seedling (mg)
		Root	Shoot	
5 q1	91.3	0.98	1.60	7.4
15	91.8	1.23	1.90	8.0
25	59.5	1.15	1.80	7.8
30 q ²	11.3	0.90	1.78	7.8
S. Em.	1.8	0.07	0.06	1.9
C. D. 0.05	5.7	0.23	0.17	NS
C. V. %	5.8	14.0	6.3	4.9

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The data on germination indicate that the higher (91.8%) germination chamber, which being at par with the seeds kept in a freezer (91.3%) and differed significantly from the rest. The least (11.3%) germination was noted when seeds were kept at an ambient temperature in a laboratory. The root and shoot length and fresh wt. of seedlings were

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also the highest at 15 x C. Therefore, it *is* suggested that the germination test of isabgol should be carried out at 15 x C in a germination chamber or in a lower shelf of a freezer having 5-6 x C temperature and even sowing should be carried out when minimum temperature is below 15 x C so as to get desired plant stand.

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Director of Agriculture, Gujarat State.

***Apanteles Taprobanae* Cam.-A
New Endoparasite of Castor Hairy
Caterpillar, *Euproctis lunata* Walker**

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Castor is reported to be infested by
umber of foliage pests. Among them, castor
airy caterpillar is also considered one of the
ajor leaf feeders of castor. It is sporadic in
ature (Kushwaha and Bhardwaj, 1967,
andey, 1967). The caterpillars feed
egoriously for some time by scratching the
af surface. Under severe infestation, it also
eds on capsules. Yield of the crop is
astically reduced by severe attack of this
st.

With a view to assess the extent of
mage due to *E. lunata* W., large number of

the castor germplasms supplied by Directorate
of Oilseeds Research, Hyderabad were grown
at Castor Research Project, G.A.U., S. K.
Nagar during 1994-95. During the screening of
the germplasm it was found that majority of
the *Euproctis* larvae were highly parasitised
(90%) by braconid parasite which was later on
identified as *Apanteles taprobanae* Cam.
Pandey (1967) recorded 15-20 per cent
parasitism due to *Apanteles colomani* V. at
Udaipur. While Lateef and Reddy (1984)
recorded 9.2% parasitism due to *A. inclusus*
at ICRISAT. The literature revealed that no
such parasite have been recorded from
Gujarat. Thus it is first record of *Apanteles*
taprobanae Cam. in Gujarat State.

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Biology and Natural Enemies of *Plutella xylostella* (L.) on its New Host Food Plant

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The diamondback moth, *Plutella xylostella* (Yponomeutidae : Lepidoptera) is a well known pest of brassica, cruciferous, solanaceous and liliaceous crops. It was observed damaging a cruciferous medicinal plant, the cress, *Lepidium sativum* L. grown at the University Campus, Junagadh during winter of 1997-98. This pest has been reported earlier on wild crucifer, *Lepidium virginicum* in Japan (Begum *et al.* 1996) and the watercress, *Nasturtium officinale* R. Br. in Cuba (Pla, 1985). A close perusal of the published literatures have shown that the present medicinal plant was recorded for the first time as a food plant of this pest in Saurashtra region of Gujarat. Therefore, studies on its biology and natural bioagents were carried out.

The larval population of the pest was observed 8 to 10 larvae plant during January, 1998. The larvae infested severally the leaves,

flowers and tender seeds. The seed damage recorded was 25.4 per cent. The larvae and pupae were collected from the field and reared in laboratory to study its biology and natural enemies. The egg period lasted for 2-3 days. The larva completed its development in 9 to 10 days and then pupated in the dense silken cocoon on the plants. The pre-pupal and pupal periods lasted for 1 and 6 to 7 days, respectively. The adult moths survived for 4 to 5 days. The sex ratio was 1.6 females : 1.0 male in the field collected sample.

Two braconids, *Cotesia* (*Apanteles* *plutellae* Kurdji and *Cotesia* sp. were found parasitizing the larvae of the pest. They were solitary endoparasitoids causing 20 per cent parasitism during February 1998. The cocoon and adult stages of *C. plutellae* lasted for 4 to 6 and 3 to 4 days, respectively. An eulophid, *Tetrastichus sokolowskii* (Kurdjumov) was also found parasitizing 24 per cent of the pupae. It was gregarious parasitoid, yielding 20 to 22 adults from a parasitized host pupae. Female parasitoid was bigger than the male parasitoid. Females outnumbered the males (16 females : 8 males). The adult parasitoids survived for 4 to 5 days. The record of these bioagents was also reported on this pest infesting the cabbage in Middle Gujarat at Anand (Yadav *et al.* 1975 and 1979).

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Biochemical Basis of Field Resistance for Shoot and Fruit Borer in Brinjal

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The shoot and fruit borer (*Leucinodes bonalis* Guen.) is the most serious pest of brinjal (*Solanum melongena* L.) in India. As much as 70 per cent of the fruits have been reported to be damaged by larvae of this insect (Krishnaiah *et al.*, 1976). With the continuous use of insecticides for its control, it is feared that this insect may become resistant towards insecticides. Further more, the present control measurement are not fully effective and are also costly and hazardous. Hence, resistant varieties against this pest are urgently needed. Resistance may be due to either physical, biochemical or both combined factors. Therefore, in the present study efforts were made to determine the biochemical basis of resistance in brinjal against shoot and fruit borer.

An experiment comprised of 41 diverse genotypes was conducted at Vegetable Research Station, Gujarat Agricultural University, Anand during 1995-96 using randomised block design with 4 replications. There was natural insect and disease infestation in the field as no spraying was

made to control it. Standard procedures were followed to determine the biochemical constituents.

Character association and direct as well as indirect effects of these traits on shoot and fruit borer infestation were studied. This will provide precise information for the selection of important biochemical traits which may contribute more towards resistance to shoot and fruit borer. The data presented in Table 1 indicated that genotypic correlation of shoot and fruit borer infestation with total phenols, polyphenoloxidase activity and glycoalkaloid content were negative and significant. However, this trait had positive and significant genotypic association with total soluble sugars, anthocyanin content and reducing sugars. The results are in agreement with the findings of Singh *et al.* (1982) and Bajaj *et al.* (1989).

The estimates of direct and indirect effects of biochemical traits on shoot and fruit borer infestation revealed that the total soluble sugars, reducing sugars and anthocyanin content had high positive and direct effect except anthocyanin content which have high indirect effect via total soluble sugars. This type of trend was also observed in reducing sugars which resulted into positive significant association of these traits with shoot and fruit borer infestation. On the other hand, total phenols, polyphenoloxidase activity and

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TABLE 1

Path coefficient analysis sharing direct (underlined) and indirect effects of seven biochemical traits on shoot and fruit borer infestation in brinjal.

Characters	Dry matter (%)	Total phenols (mg/100 wt.)	Total soluble (mg/100 mg dry wt.)	Reducing sugars (mg/100 mg dry wt.)	Anthocyanin content (mg/100 g)	Polyphen-oloxidase activity (μ O.D./min.)	Glycoalkloid content (O.D.)	Genotypic correlation with shoot and fruit borer infestation
Dry matter	-0.0723	0.0829	-0.1450	-0.0525	-0.0011	-0.0041	-0.0199	-0.2102
Total phenols	0.0142	-0.4217	0.2093	0.1038	-0.0022	-0.0005	-0.0269	-0.4239**
Total soluble sugars	0.0144	-0.1209	0.7298	00.976	0.0077	-0.0214	0.0277	0.7348**
Reducing sugars	0.0216	-0.2492	0.4056	0.1757	-0.0024	-0.0116	-0.0195	0.3202*
Anthocyanin content	0.0042	0.0495	0.2977	-0.0226	0.0188	-0.0315	0.0265	0.3426*
Polyphenoloxidase activity	-0.0026	-0.0018	0.1362	0.0177	0.0052	-0.2442	0.084	-0.3483*
Glycoalkloid content	-0.0101	-0.0799	-0.1427	0.0241	-0.0035	0.0068	-0.1418	-0.3472*

*, ** significant at 5% and 1% levels of significance, respectively.

glycoalkloid content had a high negative direct effect on shoot and fruit borer infestation.

It is suggested that the genotypes having high phenols, glycoalkloid and polyphenoloxidase activity and lower in total

soluble sugar, reducing sugars and anthocyanin content could be utilized in the breeding programme for the development of shoot and fruit borer pest resistance varieties in brinjal crop.

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Evaluation of Some Newer Insecticidal Formulations and Botanicals Against Whitegrub Beetles

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Whitegrubs are the polyphagous larvae of scarabaeid beetles. The beetles emerge from soil after onset of monsoon, congregate on host trees at night and feed and mate there. Heavy incidence results in complete defoliation of preferred host trees like ber retarding growth and vigour ultimately reducing the fruit yield. *Holotrichia consanguinea* Blanchard is the most important species damaging *Zizyphus* foliage in North Gujarat. Several insecticides have been tested against whitegrub beetle in other part of country (e.g. Brar and Sandhu, 1980; Shah and Garg, 1987 and Mishra and Singh, 1991). However, in recent years new formulations viz., quinalphos 20 Af (Ekalux 20 AF) and carbosulfan 25 EC (Marshal 25 EC) have been introduced. Therefore these new formulations were evaluated alongwith some conventional insecticides and botanical products against whitegrub beetle in ber orchard during 1998 at Arid Fruit Research Station, GAU, Sardar Krushinagar.

Total 30 ber trees of gola variety were randomly selected. One tree was assigned for each treatment and replicated thrice. Insecticidal spray fluid was sprayed on ber trees during evening hours one day after first satisfactory monsoon rain. Total number of whitegrub beetles present on each tree was counted and recorded between 9.00 and 11.00 p.m. on the same day of spraying and subsequently on second and third day during same period. The number of beetles died and fallen under each tree was counted in the next morning till three days between 5.00 and 6.00 A.M. From these data per cent beetles mortality was computed.

Perusal of results revealed significantly higher beetle mortality in all the treatments barring azadirachtin 0.05 per cent and tobacco snuf decoction (13.33 g/l) than control. The new formulation of quinalphos i.e. Ekalux 20 AF 0.05 per cent registered the highest beetle mortality (82.78%) followed by carbaryl 0.2 per cent (73.73%) and carbosulfan 0.05 per cent (58.42%) when observed 12 hours after treatment. The remaining conventional and synthetic pyrethroid compounds were less effective against whitegrub beetles.

The trend of effectiveness of insecticides changed drastically 36 and 60 hours after spraying. Carbaryl 0.2 per cent proved as the most effective insecticide causing the highest beetle mortality (63.04%). The remaining insecticides lost their toxicity

TABLE 1

Efficacy of different insecticides against whitegrub beetles damaging ber leaves.

Sr. No.	Treatments	Concen- tration	Dose (ml of g/lit.)	Beetle mortality (%) hours after spray			Mean Mortality
				12 hrs.	36 hrs	60 hrs.	
1.	Monocrotophos 36 SL	0.04	1.0	49.23 (44.56)*	36.68 (37.28)	29.95 (33.18)	38.62
2.	Fenvalerate 20 EC	0.01	0.5	39.33 (38.84)	18.35 (25.37)	8.37 (16.82)	22.02
3.	Quinalphos 20 AF	0.05	2.5	82.78 (65.49)	40.47 (39.51)	29.88 (33.14)	51.04
4.	Chlorpyrifos 20 EC	0.05	2.5	28.03 (31.97)	12.86 (21.02)	5.18 (13.16)	15.36
5.	Deltamethrin 2.8 EC	0.015	0.5	42.55 (40.72)	18.71 (25.63)	10.84 (19.23)	24.03
6.	Carbosulfan 25 EC	0.05	2.5	58.42 (49.85)	38.58 (38.40)	29.44 (32.86)	42.15
7.	Azadirachtin 0.3% EC	0.50	5.0	00.49 (4.05)	00.49 (4.05)	00.49 (4.05)	00.49
8.	Carbaryl 50 WP	0.20	4.0	73.73 (59.17)	63.04 (52.56)	39.31 (38.83)	58.69
9.	Tobacco snuf decoction	—	13.33	00.49 (4.05)	00.49 (4.05)	00.49 (4.05)	00.49
10.	Control (Untreated)	—	—	00.49 (4.05)	00.49 (4.05)	00.49 (4.05)	00.49
	S. Em. ±	:		1.63	1.47	1.19	
	C. D. at 5%	:		4.85	4.37	3.55	
	C. V. %	:		8.25	10.12	10.37	

* Figures in parenthesis are arcsin $\sqrt{\text{per cent} + 0.5}$ values.

quickly in just 36 hours after spraying. The beetle mortality decreased further and as such carbaryl recorded the highest efficacy (39.31%) 60 hours after spraying. The mean of three observations revealed the highest beetle mortality by carbaryl 0.2 per cent (58.69%) followed by quinalphos 20 AF 0.05 (51.04%) carbosulfan 0.05 (42.15%) and monocrotophos 0.04 per cent (38.62%).

Thus, from the overall results it can be inferred that carbaryl was the most effective insecticide followed by the new formulation i.e.

quinalphos 20 AF against whitegrub beetles when sprayed on ber trees. Earlier to this, Brar and Sandhu (1980) and Shah and Garg (1987) also reported carbaryl and quinalphos as the most effective insecticides against whitegrub beetles.

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Abstracts of Ph.D. Thesis

Development and Performance Evaluation of Continuous Khoa Making Machine

Submitted to Gujarat Agricultural University

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A continuous khoa making machine working on the principle of scraped surface heat exchanger (SSHE) was developed for the manufacture of khoa. The machine consists of three SSHE, Teflon coated spring loaded scraper assemblies, drive for scraper assemblies and milk supply arrangement. The performance of the khoa making machine was evaluated under different operating conditions. The present work covers evaluation of heat transfer behaviour, determination of heat transfer co-efficients, energy analysis, development of co-relationship between heat transfer and various operating parameters like scraper speed, steam pressure, milk flow rate etc. The product prepared under different operating conditions was also evaluated for its sensory chemical and rheological

attributes. The output of the machine was 11.1 kg khoa/h with 13.73% TS milk which increased to 25.1 kg/h and 38.2 kg/h when vacuum concentrated milk of 23.77% TS and 35.08% TS were used for khoa making respectively.

A mathematical model to establish functional relationship among different operating parameters, linear regression equation between TS and U-values steam side film co-efficients using Nusselt theory were obtained for the khoa making process. The model based on dimensional analysis has indicated linear co-relation between operating factor and heat transfer factor. The specific steam consumption (Kg steam/kg water of evaporation) of the khoa making machine ranged from 1.446 to 1.618 and heat utilization was 81.60%. The convection and radiation losses were also determined.

The quality of khoa prepared in the machine was acceptable and suitable for the manufacture of different khoa based sweets. The shelf life of khoa was 3 days at room temperature (28-32°C) and 20-22 days at refrigerated temperature (8-9°C). The acidity, FFA and peroxide value of control and experimental khoa did not give significant variation during storage of khoa at room temperature and under refrigerated conditions. The cost of khoa worked out was Rs. 57.19 per kg which consists of 88.19% milk cost and 11.81% manufacturing cost.

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Influence of Intercropping on Population Build Up of Insect Pests of Groundnut and their Natural Enemies

Submitted to Gujarat Agricultural University

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Investigation was carried out on the influence of intercropping on population build up of insect pests of groundnut and their natural enemies in popular varieties and crop loss estimation during kharif-1995 and summer-1996 at Gujarat Agricultural University, Junagadh.

Result revealed that when groundnut was intercropped with maize, reduced the incidence of jassid (*Empoasca kerri* Pruthi), thrips (*Caliothrips indicus* Bagnall, *Frankliniella schultzei* Trybom, *Scirtothrips dorsalis* Hood) and leafminer (*Aproaerema modicella* Deventer) whereas, other intercrops viz., pigeonpea, greengram and castor provided better conducive conditions which increased the jassids and thrips population. The intercropping of groundnut with pigeonpea, greengram and soybean also enhanced the leafminer infestation.

The influence of intercropping on natural enemy complex indicated that the population of coccinellids was higher on groundnut with maize, greengram and soybean intercrops. The predatory mite (*Balaustium* sp.) was recorded as a predator of jassids and thrips on groundnut for the first time in Gujarat. Population build up of *Chrysopa* spp. was observed as higher with maize and soybean intercrops.

The maximum pod equivalent yield (1336.37 kg/ha) and higher gross economic return (Rs. 3474.56 kg/ha) were obtained with groundnut + pigeonpea combination.

Population dynamics of key pests indicated that the activity of jassid and thrips was higher in the month of

September and March during kharif and summer, respectively. Partial regression analysis indicated that increase in one km/hr of wind speed resulted in decrease of 0.964 jassid per plant during kharif-1995. In summer, increase in 1°C of minimum temperature resulted in increase in jassid population by 0.759 per plant and an increase of one per cent relative humidity decreased 0.281 jassid per plant.

In case of thrips, the regression studies indicated that an increase at 1°C of maximum temperature resulted in decrease of thrips population by 0.981 per plant during kharif 1996. An increase in 1°C of minimum temperature resulted in increase of 0.569 thrips per plant in summer, whereas increase in one per cent relative humidity decreased 0.150 thrips per plant.

Regression analysis of population of leaf miner indicated that leafminer increased by 2.876 larvae per plant with an increase of 1°C minimum temperature during kharif-1996. But increase in one per cent relative humidity reduced 0.524 larva per plant. In summer, an increase in one per cent relative humidity also resulted in decrease by leafminer by 0.141 larva per plant.

The avoidable losses in groundnut pods were estimated to the tune of 39.31 and 41.79 per cent during kharif and summer season, respectively. High incidence of insect pests also caused 43.54 and 41.10 per cent losses in fodder yield during kharif and summer season, respectively.

Fifteen popular groundnut varieties grown for the study on incidence of key pests, indicated that GG-3 spanish bunch variety carried significantly lower population of jassid and thrips, whereas, variety GG-13 harboured lesser number of leafminer larvae. The varieties viz., Somnath and Kadir-3 carried higher numbers of jassid and thrips.

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**Biology Population Dynamics,
Varietal Screening and Management
of Groundnut Bruchid,
Caryedon serratus (Olivier)**

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Investigation on biology, population dynamics, varietal screening and management of groundnut bruchid, *Caryedon serratus* (Olivier) were carried out under laboratory conditions at the College of Agriculture, Junagadh during 1994 to 1996.

During field survey, *Parkinsonia aguanata* L. has been recorded as a new host of *C. serratus* for the first time under Junagadh conditions. The infestation was in the range of 1.0 to 3.0 per cent on forest trees under field conditions.

The groundnut bruchid multiplied by 76 folds as compared to initial infestation during 180 days of storage period. The infestation resulted into 96.26 per cent kernel damage, 95.41 per cent germination loss, 67.26 per cent weight loss and 1.23 per cent oil loss. On the other hand, the protein content and free fatty acids groundnut kernels was increased due to bruchid infestation.

The female laid eggs singly on groundnut kernels. The incubation, larval and pupal period ranged from 5.0 to 9.0 (Av. 6.37), 24.0 to 37.0 (Av. 30.57) and 12.0 to 22.0 (Av. 18.03) days, respectively, at an average temperature of $29.22 \pm 3.50^{\circ}\text{C}$ and 61.62 ± 9.87 per cent relative humidity.

The duration of adult stage of male and female varied from 10.00 to 23.00 (Av. 18.40 ± 4.03) and 17.00 to 33.00 (Av. 25.80 ± 4.57) days, respectively.

Pre-oviposition, oviposition and post oviposition period varied from 1 to 3 (Av. 1.70 ± 0.67) 8 to 17

(Av. 14.10 ± 2.73) and 3 to 14 (Av. 9.20 ± 3.22) days, respectively. The average egg laying capacity of the female bruchid range between 47 to 76 (Av. 63.70 ± 9.79) eggs female under laboratory conditions. The sex ratio was of 1.0 : 1.5 : male : female, when reared in groundnut cultivar GG 2.

Population dynamics of groundnut bruchid revealed that the infestation started during 4th week of June and reaching a peak level during second week of October. Correlation studies showed positive influence of temperature on population build up of groundnut bruchid.

Among different groundnut cultivars, GG-13 and GG-11 proved to be the resistant against *C. serratus*, whereas, GG-2 was found to be susceptible. *Arachis hypogae* linn. was proved to be the most preferred host among different hosts of *C. serratus* for oviposition.

Among the different receptacles tested, metal bin and plastic container proved to be the best for safer storage of groundnut kernels against the infestation of *C. serratus*, whereas out of different inert materials tested, clay @ 20 g/kg and neem seed kernel powder (NSKP) at 5.0 per cent (W/W) were proved better to protect the groundnut kernels upto 60 days against *C. serratus*.

Among different vegetable oils tested only neem oil @ 1 ml/kg gave better protection up to 120 days without causing any loss in germination.

None of the inert or tested plant materials, hampered the germination of groundnut kernels even at the highest dose.

Out of the different insecticides tested, decamethrin and cypermethrin @ 1.0 mg a.i./kg gave the highest relative protection to groundnut kernels upto three months against *C. serratus* without hampering the germination.

Effective control of *C. serratus* was achieved with methyl bromide fumigation @ 3 ml/quintal and aluminium phosphide fumigation @ 3 tablets/ton for 2 days (72 hr) exposure. Both the fumigates did not impair the vitality of groundnut kernels.

(Received on 21st Dec., 1998)

**A Study on Techno-Economic
Consequences in Adoption of Drip
Irrigation System by Mango Orchard
Growers of Junagadh District in
Gujarat State**

Submitted to Gujarat Agricultural University

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The study was undertaken during 1997 with 3 dependent variables (innovation-decision process, techno-economic consequences and extent of economic gain) and 26 independent variables. The major findings were : (1) Majorities (56.57 per cent) of the respondents had medium level of innovation-decision in relation to drip irrigation system. As regards the stages of innovation-decision process followed by the respondents, majorities of them (82.29 per cent) were having awareness-knowledge about drip irrigation system and were found to have reached the persuasion (89.14 per cent), confirmation (88.57 per cent), decision (53.71 per cent) and implementation (51.43 per cent) stages of innovation-decision process. (2) Majorities (73.14 per cent) of the respondents were found to have medium level of techno-economic consequences as a result of drip irrigation system. The adoption of drip irrigation system had resulted in many changes not only in the farming aspect alone, but also in the socio-economic aspects. The system had contributed for a significant increase in area under fruit crops. Cropping intensity and cropping pattern had been changed in the farmer's fields with the inclusion of several fruit and commercial crops. Farm machinery/farm implements had also been increased and many farmers

had diverted their cropped area to orchards. (3) Majority (71.43 per cent) of the respondents had accrued medium level of overall economic gain of drip irrigation system. Majority of the respondents had benefited by saving of water, weed control expenses and labour for irrigation and inter-culture operations. A little more than one-fourth of the respondents availed the benefit in respect of fertilizer economy. In addition to this, the respondents got the benefits of better yields, better fruit size, early maturity of fruits and higher market price of the produce under drip irrigation system. (4) A total of nine independent variables namely farm power, material possession, area under drip irrigation, area under mango orchard, irrigation potentiality, cropping intensity, annual income, attitude towards drip irrigation system and utilization of information sources together affected the change in techno-economic consequences to the extent of 73.39 per cent. (5) The most important economic constraints faced by the mango orchard growers in adoption of drip irrigation system were : high cost of spare parts, heavy initial expenses for installation of drip irrigation system and lack capital for covering entire area under drip irrigation system. Major technological constraints faced were : frequent clogging of drippers and microtubes, requires time to time attention for minor repairs, damage caused to the system by rodents and jackals and lack of technical know-how. Important administrative constraints being faced were : inadequacy and uncertainty in power supply, lack of after sale services from the company dealers, non-availability of spareparts at proper time with reasonable rates and lack of proper training. (6) Major suggestions offered by mango orchard growers to overcome the constraints were : provisions be made to purchase drip sets directly from open market, training be imparted alongwith drip irrigation sets for betterment of knowledge and skills, atleast five years guarantee be provided by company agents and drip sets be supervised by company agents, regularly. In addition to this, the respondents also felt that the propaganda about drip irrigation system be made through shibirs and film shows and multi-purpose sub-mains should be designed so as to use in different crops.

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