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Integrated Weed Management in Pigeonpea (*Cajanus cajan* L. Millsp.)

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ABSTRACT

A field experiment 'Effect of integrated weed management in pigeonpea (*Cajanus cajan*)' was conducted at Junagadh on medium black soil during *kharif* 1992-93, 1993-94 and 1996-97 with 12 weed management treatments. Weedfree (3 hand weeding and interculturing) treatment recorded the lowest weed density, their dry weight and the highest weed control efficiency (100%), seed yield (1646 kg ha^{-1}) and net economic return (Rs. 17192 ha^{-1}). However, integration of either pendimethalin or fluchloralin @ 0.900 kg ha^{-1} as pre-emergence with one hand weeding and interculturing at 40-45 days after sowing proved next best for efficient weed management in pigeonpea.

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INTRODUCTION

Pigeonpea (*Cajanus cajan* L. Millsp.) is the important kharif pulse crop of India and Gujarat. Recently its cultivation popularized due to higher remunerative price and usage. The crop suffers from severe weed infestation during early establishment stage due to slow crop growth coupled with wider spacing. The yield losses due to weeds ranged from 32 to 65 per cent in the crop (Vaishya and Khan, 1989). The present investigation was conducted to find out efficient and cost effective weed management method for pigeonpea under South Saurashtra conditions.

MATERIALS AND METHODS

A field experiment 'Effect of integrated weed management in pigeonpea (*Cajanus cajan*)' was carried out at Weed Control Research Scheme, Department of Agronomy, Gujarat Agricultural University,

Junagadh during rainy (*kharif*) season of 1992-93, 1993-94 and 1996-97. The soil of the field was medium black and calcareous in nature with pH 8.2, Electrical Conductivity 1.1 dSm^{-1} , low available nitrogen (216.4 kg ha^{-1}), medium phosphorus ($34.4 \text{ kg P ha}^{-1}$) and high potash ($481.6 \text{ kg K ha}^{-1}$). There were nine herbicidal treatments comprising pre-emergence applications of pendimethalin, fluchloralin and butachlor at lower and higher rates and inclusion of one HW & IC at 40-45 DAS with lower rate, HW & IC at 30 & 60 DAS, weedfree and control makes total twelve treatments (Table-1). The treatments were designed into randomized blocks with four replications. All the standard and recommended practices were followed to grow the crop. The data on seed yield and dry weight of weed were observed at harvest and subjected to statistical analysis and then interpreted with the help of Duncan's New Multiple Range Test.

RESULTS AND DISCUSSION

Weed Flora

The experimental plots were mainly infested with *Echinochloa crusgalli* Beauv., *Indigofera glandulosa*, *Digera arvensis* and *Cyperus rotundus* through out the crop season. *Commelina nudiflora*, *Leucas aspera*, *Phyllanthus niruri* and *Physilis minima* in kharif. *Eluopus villosus*, *Celsia coromandelian*, *Alysicarpus rugosus* and *Euphorbia sp.* in semi rabi season.

Weed density

The mean data of three year (Table 1) showed that hundred per cent reduction in weed density was observed in weedfree treatment as compared to control plot which

recorded the highest weed density (185.03 weeds/m²) while pre-emergence application of either pendimethalin, fluchloralin or butachlor reduced weed density ranging from 51 to 72% over control at 30 DAS. At 60 DAS, either cultural operation alone or its inclusion with herbicides proved effective to reduced weed density as compared to sole herebicide. There was fluctuation in weed density recorded at harvest which might be due to varying life period of weed-species and emergence of rabi weed during later stage. Similar effect of herbicides like pendimethalin, oxadiazon, butachlor and trifluralin on weed density has been reported in pigeonpea (Reddy *et al.*, 1990; Tripathi and Vivek, 1995).

TABLE 1
Effect of integrated weed management on weed density, their dry weight and weed control efficiency.

Treatment	Rate (kg/ha)	Weed density (No/m ²)*			Dry weed weight (kg/ha)				Weed Control efficiency (%)*
		30 DAS	60 DAS	Harvest	1992-93	1993-94	1996-97	Pooled	
A : Pendimethalin. Pre	0.900	51.86	38.81	35.79	3345 bc	1188 f	4268 c	2934 b	40.7
B : Pendimethalin. Pre	1.200	56.00	41.92	41.56	3241 bc	1624 ef	3660 f	2808 b	43.2
C : Pendimethalin. Pre+ 1 HW & IC at 40-45 DAS	0.900	51.56	38.81	49.33	1543 de	162 g	810 i	838 c	83.1
D : Fluchloralin. Pre	0.900	89.92	60.30	65.78	3106 c	2738 d	3458 g	3114 b	37.0
E : Fluchloralin. Pre	1.350	61.03	44.30	45.33	3279 bc	1949 e	4123 d	3117 b	37.0
F : Fluchloralin. Pre + 1 HW & IC at 40-45 DAS	0.900	75.70	36.44	55.11	1640 d	200 g	941 h	927 c	81.3
G : Butachlor. Pre	1.000	76.89	42.97	37.33	3491 b	4136 c	4529 b	4052 ab	18.1
H : Butachlor. Pre	1.500	70.08	40.75	39.11	3310 bc	3638 c	3877 e	3609 ab	27.0
I : Butachlor. Pre + 1 HW & IC at 40-45 DAS	1.000	63.86	30.97	36.00	1516 de	231 g	723 i	824 c	83.3
J : 2 HW & 2 IC at 30 & 60 DAS	—	167.41	25.19	40.23	1331 e	112 g	116 j	520 c	89.5
K : Weed free	—	0	0	0	f	0 g	0 k	0 c	100.0
L : Control	—	185.03	113.64	92.68	4128 a	5806 g	4905 a	4946 a	—
C. V. %	—	—	—	—	5.97	15.01	2.25	7.92	—

Pre = Pre emergence. HW = Hand weeding. IC = Interculturing. DAS = Days After Sowing

* Pooled data of 3 years

Dry Weed Weight

Significantly, the lowest dry weed weight at harvest (0 kg ha^{-1}) was observed under the weedfree treatment in 1992-93 and 1996-97 (Table-1). The same treatment recording the lowest dry weed weight, remained at par with the treatment J, C and I in 1993-94 and treatment J, I, C and F in the pooled result. These findings are in accordance with those of Chauhan *et al.* (1995).

Weed Control Efficiency

Maximum weed control efficiency (100%) was recorded under weedfree condition (pooled data) and closely followed by treatments J (89.5%), I (83.3%), C (83.1%)

and F (81.3%). This indicates integration of herbicides at lower rate with one handweeding and interculturing at 40-45 days after sowing proved its efficiency over sole herbicide application and remained comparable to weedfree condition.

Seed Yield

Effect of integrated weed management on seed yield (Table-2) was found significant in all the years as well as in pooled result. Highest seed yield was produced under the weedfree treatment in all the years and remained at par with the treatments F, A, C, D, J and B in 1993-94 and treatment C and F in the pooled, respectively. Integration of either

TABLE 2

Seed yield and economics of pigeonpea as affected by integrated weed management.

Treatment	Rate (kg/ha)	Seed yield (kg/ha)				Net return (Rs./ha)*	Additional income over control (Rs./ha)*
		1992-93	1993-94	1996-97	Pooled		
A: Pendimethalin. Pre	0.900	1265 bc	1973 ab	758 g	1332 bcd	14844	2844
B: Pendimethalin. Pre	1.200	920 ef	1869 abc	805 f	1198 de	12886	886
C: Pendimethalin. Pre+ 1 HW & IC at 40-45 DAS	0.900	1360 b	1915 abc	1131 b	1469 ab	15558	3558
D: Fluchloralin. Pre	0.900	865 fg	1912 abc	907 e	1228 cd	13946	1946
E: Fluchloralin. Pre	1.350	1145 cd	1782 bcd	909 e	1279 bcd	14383	2383
F: Fluchloralin. Pre + 1 HW & IC at 40-45 DAS	0.900	1359 b	1981 ab	1009 c	1449 abc	15408	3408
G: Butachlor. Pre	1.000	958 def	1674 cd	741 g	1124 de	12798	798
H: Butachlor. Pre	1.500	1106 cde	1732 bcd	893 e	1243 bcd	13926	1926
I: Butachlor. Pre + 1 HW & IC at 40-45 DAS	1.000	1302 bc	1772 bcd	946 b	1340 bcd	14050	2050
J: 2 HW & 2 IC at 30 & 60 DAS	—	1117 cd	1910 abc	887 e	1305 bed	13880	1880
K: Weed free	—	1653 a	2107 a	1178 a	1646 a	17192	5192
L: Control	—	709 g	1560 d	732 g	1000 e	12000	—
C. V. %	—	9.99	8.33	2.09	8.56	—	—

Pre = Pre emergence.

HW = Hand Weeding.

IC = Interculturing.

DAS = Days After Sowing

* Pooled data of 3 years

pendimethalin, fluchloralin or butachlor at lower rate with one hand weeding and interculturing at 40-45 days after sowing produced more seed yield as compared to single herbicide application either at lower or higher rates. The seed yield produced with combinations of either pendimethalin or fluchloralin with one hand weeding and interculturing at 40-45 days after sowing were comparable to the seed yield of weedfree plot. On the other hand, the lowest seed yield of 709, 1560, 732 and 1000 kg ha⁻¹ was obtained under the control treatment in the above periods respectively. Chauhan *et al.* (1995) from Hissar also reported similar results.

Economics

The data on economics (Table-2) indicated that highest net return of Rs. 17192 ha⁻¹ was obtained with the weedfree treatment resulting an increase of Rs. 5192/ha over control. This was followed by the treatments C (pendimethalin 0.9 kg/ha, pre-emergence + one hand weeding and interculturing at 40-45 days after sowing) and F (Fluchloralin 0.9 kg/ha, pre-emergence + one hand weeding and interculturing at 40-45 days after sowing) recording net returns

of Rs. 15558 ha⁻¹ and Rs. 15408 ha⁻¹, respectively. The lowest net return of Rs. 12000 ha⁻¹ was obtained under control treatment.

Thus, it can be concluded that pigeonpea field should be kept weedfree. However, under shortage of labourers, application of either pendimethalin or fluchloralin @ 0.900 kg/ha as pre emergence with one hand weeding and interculturing at 40-45 days after sowing is recommended for effective weed control in pigeonpea in south Saurashtra conditions.

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Correlation Studies on Yield and Yield Attributes of Wheat (*Triticum aestivum*)

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ABSTRACT

Field experiment with 12 genotypes was conducted to study the attributes contributing towards yield in wheat (*Triticum aestivum*) during *rabi*, 1993-94. The highest grain yield was recorded in GW 120 followed by HD 2402, UP 2003 and MACS 2496. Grain yield was positively correlated with harvest index and biological yield whereas, negative correlation with the number of sterile spikelets per spike was also observed. Negative association between harvest index and number of sterile spikelets indicated that harvest index was the most important attribute contributing towards yield.

(Received on 23rd Febru., 1998)

INTRODUCTION

Significant varietal differences were reported of wheat (*Triticum aestivum*) in relation to grain yield, length of earhead, number of grain per ear and 1000-grain weight (Patel *et al.* 1982). Positive relationship between grain yield and days to flowering was observed in a study involving 40 wheat genotypes (Singh, 1982). The present investigation was made for screening out potential high yielding wheat genotypes for the Tarai region of Uttar Pradesh and x isolating the attributes contributing towards yield for use as selection criteria.

MATERIALS AND METHODS

A field experiment was conducted at Crop Research Centre, Govind Bullabh Pant University of Agriculture and Technology, Pantnagar, during *rabi*, 1993-94. The soil was silty loam in texture with 1.06% organic

carbon, 27.75 kg ha⁻¹ available P, 135.29 kg ha⁻¹ available K and pH 7.1. Twelve wheat varieties viz. DL803-3, DWR 162, GW 190, HD 2236, HD 2270, HD 2329, HD 2402, HI 979, HI 1077, MACS 2496, UP 2003 and WH 542 were evaluated in randomized block design (RBD) with four replications. The crop was sown on 15th November and harvested on 23rd, April. A row spacing of 23 cm was given to accommodate 250 seeds m². The crop was fertilized with 120 kg N ha⁻¹ and 40 kg P₂O₅ ha⁻¹ through urea and DAP, respectively. Full P and half N were applied as basal and remaining nitrogen was applied before the first irrigation.

RESULTS AND DISCUSSION

The longest spikes were recorded in variety HI 977 followed by DL 803-3, HD 2236, DWR 162, HD 2270, HI 1077 and HD 2329 which were at par with each other. Number of fertile spikelets was more in case

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TABLE 1

Yield attributing characters, biological yield, grain yield and harvest index (%) as influenced by wheat varieties.

Treatment	Yield attributes							Harvest index (%)	
	Spike length (cm)	No. of fertile spikelets/ spike	No. of sterile spikelets/ spike	No. of grains per spike	Grain wt. per spike (g)	Thousand grain wt. (g)	Biological yield (ha ⁻¹)		Grain yield (ha ⁻¹)
DL - 803-3	11.3	18.6	2.2	48.3	2.23	46.1	12.17	4.79	39.3
DWR 162	11.2	20.8	2.8	57.6	2.45	43.0	13.54	4.74	35.0
GW 190	10.7	20.4	2.6	55.0	2.45	45.5	12.73	5.09	40.0
HD 2236	11.3	17.7	2.4	48.5	2.13	44.5	13.10	4.81	36.7
HD 2270	11.2	18.6	3.5	41.2	2.05	49.8	11.58	4.16	33.8
HD 2329	11.1	16.1	2.8	39.7	1.90	48.3	12.85	4.72	38.5
HD 2402	10.9	16.4	2.5	38.6	1.90	48.2	13.00	5.05	38.5
HI 977	11.6	19.7	3.0	43.9	2.10	47.9	13.16	4.67	35.5
HI 1077	11.2	18.7	3.0	44.1	2.10	48.1	12.42	4.50	36.3
MACS 2496	10.0	20.0	2.7	54.7	2.25	41.6	12.73	4.91	38.8
UP 2003	10.7	21.6	2.9	54.7	2.40	44.8	13.23	5.04	37.9
WH 542	10.8	21.7	2.5	58.1	2.23	39.5	12.67	4.71	38.8
CD (0.05)	0.7	1.7	0.5	5.2	0.22	2.6	1.00	0.45	3.5

TABLE 2

Correlation coefficient (r) among yield and yield attributes of wheat.

	Grain yield	Biological yield	Harvest index	Spike length	Number of sterile spikelets/spike	Number of fertile spikelets/spike	Grain number per spike	Grain weight per spike	1000 grain weight	Number of effective shoots
Biological yield	0.634*									
Harvest index	0.771**	0.093								
Spike length	-0.475	-0.045	-0.610*							
No. of sterile spikelets / spike	-0.666*	-0.301	-0.715**	0.141						
No. of fertile spikelets/spike	0.133	0.185	0.041	-0.319	0.086					
Grain number/spike	0.371	0.327	0.309	-0.463	-0.292	0.867**				
Grain weight/spike	0.386	0.324	0.226	-0.282	-0.148	0.846**	0.887**			
1000 grain wt.	-0.371	-0.350	-0.369	0.532	0.467	-0.665*	-0.881**	-0.576*		
Number of effective shoots	-0.027	-0.0230	0.198	0.115	-0.267	-0.742**	-0.669*	-0.845**	0.310	

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

of WH 542 than the other varieties. Maximum number of sterile spikelets were observed in HD 2270. The highest number of grains per spike was produced in WH 542 closely followed by DWR 162, GW 190, MACS 2496 and UP 2003 which were at par each other and significantly higher than other varieties. Variety HD 2270 recorded significantly highest 1000-grain weight and statistically at par with HD 2329, HD 2402, HD 1077 and HI 977 (Table 1).

Variety DWR 162 (13.54 t ha^{-1}) produced significantly higher biological yield than HD 1077, DL 803-3 and HD 2270 and at par with rest of the varieties. Maximising grain yield producing varieties were GW 190, HD 2402 and UP 2003 and 5.09, 5.05 and 5.04 t ha^{-1} which were at par with each other and significantly higher than HI 1077 and HD 2270. Harvest index varied from 33.8 to 40.00 per cent. The highest harvest index was recorded in GW 190 followed by DL 803-3 and MACS 2496. Grain yield significantly correlated with the harvest index ($r = 0.771$), biological yield ($r = 0.634$) whereas, its association with number of sterile spikelets per spike was negative. The positive association of grain yield with number of fertility spikelets, number of grains and grain weight per spike were non significant. Harvest index was also negatively

associated with spike length and number of sterile spikelets per spike. This significant negative association of number of sterile spikelets per spike with both harvest index and grain yield clearly establishes harvest index as the most important attribute contributing towards grain yield. The number of sterile spikelets and the spike length were negatively correlated with each other in view of nonsignificant relationship with grain yield (Table - 2). Positive correlation between grain and biological yield and harvest index was also reported (Reddy and Bhardwaj, 1982, Choudhary and Singh, 1991).

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Survey, Distribution, Extent of Damage, Field Behaviour and Biology of Red Palm Weevil, *Rhynchophorus ferrugineus* Oliv. on Date Groves of Kachchh (Gujarat)

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ABSTRACT

Extensive survey conducted during 1993 - 1995 in the date palm growing areas of Kachchh revealed that Red palm weevil is a serious pest of this crop and distributed in almost entire date palm growing areas of this region. The infestation was more in areas away from the coast and young plants (2-5 years) are more prone to weevil infestation. The point of attachment of suckers to mother palm is the most vulnerable portion to weevil attack and many generations are completed in a single palm. The difficulty in early detection, unawareness among farmers, absence of systematic plantations, poor orchard management etc. are some of the reasons for the endemic problems of this pest in date groves of Kachchh. Biology of the weevil studied on date palm indicated that an average of 67.3 days is required for an egg to become adult under laboratory conditions. The female lays 206 ± 24.03 eggs in captivity. Longevity of adult male and female was observed to be 70 ± 6.95 and 58 ± 3.49 respectively.

(Received on 8th Sept. 1998)

INTRODUCTION

Date palm, *Phoenix dactylifera* Linn.) is the main crop of Arabian countries and its cultivation in India is quite unknown besides the fact that it has grown extensively in the arid region of North - West India. The date palm groves wide spread on the coastal belt of Kachchh (Fig. 1) and this is the only area in India where date palm is commercially cultivated. Being a salt and drought tolerant crop, it is well adapted to the arid conditions of Kachchh giving good remuneration to farmers. Its cultivation is slowly spreading to coastal Saurashtra and North Gujarat and it is becoming an important horticultural crop of the state.

Among various constraints for successful cultivation of the crop, insect

pests cause real concern and red palm weevil, (*Rhynchophorus ferrugineus* Oliv.) is the most serious one. A lot of information is available regarding the insect pests of date palm in other part of the world (Carpenter and Elmer, 1978), however most of the available information on red palm weevil is with respect to coconut (*Cocos nucifera*) only (Divakaran Pillai, 1984) and no information is available on its distribution, extent of damage, field behaviour, biology etc. in relation to date groves of Kachchh, which are briefly discussed in this communication.

MATERIALS AND METHODS

To find distribution, extent of damage and field behaviour of *R. ferrugineus*, a roving survey was conducted during 1992-95 in the

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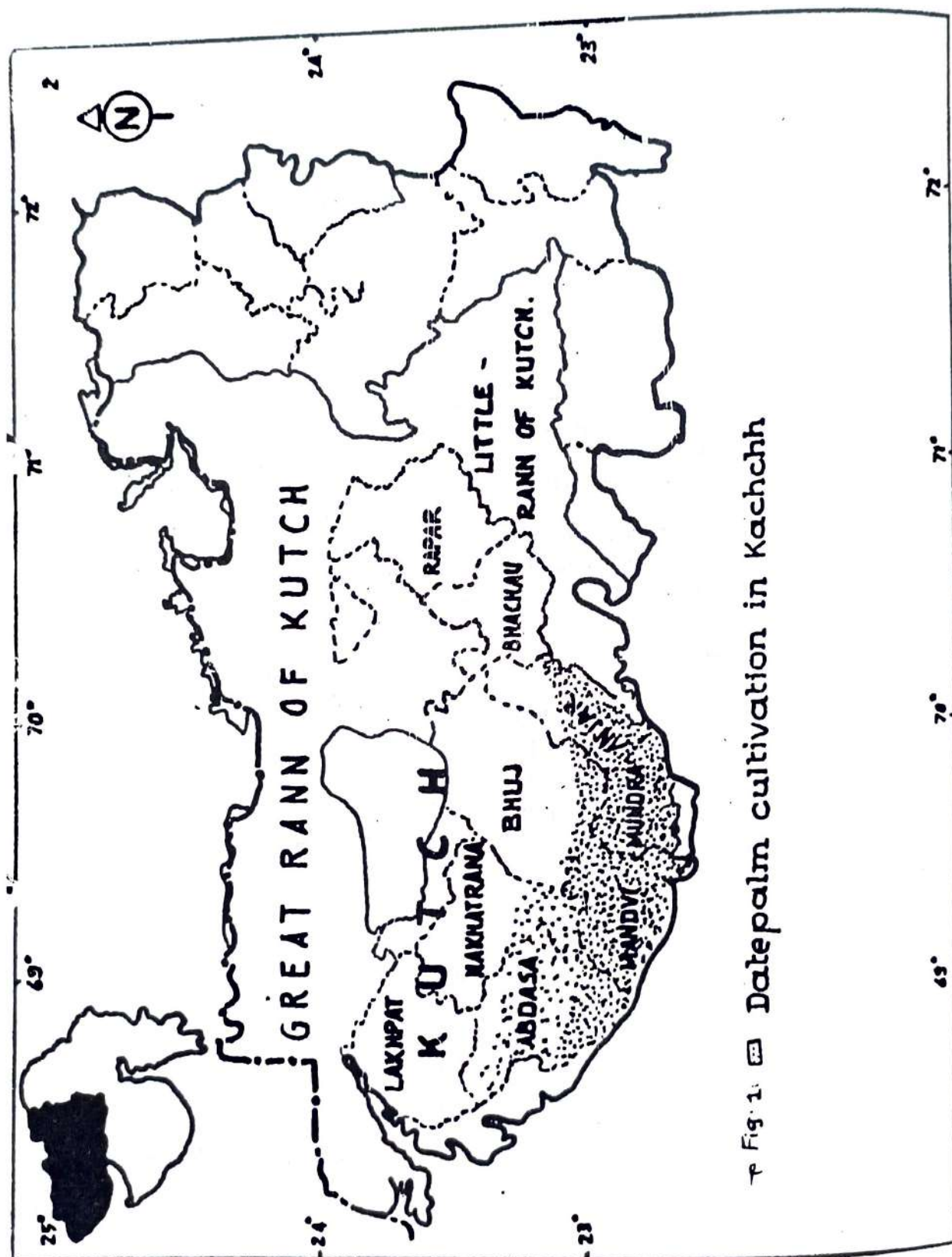


Fig. 1. Date palm cultivation in Kutch

date palm growing areas of Kachchh. A total of 110 gardens were visited covering 28 villages. In each garden total number of palms (Age wise) and weevil infestation in each group were noted. In infested palms, the point of entry, external symptoms etc. were noted and number of grubs, pupae and adults/ palm was recorded after cutting open the heavily infested palms. The farmer's practice to detect the infestation and traditional methods for the management of this pest also recorded. The biology of *R. ferrugineus* on date palm was studied during 1993 at Date Palm Research Station, Mundra under room temperature (Maximum 32.49°C, Minimum 27.29°C, RH 72%). Adults collected from infested date palms formed the nucleus culture of the study. Freshly emerged adults were paired and kept in plastic jars (500-ml capacity) and soft petioles of date palm were provided for oviposition. The freshly hatched grubs were reared on small sized date palm suckers till adult emergence. The time taken for completion of all developmental stages,

number of eggs laid/female, adult longevity, fertility of eggs (% age) etc. was recorded.

RESULTS AND DISCUSSION

(i) Distribution and extent of damage

The details of survey conducted in 28 villages (covering 110 gardens) and the occurrence and extent of damage caused by the red palm weevil are presented in table 1. The survey indicated that the red palm weevil infestation was found in almost all the date palm growing areas of Kachchh irrespective of the locality. Among the 110 gardens visited the infestation was observed in 78 gardens (70.90%). The percentage infestations varied from 0.38% in Bhuj taluka to 1.02% in Anjar taluka. In each locality some hot pockets of this pest were also observed, where the extent of damage was very severe. Such pockets are observed in Desalpur (Mundra taluka), Khedoi, Weedi and Luharia (Anjar taluka) and Gadval in Abdassa taluka. The study also revealed that the extent of damage by the weevil was more in areas away from the coast (Anjar

TABLE 1

Distribution of extent of damage by Red palm weevil in different villages of Kachchh.

Taluka	Villages surveyed	No. of gardens visited	Red Palm Weevil		
			Presence	Absence	Infestation %
1. Mundra	Dhrub	25	22	3	0.68
	Zarpara	9	8	1	0.65
	Mundra	7	6	1	0.33
	Borana	6	4	2	0.24
	Vadala	1	0	1	0
	Navinar	1	1	0	0.4
	Desalpar	3	3	0	1.98
	Bhujpar	3	2	1	0.3
	Somogoga	2	1	1	0.33

1	2	3	4	5	6	7
		Sadan	2	2	0	0.36
		Motakapaya	1	0	1	0
		Pragpar	1	0	1	0
		Patri	1	1	0	0.6
2.	Anjar	Khedoi	19	19	0	1.46
		Anjar	3	2	1	0.86
		Weedi	2	2	0	1.52
		Wada	2	0	2	0
		Luhariya	1	1	0	1.74
		Pantia	1	1	0	0.56
3.	Bhuj	Madhapar	2	2	0	0.39
		Kera	1	1	0	0.38
4.	Mandvi	Rayan	2	2	0	0.29
		Gundiyali	4	3	1	0.54
		Mandvi	1	0	1	0
5.	Abdasa	Tera	5	0	5	0
		Gandaval	3	3	0	1.18
		Hajipar	1	0	1	0
		Kothara	1	0	1	0
Total		28	110	78	32	0.84

and Khedoi), where palms were generally irrigated by well water.

(ii) Field behaviour and some reasons for heavy infestations

a. Mode of entry

The field behaviour and symptomatology of the weevil is almost similar to that in coconut plantation, which is well documented by Nirula (1956). As in all palms, the early detection of this pest is very difficult. Our observation, during survey indicated that the point of attachment of suckers to mother palm was most vulnerable portion of the weevil attack in date palm. Like in coconut it never enters through the cut portion of the petiole or the crown (if crown is already infested with rhinoceros beetle, there is a possibility of entry from the top). Out of the 430 infested palms observed,

only two were found infested from the top.

b. Age of plam

Like in other plams, young date plams of 2-5 years were more susceptible to weevil attack, whereas old palms (>50 years) recorded only negligible damage by this weevil. Among the infested palms 2.01% infestation was found in 2-5 years age group whereas older palms (21-50 years) recorded only 0.05% infestation. The vulnerability of *Rhynchophorus* spp. to young and stress trees were also reported by Giblin Davis and Howard (1989). The presence of more suckers and sappy nature of young palms may contribute for the increased infestation in young palms. Moreover young palms were more prone to injuries during field operations which helped the weevil to eggs in the exposed tissues.

Field activity

During survey adults active in the field were not seen. This might be due to the fact the weevils were more active from sunrise to 9 a.m. and from 5 p.m. to sunset as reported by Nirula (1956).The observations on infested palms revealed a heterogenous population at all developmental stages (Grubs, pupae, adult etc.) indicating that many generations might complete in the

same palm until it died. As many as 103 grubs, 28 pupae and 18 adults were recorded in a infested palm (Table 2), indicating the prolific breeding habit of the pest. It was also noted that the grubs normally migrated towards the leaf base for pupation as number of pupae was more at the leaf base. That helped the weevil to come out easily. Many farmers were of the view that sweetest palms were more prone to weevil attack.

TABLE 2
Population of Red palm weevil in infested palms.

Date of Collection	Village	Red palm weevil population					Sex Ratio Male : Female
		Grubs	Pupae	Adults	Male	Female	
12-12-93	Dhrub	25	13	7	3	4	1 : 1.33
18-12-93	Dhrub	103	28	18	4	14	1 : 3.50
09-12-93	Khedoi	85	16	34	18	16	1 : 0.89
11-01-94	Dhrub	15	8	27	11	16	1 : 1.45
18-08-94	Dhrub	8	14	21	9	12	1 : 1.33
01-10-95	Mundra	47	19	14	8	6	1 : 0.75
28-10-95	Gundiyala	10	7	17	7	10	1 : 1.43
24-03-95	Gadaval	—	—	16	6	10	1 : 1.67
03-11-95	Somogaga	6	6	—	—	—	—

(iii) Reasons for heavy infestation

The observations made during survey led to arrive at following possible reasons for the heavy infestations of red palm weevil in the date groves of Kachchh.

1. **Difficulty in early detection :**
Unless closely examined, there is no immediate external symptoms on the palm, after invasion of the weevil. Farmers recognize the infested palms very late and by that time it damage a major portion of the trunk.
2. **Adoption of crude methods of control :** Only very few farmers followed the recommended plant protection measures to manage this pest. Farmers normally pour

burnt oil, boiled water, etc. on infested portion of the palm which kill only very few grubs and the remanining further damage the palm.

3. **Religious farmers :** The farmers of this area never kill the weevils/grubs due to religious reasons. If a male palm is infested with weevil it is left as such without destroying weevel, which facilitate the further breeding of the pest.
4. **Toddy taping :** In certain village (Khedio, Zarpara, etc.), male palms were used for toddy extraction an intoxicating liquid) by making cuts/holes below the crown which attract adults weevils that further inflict damage to other palms.

5. Absence of systematic plantations and poor orchard management :

The farmers of this area plant seedlings close on boundaries and do not care for timely removal of suckers, unwanted male palms, pruning and other orchard management practices. Thus, uncared gardens form good breeding sites for the weevil.

TABLE 3

Development of *Rhynchophorus ferrugineus*, when reared on date palm.

Sr. No.	Criteria	Period (in days)*
1.	Pre- Oviposition period	6.5 + - 0.5
2.	Oviposition period	43.9 + - 2.33
3.	Incubation period	2.4 + - 0.22
4.	Larval period	44.6 + - 0.89
5.	Pupul period	20.3 + - 0.49
6.	Adult longevity	
	(a) Male	70.7 + - 6.65
	(b) Female	58.5 + - 3.49
7.	Fecundity	206.3 + - 24.03
8.	(Eggs/Female)	88.84 + - 1.81
	Fertility of eggs (%)	

study indicated that the developmental periods were more or less comparable to that on coconut. The larval period was 44.6 + 0.89 days on date palm as against 55 days when reared on coconut. The pupal stage lasted about 20 + 0.49 days and the newly emerged females started egg laying after a short oviposition period of 6.5 + 0.54 days. The oviposition continued 43.9 + 2.35 days laying an average of 206 + 24.03 eggs. The adult longevity of male and female when reared on date palm was 70.7 + 6.95 days and 58.5 + 3.49 days respectively which were 43 and 18 days less as compared to coconut. Thus, 67.3 days were required for an egg to become adult when reared on date palm. The entire life cycle completed within 37 days for male and 125 days for female.

Biology

The life history of red palm weevil on coconut was studied by Nirula (1956) and Rahalkar *et al.* (1972) successfully reared this pest on sugarcane under laboratory conditions. The developmental periods of various stages of red palm weevil, when reared on date palm is given in table 3. The

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Growth and Yield of Pigeonpea as Influenced by Association of Soybean and Phosphorus Application*

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ABSTRACT

Experiment on growth and yield of pigeonpea as influenced by association of soybean and phosphorus fertilization revealed that grain yield of pigeonpea in replacement system (14.07 q/ha or 83.89%) and in additive system (13.96 q/ha or 83.24%) being at par was about 17.5 per cent less than sole pigeonpea (16.77 a/ha or 100%). Harvest index of pigeonpea was increased in replacement system (17.66%) than sole pigeonpea (16.70%). Superior yield attributes and growth character were observed in replacement series of soybean intercropping than sole cropping. Growth and yield of pigeonpea was found significant upto 60 kg P_2O_5 / ha. X optima for pigeonpea crop was computed as 68.82 kg P_2O_5 /ha however yield was maximized by 86.5 kg P_2O_5 /ha.

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INTRODUCTION

Intercropping of early maturing pigeonpea and soybean has become popular in soybean growing tract of Madhya Pradesh which is also gaining popularity in Uttar Pradesh both as in sole and in intercropping systems. Saxena and Yadav (1976) first time made an attempt to evaluate optimum row proportion of soybean cultivars in intercropping with short duration pigeonpea at Pantnagar in additive series. In intercropping of soybean with pigeonpea, most of the research worker have considered pigeonpea as main crop and soybean as an intercrop (Ahlawat *et al.*, 1982).

Phosphorus is one of the most limiting plant nutrients which is essential for good

growth of crop. The beneficial role of phosphorus in improving physical conditions of soil well realised when fertilizer is applied to leguminous crop. But the recommendations are not available on phosphorus requirement of pigeonpea in intercropping with soybean.

MATERIALS AND METHODS

The present field investigation was made at Student's Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur in Central U. P. during 1995-96 and 1996-97 in which 4 cropping systems (sole soybean, sole pigeonpea, two rows of soybean in between 2 rows of pigeonpea in additive and 4 rows of soybean followed by 2 rows of pigeonpea in replacement series) was tried

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under increasing doses of phosphorus (@ 0, 30, 60 and 90 kg P_2O_5 /ha) in a 4 replicated randomized block design. The sowing was done on June 25th during both the years with uniform application of 20 kg N + 20 kg K_2O /ha. Phosphorus application was done through single superphosphate in rows 40 cm apart using 100 kg seed of JS-72-44 and 16 kg seed of UPAS 120 per hectare in pure cropping of soybean and pigeonpea, respectively. While in case of intercropping, the seed rate per row was used on the basis of seed rate used in sole cropping. The experimental field was sandy loam in texture, low in organic carbon and nitrogen, medium in available P and potash with slightly alkaline in reaction. The error variances for the two years for the yield of pigeonpea were subjected to homogeneity test which was found to be non significant, hence, the results were pooled.

RESULTS AND DISCUSSION

Growth and yield of pigeonpea in association of soybean

Pigeonpea was grown in association of soybean with 100% rows in additive series and 66.6% rows in replacement series in comparison to pure soybean. Perusal of the results in Table 1 revealed that initial stand of the crop was as per treatment but number of plants of pigeonpea in additive series was reduced by 11.58 per cent without any reduction in replacement series. This is attributed to higher mortality of the plants (15.6%) in additive series. This indicated the teletoxic association of soybean with pigeonpea which was more pronounced in additive than replacement system. This was reflected by height of the crop, leaf area index, branches per plant and other yield

attributes. The increase in the extent of adverse effect of soybean on growth of pigeonpea plants was observed upto 90 day stage with a slight recovery thereafter.

Consequently the grain and stick yield of pigeonpea was found to be reduced in intercropping in additive system by a margin of 16.7% and 14.63% respectively. The reduction in grain and straw yield of pigeonpea particularly in additive series is attributed to the combine effect of harvested plants and seed yield per plant which was due to reduction in number of seeds per plant. The adverse effect of soybean on pigeonpea in additive series of intercropping was also reported by Saxena and Yadav (1976). @ 17.6% and Tomar *et al.* (1987), @ 6.25%.

But in case of replacement series, a different trend was noticed in the growth and yield of pigeonpea, growth of pigeonpea measured in terms of LAI, development of pods, grain and productive branches per plant were found to be increased over pure as well as in intercropping of pigeonpea (additive). This resulted into 32.20% increase in the seed yield per plant in comparison to pure pigeonpea. It is because of this fact that the grain yield of pigeonpea in replacement series with soybean was 83.89% with 65.14% plant population showing an increase of 18.25%. Similarly sticks and straw yield of pigeonpea in replacement series was 74.07% and 92.37% with 65.14% plant population. This showed a positive effect of soybean on growth and yield of pigeonpea. Similar results have also been reported by Tomar *et al.* (1997) and Billore *et al.* (1993) in 4:2 row system.

TABLE 1

Growth and yield of pigeonpea as influenced by association of soybean and phosphorus application.

Treatment	Plant population ooooha Initial	at harvest	Morta- lity %	Number of pods/ plant	Pod yield plant (g)	Number of seeds/ plant	Seed yield plant (g)
Cropping System							
Sole pigeonpea	91.57	88.07	3.68	124.19	30.12	277.40	19.58
Soybean + pigeonpea (2 : 1) additive	91.57	77.88	15.16	120.71	28.23	260.96	17.64
Soybean + pigeonpea (4:2) replacement	60.71	57.37	5.55	156.40	41.66	370.93	25.85
SE (diff.)	0.363	0.404	0.498	3.499	0.909	7.89	0.525
CD at 5%	0.725	0.807	0.994	6.985	1.815	15.76	1.048
Doses of P₂O₅ kg/ha							
0	80.88	74.51	7.49	99.25	24.11	216.27	14.94
30	81.26	74.86	7.98	132.45	33.01	298.20	21.07
60	81.65	74.33	8.44	152.40	37.92	347.75	24.05
90	81.34	74.25	8.60	150.42	38.28	350.13	24.51
SE (diff.)	0.419	0.467	0.575	4.039	1.049	9.12	0.606
CD at 5%	NS	NS	NS	08.066	2.066	18.20	1.211

The total P uptake was 12.6 kg/ha in additive system and 12.17 kg/ha in replacement system which was comparatively lower than its sole cropping (12.27 kg/ha). Phosphorus use efficiency was significantly higher in replacement system and P use efficiency was highest in replacement system (25.36%) and lower in sole pigeonpea (17.82%).

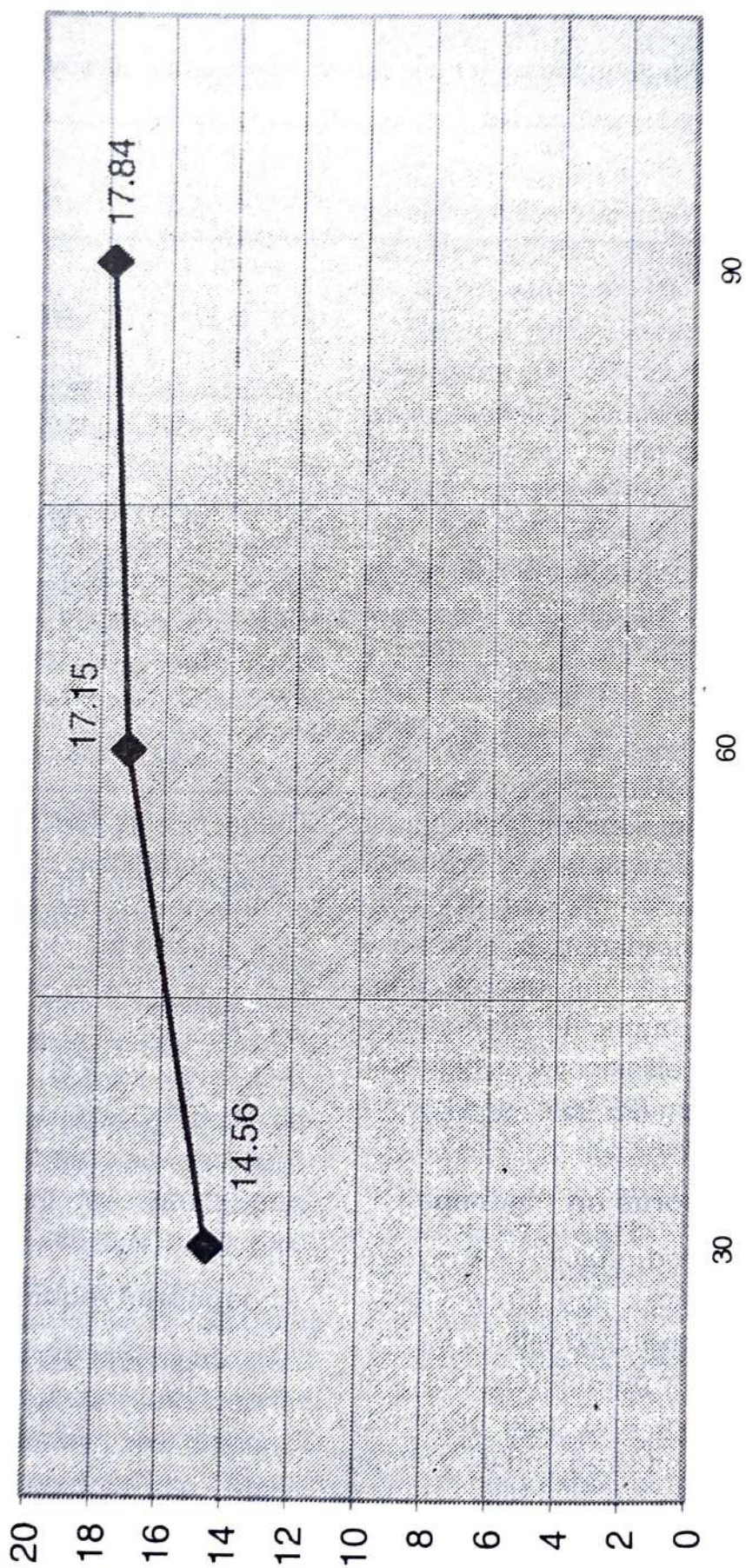
Effect of Phosphorus on Pigeonpea

Data presented in Table-1 & 2 revealed that the grain, sticks and straw yield of pigeonpea was maximized with 60 kg P₂O₅/ha. All the growth parameters like plant height, productive and total branches, number of pods and seed and its yield per plant showed tendency of maximizing their values with the application of 60 kg P₂O₅/ha in pure and in intercropping systems.

These results find the support of Nimje (1995) and Billore *et al.* (1993). The results on phosphorus use efficiency of pigeonpea crop showed that it was maximum at 30 kg P₂O₅/ha (17.14 kg grain per kg of P₂O₅) and was decreased to 13.59 kg grain per kg of P₂O₅ at 60 kg P₂O₅/ha and 10.02 kg grain per kg of P₂O₅ at 90 kg P₂O₅/ha. Phosphorus recovery was estimated @ 33.69%, 25.36% and 20.09% with the application of 30, 60 and 90 kg P₂O₅/ha, respectively.

Phosphorus requirements of pigeonpea

In view of the hand of the response to phosphorus rates, single degree freedom analysis was carried out in respect to grain yield data of pigeonpea and Quadratic regression equation $y = 10.17 + 5.34x - 0.93x^2$ was calculated and depicted in Fig-1.



Quadratic Response Curve of Grain Yield of Pigeonpea (q/ha) on Phosphorus Doses

TABLE 2

Yield and phosphorus uptake of pigeonpea under the influence of soybean intercropping and phosphorus application.

(2 years pooled data)

Treatment	Biomass q/ha	Straw yield q/ha.	Sticks yield q/ha.	Grain yield q/ha.	HI%	Phosphorus uptake kg/ha			P use efficiency kg grain per kg of P ₂ O ₅	P utilization efficiency %
						Sticks +straw	Grain	Total		
Cropping System										
Sole pigeonpea	95.55	13.11	69.56	16.77	16.70	8.99	6.29	15.27	8.422	17.82
Soybean + pigeonpea (2:1) additive	85.47	11.80	59.39	13.96	15.63	7.68	4.92	12.60	8.77	16.16
Soybean + pigeonpea (4:2) replacement	77.72	12.11	51.53	14.07	17.66	6.88	5.29	12.17	13.37	25.36
SE (diff.)	2.149	0.315	1.773	0.339	0.195	0.218	0.159	0.344	—	—
CD at 5%	4.292	0.628	3.540	0.678	0.391	0.436	0.318	0.713	—	—
Doses of P ₂ O ₅ kg/ha										
0	70.55	8.94	51.44	10.17	14.78	5.98	3.28	9.25	0.00	0.00
30	86.04	12.432	59.05	14.56	16.57	7.72	5.31	13.02	17.14	33.69
60	94.13	13.89	63.07	17.15	18.22	8.52	6.47	14.99	13.59	25.36
90	99.32	14.38	67.10	17.84	17.96	9.08	6.94	16.01	10.02	20.09
SE (diff.)	2.482	0.383	2.047	0.392	0.226	0.252	0.184	0.397	—	—
CD at 5%	4.596	0.726	4.088	0.783	0.451	0.503	0.367	0.823	—	—

On this equation x maxima, yield at x maxima and response to P application was computed. Results showed that maximum grain yield of pigeonpea (17.85 q/ha) was obtained with the application of 86.5 kg P_2O_5 /ha @ 33.08 kg grain per kg of P_2O_5 or Rs. 30.30 per one rupee spent on phosphorus. Optimum yield for pigeonpea was 20.23 q/ha 'however' obtained with 68.82 kg P_2O_5 /ha.

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Response of Summer Greengram to Irrigation Systems Based on IW/CPE Ratio

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ABSTRACT

Results of the experiment conducted at GAU, Navsari showed that irrigation scheduled at IW/CPE ratio of 0.75 recorded higher grain and stover yields of greengram as well as higher values of consumptive use of water. Whereas, negative trend was observed for crop water use and field water use efficiency. The higher gross and net realization was also observed under this ratio in both the methods of irrigation. Higher initial cost of sprinkler system, surface method was found economical but mini sprinkler method saved 2.1 per cent water which covered an additional area of 0.27 ha at IW / CPE ratio 0.75.

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INTRODUCTION

Of late, the cultivation of pulse crop has received major attention in India in view of the increased demand for meeting the protein requirement of the escalating population. Among these, greengram (*Vigna radiata* (L) Wilczek) occupies a prominent place and gaining increasing popularity by virtue of its short growth period, high yield and outstanding nutritional value of food, feed and forage. Optimal utilization of water resources as one of the most critical factor in agriculture. The crop production generally depends upon the prudent application of water essential for the higher production per unit area and time. Pampatiwar *et al.*, (1983) observed that the sprinkler method of irrigation is more efficient from the water use efficiency and water saving point of view.

Present investigation was therefore carried out to evaluate the mini - sprinkler method of irrigation with different IW/CPE ratio in summer greengram.

MATERIALS AND METHODS

A field experiment was conducted at the farm of Gujarat Agricultural University, Navsari during the summer seasons of 1992-93 and 1993-94. The treatment comprised of four irrigation levels based on IW/CPE ratio (0.30, 0.45, 0.60 and 0.75) and two methods of irrigation (surface and mini - sprinkler) laid out in randomized block design with six replications. The typical Ustochrepts soil was deep black clayey (13.4% sand, 19.9% silt and 66.6% clay), low in available nitrogen (231 kg N/ha), medium in available phosphorus (35 kg P_2O_5 /ha),

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high in available potash (350 kg K_2O /ha) and the soil reaction was slightly saline pH 7.8. Greengram cv. K-851 were sown on 20th and 29th March during 1992-93 and 1993-94, respectively. A basal dose of 20 kg N/ha and 40 kg P_2O_5 /ha was applied uniformly to the experimental plots before sowing. The gross and net plot size were 6.0 m x 4.5 m and 4.0 m x 2.7 m for surface method and 7.5 m x 7.5 m and 2.5 m x 3.3 m for mini sprinkler method, respectively. Two meter buffer strip were kept around the plot. Two common irrigations, first immediately after sowing with 80 and 50 mm depth and second

four days thereafter with 60 and 30 mm depth in surface and minisprinkler method of irrigation, respectively, were provided for proper germination and establishment of the crop. The remaining irrigations were scheduled as per irrigation treatments with 60 and 50 mm depth of water in surface and mini - sprinkler method, respectively. The CPE values were calculated after second common irrigation from USWB open Pan Class A evaporimeter. Irrigation was applied when CPE values approaches to 80, 100, 133 and 200 mm for surface and 67, 83, 111 and 167 mm in mini-sprinkler for 0.75, 0.60,

TABLE 1

Economic of surface and mini-srpinkler method of irrigation at varying IW/CPE ratios (Mean of 1992-93 and 1993-94).

Treatment	Yield (kg/ha)		Gross return (Rs/ha)	Cost of production (Rs/ha)			Net return (Rs/ha)	With reference to 0.30 IW/CPE ratio	
	Grain	Stover		Fixed	Variable	Total		Additional return (Rs/ha)	Additional cost (Rs/ha)
IW/CPE ratio									
	Surface Method								
0.30	626	1035	8034	210	5773	5983	2651	—	—
0.45	825	1455	10633	210	5312	5522	5111	2460	139
0.60	861	1752	11209	210	5451	5661	5548	2897	165
0.75	961	1939	12497	210	5590	5800	6907	4256	417
C.D. at 5%	94.8	198.1							
	Mini-Sprinkler Method*								
0.30	545	1794	7436	2373	4894	7267	169	—	—
0.45	695	2231	9454	2373	5036	7409	2045	1876	142
0.60	962	3076	13077	2373	5321	7694	5383	5214	427
0.75	1102	3423	14939	2373	5496	7867	7102	6933	570
C. D. at 5%	92.1	295.7							
	Economics of Irrigation Methods								
Surface method	961	1939	12497	210	5590	5800	6907	—	—
Mini srpinkler method	1400	4347	18974	3014	5987	9001	9973	3066	3201
C.D. at 5%	NS	NS							

* Partially portable system with 0.25 ha area coverage in as shifting alongwith additional area 0.27 ha to be irrigated with saved water. Cost of production also can be computed as per area basis.

0.45 and 0.30 IW/CPE ratios, respectively. The quantity of irrigation water was measured with the help of 7.5" Parshall

Flume for surface method and time of operation of minisprinkler was calculated by uniformity co-efficient.

TABLE 2

Consumptive use of water, WUE, saving in water (%) and increase in yield (%) as influenced by irrigation methods and IW/CPE ratios (Mean of 1992-93 and 1993-94).

Sr. No.	Particulars	Mini sprinkler method IW/CPE ratios					Surface method** IW/CPE ratios				
		0.30	0.45	0.60	0.75	Mean	0.30	0.45	0.60	0.75	Mean
1.	Total water applied (mm*)	130	180	280	330	230	220	286	352	418	319
2.	Consumptive use of water (mm)	117	157	229	226	192	182	224	261	304	243
3.	Crop water use efficiency (kg/ha-mm)	4.66	4.43	4.20	4.14	4.36	3.44	3.69	3.30	3.16	3.40
4.	Field water use efficiency (kg/ha-mm)	4.19	3.86	3.43	3.34	3.71	2.85	2.87	2.45	2.30	2.42
5.	Saving in water (%) over respective ratios of surface method	40.91	37.06	20.45	21.05	27.90	—	—	—	—	—
6.	Increase in yield (%) over respective ratio of surface method	-13.01	-15.82	11.67	14.75	0.92	—	—	—	—	—
7.	Additional possible area can be covered (ha) over respective ratios of surface method	0.69	0.59	0.26	0.27	0.39	—	—	—	—	—

* Including two common irrigations for establishment of crop.

** Ten per cent application losses was added in surface irrigation method.

RESULTS AND DISCUSSION

Effect of IW/CPE ratios

The grain and stover yields increased with the increase in the supply of soil moisture in both the methods of irrigation. Significantly the highest grain (961 and 1102

kg/ha) and stover (1993 and 3423 kg/ha) yields (Table : 1) were recorded under IW/CPE ratio of 0.75 in surface and mini-sprinkler method of irrigation, respectively. Consumptive use of water was increased with the increase in moisture regimes from 0.30 to 0.75 IW/CPE ratios in both the

methods (Table : 2). Adequate moisture supply favourably improved nutrient uptake and translocation which ultimately linked with the plant growth and development. Beneficial effect of these parameters resulted in higher grain and stover yields and ultimately more consumptive use of water. Irrigation schedule influenced the water status of the soil profile, evapotranspiration and water use efficiency in greengram. An increase in the frequency of irrigation resulted in higher soil moisture content and greater ET. Frequent wetting of the upper surface layer exposed to the hot atmosphere in 0.75 IW/CPE ratio created a higher vapour pressure gradient between the crop canopy and the atmosphere, which might have caused relatively larger loss of water from the soil surface than in other schedules which resulted in lower field and crop water use efficiency. The results are in line with those of Khade *et al.* (1986) and Patel (1994).

Effect of irrigation method

Greengram irrigated through mini-sprinkler produced higher grain (1400 kg/ha) and stover (4347 kg/ha) yields (Table-1) and higher values of crop and field water use efficiency than surface method of irrigation (Table-2). This was mainly due to higher yield in mini-sprinkler with less evapotranspiration than surface method. An increase in quantity of irrigation water reduced the field and crop water use efficiency in surface method due to proportionately greater loss of water than correspondingly increase in yield. The findings are in agreement with those of Khade *et al.*, (1989) in greengram and Patel (1994) in safflower.

Frequent irrigation through mini-sprinkler at 0.75 IW/CPE ratio resulted in 21 per cent water saving which cover an additional area of 0.27 ha and gave 15 per

cent higher grain yield over the surface method of irrigation in same IW/CPE ratio.

Economics

The net return and cost of cultivation were increased with the increase in IW/CPE ratio in surface method. The maximum gross return Rs. 12497/ha and net return Rs. 6907/ha were realized at 0.75 IW/CPE ratio followed by 0.60, 0.45 and 0.30 IW/CPE ratio (Table-1).

The mini-sprinkler method was not viable compared to surface method due to initial higher cost. To minimize the initial cost of mini-sprinkler system, partially portable system covering 0.25 ha area with additional area of 0.27 ha coverage due to saved water in shifting showed maximum net profit of Rs. 7102/ha followed by Rs. 5383, Rs. 2045 and Rs. 169/ha at IW/CPE ratio 0.75, 0.60, 0.45 and 0.30 respectively.

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Study of the Analytical Growth Parameters and Productivity of Different Genotyp of Methi (*Trigonella foenum graecum* L.)

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ABSTRACT

Fenugreek (*Trigonella foenum graecum* L.), commonly known as methi, is one of the common leafy vegetables and its seeds form an important spices besides used in Ayurvedic and Unani medicines. An experiment with nine genotypes was conducted at JNKVV, RAK Research Farm, Sehore with 30 kg N, 40 kg P_2O_5 and 20 kg K_2O /ha under irrigation conditions in *rabi* season.

From the data it was observed that genotype (CS-381) gave significantly highest dry weight/plant till 100 days of crop growth, followed by plume-23 and plume-55 which were at par. Maximum leaf area and LAI was also in CS-381, followed by plume-57 and plume-20, but significantly maximum CGR was in CS-381, while there was no significant difference in RGR among all the entries, but maximum was in Jabalpur local followed by plume-20. Significantly highest seed yield was noted in plume-55 followed by plume-5. The results indicated that plume-55 and plume-57 had better expression of physiological parameters and the sink. For green leafy vegetable, CS-381 was the best followed by plume-57, plume-20 and plume-47 but for grain yield as spices, plume-55 was the best followed by plume-57.

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INTRODUCTION

Methi is one of the most important leafy vegetables of Indian dishes and its seed is one of the well known and commonly used spices. In our country most of the population is vegetarian. Under such conditions leafy vegetables/crops are the only valuable source of iron and protein alongwith other nutrients. Variations in the yield of different parts of a plant to a certain extent depends upon the parameters of growth and productivity of the crop and hence the study of physiological growth analytical paremeters of the crop is important. This will help in understanding the contribution of different growth parameters and their relationship with the sink to raise the productivity of methi. The growth analysis concept was first

started in the early 20th century in Egypt on cotton crop and further by the British scientists Blackman and Black (1968) for estimating net photosynthetic production of crops. With this approach in view the present experiment was carried out.

MATERIALS AND METHODS

The present investigation taken up during the *rabi* season of 1994-95 at RAK Research Farm, Sehore. Nine genotypes were grown in a complete randomized block design with four replications. Sehore is situated on 23.9' N latitude and 79.58' E longitude having the altitude of 411.78 metres above the mean sea level. The sowing was done on 10th November. Net plot size was 4.20 m x 3.0 m spacing the rows at 30 cm and plants 20 cm apart. Before

sowing, the seeds were treated with thirum @ 3 g per kg seed. The fertilizers were applied @ 30 kg nitrogen, 40 kg phosphorus and 20 kg potash per hectare through urea, single superphosphate and muriate of potash, respectively, for observations ten plants were selected in a row from each treatment and replication. The observations were recorded on fresh and dry weight/plant, leaf area, leaf area index per plant, crop growth rate, relative growth rate as per standard formulae and seed yield per hectare was also recorded. The different parameters were subjected for statistical analysis for final conclusions.

RESULTS AND DISCUSSION

In general it was observed that the fresh weight and whole plant biomass of plants increased rapidly upto flowering in all

the genotypes. CS-381, Plume-55, Plume-57 had significantly maximum fresh and whole plant biomass. This may be due to the increase in size and number of leaflets and branches. At final stages the maximum fresh and dry weight was noted in CS-381. This may be due to higher crop growth rate and net estimation rate in this variety. Also, the moisture content of plant caused the variation in the fresh weight of plants of different genotypes.

In plume-23 fresh and dry weight increased suddenly, which was due to high assimilation of photo-synthates at final stage suggesting that the genotype is physiologically more efficient in growth and productivity.

TABLE 1

Mean fresh weight, dry weight, leaf area and leaf area index, CGR and yield crop stage.

Sr. No.	Variety	Fresh weight	Dry weight	Leaf area	Leaf area index	CGR	RGR	Yield kg/ha
1.	Plume-20	46.40	10.20	1072.78	17.87	25.80	30.00	1221
2.	Plume-23	54.95	13.62	831.58	13.85	30.27	28.71	1500
3.	Plume-47	44.45	11.50	1064.08	17.73	25.37	28.57	1051
4.	Plume-55	54.70	12.65	897.63	14.96	27.90	28.27	2313
5.	Plume-57	38.30	10.72	1075.89	17.93	23.65	27.09	2003
6.	IC-5487	36.32	10.72	1058.70	17.64	22.35	29.45	1347
7.	CS-381	61.80	13.80	1140.51	19.00	30.52	26.75	1648
8.	Jabalpur Local	44.12	11.47	998.67	16.64	25.34	30.17	1081
9.	Lucknow Local	35.27	9.80	811.40	13.52	21.64	29.48	1134
	S.E.m. $\pm$	2.99	0.74	52.19	0.87	2.24	2.54	63.64
	C.D. 5%	8.70	2.18	152.36	2.53	6.76	7.68	185.80

Leaf area index progressively increased with the age of the plants in all the varieties. Higher leaf area index was noted in CS-381 (19.00) and lowest in Lucknow local (13.52) at 100 days. Higher LAI may be attributed to the higher number of triplicates

and their larger leaf area tend to be more common determinant of plant growth than the photosynthetic capacity of individual leaf (Watson, 1952) so that effective exposure of the leaf surface becomes critical. High density affords green leaf area per unit land

area and therefore a greater potential for yield but the photosynthetic rate of individual leaf will tend to be reduced to mutual shading. Watson (1952) reported similar results.

The relative growth rate (RGR) i. e. the rate of increase in weight over a fixed time interval. Though, it was highest in Jabalpur local (30.17 mg-g⁻¹ day⁻¹) followed by plume-20 (30.0 mg-g⁻¹ day⁻¹) while CS-381 gave lowest. But statistically all the nine genotypes were at par for RGR. The reduction in RGR with age of the plant might be due to shading effects of leaves and senescence of the lower leaves and also due to climatic condition. Evidence has steadily occurred and Ondok and Kvet (1971) also recorded similar trends in RGR.

The crop growth rate represented the total dry matter productivity of the plant community per unit and area over a certain time open. At the final stage the CGR was significantly highest in CS-381 followed by plume-23 and plume-55 and all being at par but much reduced CGR was observed in other varieties. This might be due to slow rate of absorption of nutrient and RGR responsible for the growth in initial stages which later on could have more potential of

uptake rate of essential nutrients. The similar facts have also been reported by other research workers viz., Watson (1958), Wallace and Munger (1965) in bean crop.

The grain yield depends on number of pods per plant number of seeds per pod and test weight of seed as well as the efficiency of sink of the genotype. In variety plume-55 all yield attributing characters were superior than the other varieties and therefore the seed yield per hectare was highest (2313 kg). It was minimum in variety Plume-47 (1051 kg) followed by Jabalpur local (1081 kg/ha).

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Efficacy of New Insecticidal Formulations as Seed Treatment Against Whitegrub in Groundnut*

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ABSTRACT

Field experiment was conducted at Gujarat Agricultural University, Sardar Krushinagar during 1997 to evaluate efficacy of quinalphos 25 EC (Ekalux 25 EC), quinalphos 20 AF (Ekalux 20 AF) and carbosulfan 25 EC (Marshal 25 EC) at 15, 20 and 25 ml/kg seeds as seed treatment against whitegrub in groundnut. The results revealed that all the insecticides proved safe as seed treatment as none of them adversely affected seed germination. Further, the new formulation i.e. quinalphos 20 AF (Ekalux 20 AF) @ 25 ml/kg seeds was adjudged as the best seed treatment against whitegrub in groundnut from view point of multiple ranking considering plant mortality, grub population and Net Insecticide Cost Benefit Ratio (NICBR). The next effective seed treatments were quinalphos 20 AF @ 20 ml, quinalphos 25 EC @ 25 and 20 ml/kg seeds. Corbosulfan 25 EC @ 25 ml/kg seeds was also effective against whitegrub but its NICBR was low.

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INTRODUCTION

Groundnut, *Arachis hypogaea* L. is a major *kharif* seed crop of India. Whitegrub, *Holotrichia consanguinea* Blanch. is the key pest of groundnut that inflicts 50 to 100 per cent loss in pod yield in Rajasthan, Gujarat and Punjab (Shah *et al.*, 1975; Yadava *et al.*, 1977 and Bakhietia, 1982). Efforts have been made to control whitegrub either through presowing soil application of granular insecticides like phorate and carbofuran (e.g. Yadava and Sharma, 1955) or through seed treatment with EC formulation of quinalphos, chlorpyrifos etc. (Bakhietia and Brar, 1983 and Patel *et al.*, 1995). However, in recent years, new formulation of quinalphos and carbosulfan i.e. Ekalux 20

AF and Marshal 25 EC have been introduced in market. It was therefore thought necessary to compare the efficacy of these new formulations with the conventional one against whitegrub as seed treatment in groundnut.

MATERIALS AND METHODS

Field experiment was conducted at Instructional Farm of Agronomy, C. P. College of Agriculture, Gujarat Agricultural University, Sardar Krushinagar during *kharif* 1997. Groundnut cultivar GG-2 was sown in Randomised Block Design in plots measuring 5.0 x 3.5 m. The trial was replicated thrice. Three insecticides viz., quinalphos 25 EC, quinalphos 20 AF (both

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from Sandoz India Ltd., now Novartis (India) Ltd., Mumbai) and carbosulfan 25 EC were tested at 15, 20 and 25 ml per kg seeds against whitegrub in groundnut. All the groundnut seeds were treated first with carbendazim 25 per cent S D @ 3 g per kg to prevent attack of seed and soil born pathogen and then one kg of seeds were treated separately for each treatment as per method described by Patel *et al.*, 1995. The germination test of treated seeds was also conducted by sandwiching treated seeds between two discs of blotting paper. Such test was conducted 1, 3, 7 and 10 days after seed treatment and per cent germination was worked out.

Total number of plants and plants killed due to whitegrub damage were recorded 30, 45, 60 and 75 days after sowing from net plot area in all the treatments. The damage plants were removed after each count. From these data, cumulative per cent plant mortality were computed. Pod and dry fodder yield was recorded from the net plot area separately for each plot at the time of harvest. After harvesting, grub population was recorded from one square meter area in each plot by digging soil upto 75 cm deep. Per cent avoidable loss in groundnut pod and fodder yield and increase in the yield in various treatments over control was computed using formulae suggested by Khosla (1977). Economics of various treatments was worked out considering market price of groundnut pod dry fodder, and the insecticides.

RESULTS AND DISCUSSION

Germination

The results of germination test conducted in laboratory condition clearly

indicated that seed germination did not differ significantly when treated with chemical insecticides viz., quinalphos 25 EC, quinalphos 20 AF and carbosulfan 25 EC at 15, 20 and 25 ml dose as compared to germination was substantial (more than 75%) even 10 days after seed treatment in all the insecticidal treatments. Thus, quinalphos 25 EC as well as quinalphos 20 AF and carbofuran 25 EC proved safe as seed treatment for groundnut at all the three doses tested. In past, these insecticides have been found safe as seed treatment for groundnut (e.g. Anon., 1994 C and Patel *et al.*, 1995).

Plant mortality

The cumulative plant mortality of groundnut due to whitegrub was significantly low in all the insecticidal treatments irrespective of the dose (Table-1). The lowest plant mortality was recorded in the seed treatment of quinalphos 20 AF @ 25 ml per kg (12.05%) closely followed by quinalphos 25 EC at same dose whereas the untreated plots witnessed maximum plant mortality (50.71%). Thus, the new formulation of quinalphos i.e.; Ekalux 20 AF was as effective as its EC formulation against whitegrub in groundnut. Quinalphos 20 AF has been also found effective against whitegrub at Jaipur (Anon., 1994 C).

Grub population

The grub population after harvest of the crop was significantly less in all the seed treatments as compared to the grub population recorded in untreated plots (6.33 grubs/m²). The lowest grub population was recorded in the treatments of EC as well as AF formulation of quinalphos in 25 ml dose.

from Sandoz India Ltd., now Novartis (India) Ltd., Mumbai) and carbosulfan 25 EC were tested at 15, 20 and 25 ml per kg seeds against whitegrub in groundnut. All the groundnut seeds were treated first with carbendazim 25 per cent S D @ 3 g per kg to prevent attack of seed and soil born pathogen and then one kg of seeds were treated separately for each treatment as per method described by Patel *et al.*, 1995. The germination test of treated seeds was also conducted by sandwiching treated seeds between two discs of blotting paper. Such test was conducted 1, 3, 7 and 10 days after seed treatment and per cent germination was worked out.

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TABLE 1

Efficacy of some newer formulations of insecticides as seed treatment against whitegrub in groundnut.

Sr. No.	Treatment	Dose (ml/kg seeds)	Germination (%) 10 days after treatment	Cumulative plant mortality (%) 75 DAS	Av. No. of grubs/m ²	Yield (q/ha)	
						Pod	Dry fodder
1.	Quinalphos 25 EC	15	75.00	22.24 (28.14)*	3.00 (1.87)**	7.14	34.73
2.	Quinalphos 25 EC	20	80.00	17.24 (24.54)	1.66 (1.46)	12.00	40.08
3.	Quinalphos 25 EC	25	81.66	12.49 (20.70)	0.66 (1.05)	13.13	41.30
4.	Quinalphos 20 AF	15	75.00	23.40 (28.93)	3.00 (1.87)	7.37	35.07
5.	Quinalphos 20 AF	20	80.00	16.90 (24.28)	1.33 (1.34)	11.91	41.50
6.	Quinalphos 20 AF	25	78.33	12.05 (20.32)	0.66 (1.05)	13.33	44.36
7.	Carbosulfan 25 EC	15	83.33	23.04 (28.69)	4.33 (2.19)	6.46	34.13
8.	Carbosulfan 25 EC	20	76.33	19.93 (26.52)	2.33 (1.64)	8.98	39.38
9.	Carbosulfan 25 EC	25	76.33	19.20 (25.99)	2.00 (1.58)	9.38	40.02
10.	Control (Untreated)	—	75.00	50.71 (45.41)	6.33 (2.61)	4.19	21.22
S.Em ±			3.40	1.05	0.13	0.84	1.26
C. D. at 5 %			N. S.	3.11	0.38	2.51	3.74
C.V. %			7.45	6.62	13.36	15.58	5.68

1 DAS = Days after sowing.

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

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

The lowest dose of all the tree insecticides were less effective in crecking whitegrub population in groundnut (Table-1). Thus, the results largely corroborate the findings of earlier worker (Suthar, 1994).

Pod yield

Groundnut pod yield was significantly higher in all the seed treatments except the lowest dose of carbosulfan (15 ml/kg) than untreated plots. Among various seed treatments, quinalphos 20 AF 25 ml proved as the best treatments, quinalphos 20 AF 25 ml proved as the best treatment as it recorded the highest pod yield (13.33 q/ha) however, it was at par with similar dose of its EC formulation and 20 ml dose of either of these formulations (Table-1). Similar findings have been reported in past (Anon., 1994). Carbosulfan @ 25 ml per kg was another effective treatment (9.38 q/ha) and it was at par with its 20 ml dose and lowest dose of quinalphos AF as well as EC formulation. However, the lowest dose of carbosulfan 25 EC witnessed the lowest pod yield and was at par with untreated plots and thus, proved ineffective.

Fodder yield

The dry fodder yield (Table-1) was also significantly higher in all the seed treatments as compared to the control plots (21.22 q/ha). The highest dry fodder yield was recorded in the seed treatment of quinalphos 20 AF in 25 ml dose (44.36 q/ha) which was at par with its 20 ml dose and quinalphos 25 EC @ 25 ml dose. The next effective treatments included carbosulfan 25 EC at 25 and 20 ml dose with respect to fodder yield.

Increase in yield over control

The highest per cent increase in groundnut pod yield over control was observed in the treatment of quinalphos 20 AF 25 ml dose (218.13%) and it was closely followed by similar dose of quinalphos 25 EC (213.36%). The descending order of efficacy of seed treatments on the basis of per cent increase in pod yield over control was quinalphos 20 AF 25 ml > quinalphos 25 EC 25 ml > quinalphos 25 EC 20 ml > quinalphos 20 AF 20 ml > carbosulfan 25 EC 25 ml > carbosulfan 25 EC 20 ml > quinalphos 20 AF 15 ml > quinalphos 25 EC 15 ml > and carbosulfan 25 EC 25 ml > per kg seeds.

Similarly, the highest increase in dry fodder yield over control was also recorded in the treatment of quinalphos 20 AF 25 ml dose (109.04%) and it was closely followed by its lower dose i.e. 20 ml (95.57%) and quinalphos 25 EC 25 ml dose (94.62%). The descending order of efficacy of treatments on the basis of per cent increase in dry fodder yield over control was quinalphos 20 AF 25 ml > quinalphos 20 AF 20 ml > quinalphos 25 EC 25 ml > quinalphos 25 EC 20 ml > carbosulfan 25 EC 25 ml > carbosulfan 25 EC 20 ml > quinalphos 20 AF 15 ml > quinalphos 25 EC 15 ml > and carbosulfan 25 EC 15 ml per kg seeds.

Avoidable loss in yield

The highest avoidable loss in pod yield was recorded in untreated control plots (68.56%), followed by carbosulfan 25 EC 15 ml (51.53%), quinalphos 25 EC 15 ml (46.43%) and quinalphos 20 AF 15 ml per kg seeds (44.71%). Whereas, the lowest loss in pod yield was observed in the treatment of quinalphos 25 EC 25 ml (1.5%).

TABLE 2
Economics of various seed treatments against whitegrub in groundnut.

Sr. No.	Treatments	Total quantity of insecticides used (1/ha)		Cost of insecticides including labour charge (Rs/ha)		Average yield (q/ha)		Increase over control (%)		Avoidable loss in yield (%)		Net gain over control (Rs/ha)		Net profit (Rs/ha)	Net ICBR
		Pod	Dry fodder	Pod	Dry fodder	Pod	Dry fodder	Pod	Dry fodder	Pod	Dry fodder	Pod	Dry fodder		
1.	Quinalphos 25 EC	1.2	494	7.14	34.73	70.4	63.7	46.4	21.7	3835	676	4511	4017	1:8.13	
2.	Quinalphos 25 EC	1.6	646	12.00	40.00	186.4	88.9	9.9	9.6	10153	943	11096	10450	1:16.17	
3.	Quinalphos 25 EC	2.0	798	13.13	41.30	213.4	94.6	1.5	6.9	11622	1004	12626	11828	1:14.82	
4.	Quinalphos 20 AF	1.2	482	7.39	35.07	75.9	65.3	44.7	20.9	4134	693	4827	4345	1:9.01	
5.	Quinalphos 20 AF	1.6	630	11.91	41.50	184.2	95.57	10.7	6.4	10036	1014	11050	11420	1:16.53	
6.	Quinalphos 20 AF	2.0	778	13.33	44.36	218.1	109.0	—	—	11882	1157	13039	12261	1:15.75	
7.	Carbosulfan 25 EC	1.2	648	6.46	34.13	54.2	57.4	51.3	23.1	2951	646	3597	2949	1:4.55	
8.	Carbosulfan 25 EC	1.6	851	8.98	39.38	114.3	85.6	32.6	11.2	6227	908	7135	6284	1:7.38	
9.	Carbosulfan 25 EC	2.0	1054	9.38	40.02	123.9	88.6	29.6	9.8	6747	940	7687	6633	1:6.29	
10.	Control (Untreated)	—	—	4.19	21.22	—	—	68.6	52.2	—	—	—	—	—	—

Market price : Groundnut pod : Rs. 1300/quintal

Groundnut dry fodder : Rs. 58/quintal

Quinalphos 25 EC : Rs. 380/Litre

Quinalphos 20 AF : Rs. 370/Litre

Carbosulfan 25 EC : Rs. 508/Litre

Labour Charges : Rs. 38/day

TABLE 3

Multiple ranking for judging overall effectiveness of seed treatment in groundnut against whitegrub.

Sr. No.	Treatment	Dose (ml/kg seeds)	Cumulative plant mortality	Grub population per m ²	NICBR	Total rank	Alphabetic grade
1	Quinalphos 25 EC	15	22.24 ⁷	3.00 ⁶	1:8.13 ⁶	19	G
2	Quinalphos 25 EC	20	17.24 ⁴	1.66 ³	1:16.17 ²	9	D
3.	Quinalphos 25 EC	25	12.49 ²	0.66 ¹	1:14.82 ⁴	7	C
4.	Quinalphos 20 AF	15	23.40 ⁹	3.00 ⁶	1:9.01 ⁵	20	H
5.	Quinalphos 20 AF	20	16.90 ³	1.33 ²	1:16.53 ¹	6	B
6.	Quinalphos 20 AF	25	12.05 ¹	0.66 ¹	1:15.75 ³	5	A
7.	Carbosulfan 25 EC	15	23.04 ³	4.33 ⁷	1:4.55 ⁹	24	I
8.	Carbosulfan 25 EC	20	19.93 ⁶	2.33 ⁵	1:7.38 ⁷	18	F
9.	Carbosulfan 25 EC	25	19.28 ⁵	2.00 ⁴	1:6.29 ⁸	17	E

Thus, the highest dose of both formulations of quinalphos proved highly effective in preventing yield loss in groundnut pod. The result further indicated the highest avoidable loss in the dry fodder yield of groundnut in control (52.16%) which was followed by carbosulfan 25 EC, quinalphos 25 EC and carbosulfan 20 AF all @ 15 ml per kg seeds, wherees, the lowest yield loss was recorded in the treatment of quinalphos 20 AF @ 20 ml per kg seeds and it was closely followed by quinalphos 25 EC @ 25 ml loss in groundnut crop have been reported between 50 and 100 per cent from Gujarat, Rajasthan and Punjab (Shah *et al.*, 1975, Yadava *et al.*, 1977 and Bakhietia, 1982), which explicate the present findings.

Economics of seed treatment

Economics of seed treatment against whitegrub was worked out considering prevailing market price of insecticidal treatment including labour charges and groundnut pod as well as dry fodder yield. The results indicated highest net gain in pod

yield (Rs. 11882/ha) as well as dry fodder (Rs. 1157/ha) the treatment of quinalphos 20 AF 25 ml over control followed by quinalphos 25 EC 25 ml (Rs. 11622 for pod and Rs. 1004 per ha for dry fodder). Likewise, the highest total net gain over control was observed in quinalphos 20 AF 25 ml (Rs. 13039/ha) followed by quinalphos 20 EC 25 ml (Rs. 12626) and 20 ml (Rs. 11096/ha) and quinalphos 20 AF 20 ml per kg seeds (Rs. 11050/ha).

The results further indicated maximum net profit in the seed treatment of quinalphos 20 AF 25 ml per kg seeds (Rs. 12261/ha) and it was closely followed by same dose of quinalphos 25 EC (Rs. 11828/ha), quinalphos 20 AF 20 ml (Rs. 11420/ha) and quinalphos 25 EC 20 ml per kg seeds (Rs. 10450/ha). The net profit was obviously minimum in the seed treatment of carbosulfan 25 EC 15 ml dose (Rs. 2948.9/ha). The highest net incremental cost benefit ratio (NICBR) was observed in the seed treatment of quinalphos 20 AF 20 ml per kg

seeds (1:16.53) and it was closely followed by quinalphos 25 EC 20 ml (1:16.17), quinalphos 20 AF 25 ml (1:15.75) and quinalphos 25 EC 25 ml per kg seeds (1:14.82).

Multiple ranking for overall effectiveness of seed treatments

To judge the best treatment from view point of its efficacy against whitegrub as well as a multiple ranking system was adopted. For this purpose, three characters viz., cumulative plant mortality, grub population and NICBR were taken in to consideration. The treatment that showed lowest plant mortality was assigned numerical rank 1 (Table-3). The treatment were assigned such ranks in ascending order with increase in plant mortality. The treatments having same value of character were assigned same numerical rank. Similar rank was also assigned for grub population. In case of NICBR, the treatment that gained the highest ratio was assigned rank 1 and remaining treatment were assigned such ranks in descending order of value of NICBR. The ranks obtained by a treatment for all the three characters were added to obtain a total rank. The treatment that gained the least total rank was considered as the best treatment in all aspects and assigned an alphabetic rank 'A'. The remaining treatments were ranked from 'B' onward according to ascending order of their total rank. Thus, quinalphos 20 AF @ 25 ml per.kg seeds was adjudged as the best for seed treatment against whitegrub in groundnut and it was followed by the 20 ml dose of the same treatment quinalphos 25 EC @ 25 ml and 20 ml per kg seeds.

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Seed Bacterization for Better Quality and More Yield of Fenugreek

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ABSTRACT

The effect of combined application of *Azotobacter* with other two beneficial microbes, viz.; *Rhizobium* and *Pseudomonas striata* on fenugreek was studied. The nodular mass, shoot height and yield (1068 kg/ha) were greatly influenced by co-inoculation of *Azotobacter* and *Rhizobia*, which gave the highest net return of Rs. 3594/ha but the co-inoculation of *Azotobacter* with *P. striata* gave the highest incremental cost benefit ratio (1:55.50). The bacterization of seed could sustain the NPK content in soil.

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INTRODUCTION

In recent years due emphasis has been given to the biofertilizers use for sustainable farming. Pulse *Rhizobia* differ not only among themselves but their effectiveness also varies when used as co-inoculants (Bhatnagar *et al.* 1979 and Malik and Sanoria 1981). The seed inoculation of *Azotobacter* alone or in combination of compatible strains of *Rhizobium* fixes additional atmospheric nitrogen in addition to the secretion of considerable quantities of biologically active substance which ultimately help in enhancing the yield and quality of different crops (Rawat and Sanoria, 1977; Malik and Sanoria, 1981; Maurya *et al.* 1987). Hence field investigation was undertaken to assess the efficacy of *Rhizobia* alone and in combination with *Azotobacter* (with and without additional phosphate application) and phosphate solubilizer (*Pseudomonas striata*) on nodulation and yield under south Saurashtra Agroclimatic Zone of Gujarat.

MATERIALS AND METHODS

A field experiment (RBD) with 11 treatments (Table 2) replicated thrice was carried out in medium black soil having a pH 7.5 and fertility status of N 204.19, P 58.88 and K 358.81 kg/ha. The plot size was 5.0 x 2.0 m. The local fenugreek variety was broadcasted in the third week of November @30 kg seed/ha. Four treatments received the seed inoculation of *Rhizobia* and *Azotobacter* separately with zero and 10 kg of N/ha. Combined inoculation was tested with only 40 kg P/ha. Co-inoculation of *Azotobacter* and *P. striata* were evaluated with half recommended dose (RD) of fertilizers i.e. 10 kg N and 20 kg P/ha. The efficacy of *P. striata* was also tested with 20 kg N/ha alone and in combination with *Rhizobium* and *Azotobacter* without adding any fertilizers. The plots where no any treatment was given served as control. The chemical fertilizers N and P were substituted in the form of urea and single super phosphate.

The *Rhizobium*, *Azotobacter* and *P. striata* were cultured in Ashby's mannitol yeast extract mannitol and Pikovskaya's broth medium, respectively. The culture suspension (10^8 cfu/ml) of each bacterium were prepared from eight days old culture and used @ 25 ml/kg seed. After sixty days of sowing, ten plants were randomly selected and uprooted with soil from each plot for nodulation study. After thorough washing of root, nodules were separated, weighed while fresh and dried in hot-air oven at 70° C for dry weight. Ten randomly selected plants from each plot were studied for fresh and dry weight of root and shoot, height and number of pods at the time of harvesting. The final plot yield was also recorded after harvesting. The initial fertility status of the field for N, P and K were measured before the conduct of the trial. The final status of N, P and K was also measured from each plot after the harvest.

RESULTS AND DISCUSSION

It is evident from table-1 that the co-inoculation of *Azotobacter* with *Rhizobium* resulted in maximum nodulation (23.13/plant) followed by *Azotobacter* alone (21.72/plant). The fresh and dry weight of nodules were also significantly higher in comparison to control treatment. In both these treatments, number of pods, fresh and dry weight of shoot and roots were comparatively more indicating the additive effect of *Azotobacter* inoculation. Maurya *et al.* (1987) has also reported synergistic influence of co-inoculation of *Azotobacter* on *Rhizobium* in chickpea. The concomitant inoculation of *Azotobacter* and *P. striata* with half RD of fertilizers (i.e. 10 kg N and 20 kg P/ha) was also found significantly effective in increasing fresh and dry weight of nodulation. The shoot

height was significantly increased in the co-inoculation of *Azotobacter* and *Rhizobium* with 40 kg P/ha followed by *Azotobacter* alone with 40 kg P/ha and *Azotobacter* + *P. striata* with half RD of fertilizers (i.e. 10 kg N and 20 kg P/ha) but with at par in between. The inoculation of *Rhizobium* alone was not found effective in increasing nodules numbers, fresh and dry weight, which probably might be due to the presence of native *Rhizobium* in soil.

The seed yield of fenugreek was maximum (1068 kg/ha) in concomitant seed inoculation of *Azotobacter* with *Rhizobium* followed by *Azotobacter* alone (986 kg/ha). An increase in yield due to combined culture inoculation of *Rhizobium* with *Azotobacter* in different legumes has been reported by Malik and Sonoria (1981) and Rawat and Sanoria (1977). The co-inoculation of *Azotobacter* with *P. striata* + 10 kg N and 20 kg P/ha (968 kg/ha) and *Rhizobium* + *P. striata* (914 kg/ha) also gave significantly more yield as compared to check corroborating with the finding of Maurya *et al.* (1987).

In terms of economic returns, the highest amount of 3594 Rs/ha was obtained in the treatment of *Azotobacter* + *Rhizobium* inoculation of seeds (ICBR 1:5.43) followed by half dose of chemical fertilizers i.e. N 10 kg/ha and P 20 kg/ha with seed bacterization of *Azotobacter* (500 g / 30 kg seed) + *P. striata* (500 g/30 kg seed). Though incremental cost benefit ratio of the treatment *Azotobacter* + *P. striata* was highest (1:55.50) but net return was less in comparison to the treatment of all the three bacteria i.e. *Rhizobium*, *Azotobacter* and *P. striata* which gave the 1:46.47 ICBR.

TABLE 1

Effect of seed bacterization of endo *Azotobacter*, *Rhizobium* and *Pseudomonas striata* on various plant character of fenugreek.

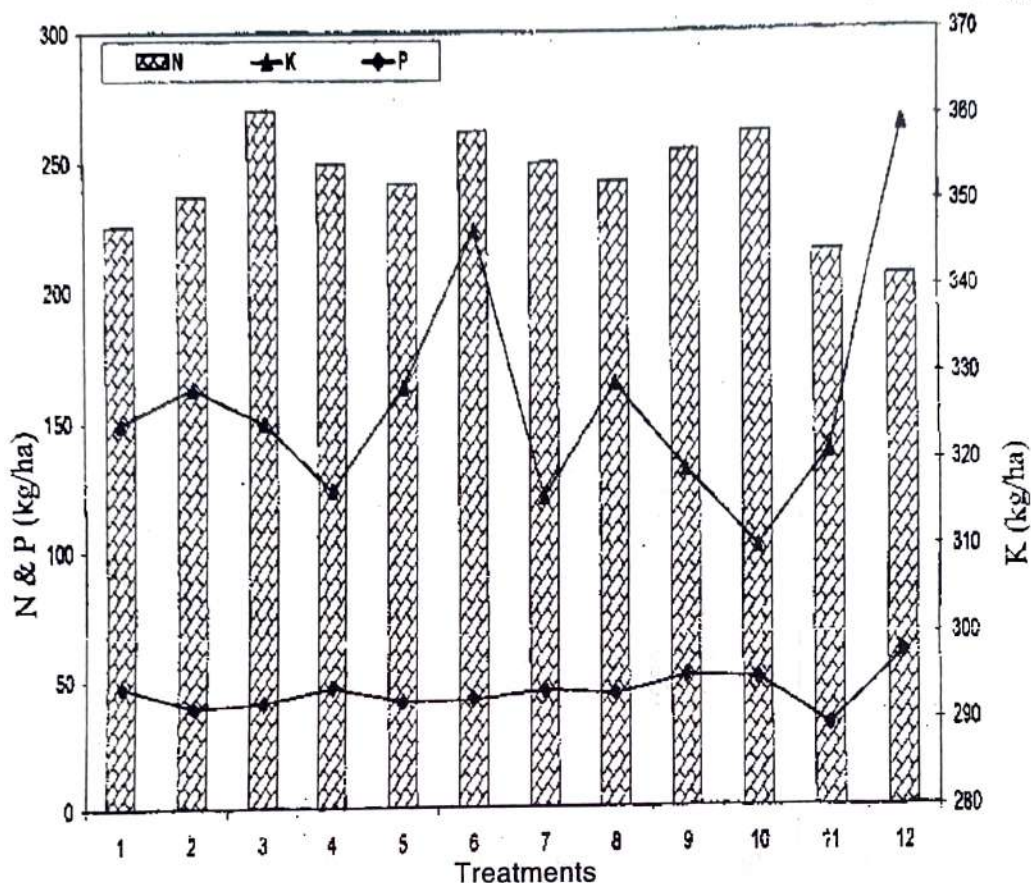
Treatment	*No. of modules/ plant	*Fresh wt. of nodules/ plant (mg)	*Dry wt. of nodules/ plant (mg)	*Pods/ plant	*Fresh wt. of shoot/ plant (g)	*Dry wt. of shoot/plant (g)	*Shoot height (cm)	*Fresh wt. of root/ plant (g)	*Dry wt. of root/plant (g)
T ₁	16.53	113.33	50.33	20.73	29.53	6.62	48.56	0.94	0.41
T ₂	21.72	161.66	64.88	23.91	36.25	8.76	55.31	1.39	0.66
T ₃	23.13	175.55	72.55	26.82	39.84	10.46	58.35	1.30	0.69
T ₄	20.56	133.88	57.33	22.82	30.20	8.14	53.57	1.13	0.60
T ₅	15.76	113.33	50.00	20.32	stet 27.95	6.52	48.06	0.87	0.33
T ₆	17.33	120.55	58.77	21.17	30.16	7.07	50.16	0.95	0.45
T ₇	19.83	126.66	57.00	22.00	30.44	7.21	50.91	1.01	0.57
T ₈	20.96	152.22	63.94	23.61	33.46	8.54	54.40	1.21	0.61
T ₉	20.38	142.11	57.27	22.65	31.21	7.40	53.56	1.09	0.59
T ₁₀	15.10	100.44	43.66	20.07	25.81	6.28	47.10	0.81	0.37
T ₁₁	14.37	98.33	37.22	15.35	24.17	5.78	45.24	0.74	0.36
S.Em ±	2.44	12.37	6.18	2.16	3.16	0.96	1.43	0.154	0.111
C.D. at 5%	NS	36.49	18.24	NS	NS	NS	4.04	NS	NS
C. V. %	8.94	7.30	9.68	6.86	5.62	17.90	9.04	12.81	28.75

* Average of ten plants.

TABLE 2
Effect of seed bacterization of endo *Azotobacter*, *Rhizobium* and *Pseudomonas striata* on grain yield of fenugreek.

Sr. No.	Treatment	Yield kg / ha			Pooled yield (kg/ha)	Net return (Rs.)	I.C.B.R.	Test weight (1000 seed)
		1995-96	1996-97	1997-98				
1.	Rhizo. + 40 kg P/ha	1155	770	486	803	429	1 : 1.53	9.5
2.	Azo. + 40 kg P/ha	1438	947	573	986	2625	1 : 4.30	13.5
3.	Rhizo + Azo. + 40 kg P/ha	1641	983	580	1068	3594	1 : 5.43	13.8
4.	N-P-K (20-40-0 kg/ha)	1286	876	451	871	1086	1 : 2.14	12.0
5.	Azo. + 10 kg N + 40 kg P	1113	763	486	787	145	1 : 1.16	9.0
6.	Rhizo. + 10 kg N + 40 kg P	1228	860	528	872	1165	1 : 2.31	10.0
7.	Azo. + <i>P. striata</i>	1248	870	540	886	2180	1 : 55.50	10.5
8.	Azo. + P.S. + 10 kg N + 20 kg P	1428	910	567	968	2687	1 : 6.20	13.0
9.	Rhizo. + Azo. + <i>P. striata</i>	1311	883	548	914	2501	1 : 46.47	11.0
10.	<i>P. striata</i> + 20 kg N / ha	1065	707	468	746	33	1 : 2.88	10.0
11.	Contol	1060	633	410	701	—	—	10.0
	S. Em. ±	11.66	22.46	1.35	42.0	—	—	—
	C. D. at 5%	34.38	66.26	3.99	123.0	—	—	—
	C. V. %	11.58	14.65	14.57	12.90	—	—	—

Rhizo. : *Rhizobium*, Azo. : *Azotobacter*



Final N, P & K status after harvest, Initial

Fig. 1. N, P & K balance in soil

Bacterization could be able to fulfill the nitrogen and phosphorus requirement through efficient way from the soil as evident from the result on soil analysis before sowing and after harvesting of crop for N, P and K content. *Azotobacter* in combination with *Rhizobium* application, the nitrogen level was increased (217 kg/ha) as against initial level of nitrogen (204.19 kg/ha).

The present findings reveal that seed bacterization with *Azotobacter* + *Rhizobium* can contribute for better quality and more yield of fenugreek.

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Personal and Socio-Economic Characteristics of the Coconut Growers in Valsad District (South Gujarat)

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ABSTRACT

To study the personal and socio-economic characteristics of the coconut growers in Valsad district (South Gujarat) a diagnostic survey study was carried out from N. M. College of Agriculture, Gujarat Agricultural University, Navsari Campus, Navsari during the year 1996-97. In all, 50 farmers were selected from 36 villages of six talukas in Valsad district.

Sixty per cent of the respondents were from middle age group and sixty two per cent respondents were from literate upto secondary levels of education, while eighty two per cent had farming as main occupation. Fifty eight per cent of the respondents possessed land below 5 hectares, which includes small and medium size groups. Seventy two per cent respondents belonged to joint family and fifty eight per cent was found as medium size of family. Eighty per cent of the respondents possessed coconut garden holding below 2 hectares.

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INTRODUCTION

Coconut (*Cocos nucifera* L.) is an important commercial plantation crop of the tropical region. It is being cultivated since time immemorial, as references are available in various literatures including Ramayana. The coconut palm eulogised as 'Kalpavriksha' and 'Tree of Heaven'. It provides not only edible products but also fuel, shelter, medicine and employment to the millions of people in the tropics. More than 10 million families directly and indirectly depends upon it for their livelihood (Nampoothiri *et al.* 1998).

Personal and socio-economic characters of farmers viz., age, education, occupation, size of land holding, type and size of family and size of coconut garden

holding are important factors, which influence the adoption of improved agricultural technology. Considering this, it was decided to study the socio-economic characteristics of the respondents.

MATERIALS AND METHODS

The field study survey was conducted during the 1996-97 by using random sampling technique. From the eight talukas in the Valsad district of South Gujarat, six talukas were selected for this survey study. In all, 50 coconut growers (Respondents) were randomly selected from 36 villages of six talukas. The randomization was done with the help of computer. The coconut growers were contacted individually on their farm and the data were collected by using a pre-tested interview schedule for socio-

economic characteristics of respondents such as age, education, occupation, size of land holding, type of family, size of family and size of coconut garden holding. According to the personal and socio-economic characteristics, the respondents were grouped into different categories.

RESULTS AND DISCUSSION

The data regarding personal and socio-economic characteristics of the respondents were analyzed and presented in Table 1 to 7 and graphically depicted in Fig.

Age

The data regarding age group are presented in Table 1 and graphically represented in Fig. 1. Sixty per cent of the respondents belonged to middle age group followed by 34 and 6 per cent of the respondents who

belonged to old and young group, respectively. The farmers of middle age group might have good experience and seem able to do coconut farming whereas the old age and young age groups of family were dominated by middle age farmers and both the extreme groups might not be able to shoulder the responsibility of doing farming. These findings are in accordance with those reported by Tarpara (1981), Naik (1982), Chawkedar (1984), Prajapati (1987), Roy (1991) Talati (1991), Swaminathan *et al.* (1991), Patel (1993), Jondhale *et al.* (1993) and Desai (1994) who have worked on different crops like mango, chiku, tea and agro-forestry. Contrary to this, Shanmukappa (1978) found non-significant association between age and adoption behaviour of arecanut growers.

Education

TABLE 1

Distribution of the respondents according to their age.

Sr. No.	Age group	Respondents (No. 50)	
		Number	Per cent
1.	Young age group (up to 30 years)	03	06
2.	Middle age group (31 to 50 years)	30	60
3.	Old age group (above 50 years)	17	34
Total		50	100

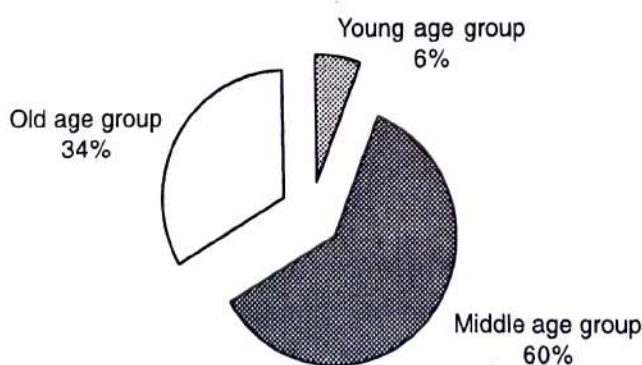


Fig. 1 : Distribution of the respondents in percentage according to their age.

It is believed that the level of education of the farmers plays a vital role in grasping new innovation and advanced agriculture technology. The data presented in Table 2 and graphically shown in Fig. 2 revealed that 90 per cent of the respondents were literate, while only 10 per cent were found illiterate.

These findings are in conformity with those of Tarpara (1981), Patel (1982), Naik (1982), Chawkedar (1984), Prajapati (1987), Roy (1991), Talati (1991), Patel (1993) and Desai (1994) who have worked on different crops.

TABLE 2

Distribution of the respondents according to their education level.

Sr. No.	Category	Respondents (No. 50)	
		Number	Per cent
1.	Illiterate	05	10
2.	Primary education	09	18
3.	Secondary education	31	62
4.	College level education	05	10
Total		50	100

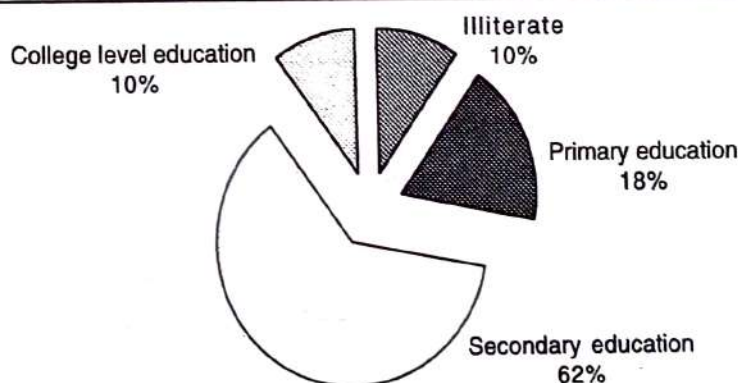


Fig. 2 : Distribution of the respondents in percentage according to their educational level.

Occupation

The data presented in Table 3 revealed that 82 per cent respondents were completely dependent on farming followed by 16 per cent who were engaged in farming + business, while 2 per cent respondents had farming + labour work and it was zero per cent in case of respondents having farming + service. The trend of the results seems to be correct because more than

75 per cent people are engaged in farming only in our country. These findings are in accordance with those of Bhatol (1987), Patel (1991) and Talati (1991) working on paddy, cotton and banana, respectively. Contradictory report is therefrom Shanmukappa (1978) who had found non-significant association between education and adoption behaviour of coconut growers.

TABLE 3

Distribution of the respondents according to thier occupation.

Sr. No.	Occupation	Respondents (No. 50)	
		Number	Per cent
1.	Farming only	41	82
2.	Farming + business	08	16
3.	Farming + labour work	01	02
4.	Farming + service	—	—
Total		50	100

Size of land holding

The data are presented in Table 4 and graphically depicted in Fig. 3. It revealed that 46 per cent of the respondents had medium size of land holding followed by 42 per cent of the respondents having large size of land holding, while only 12 per cent of the respondents had small size of land holding. These findings regarding small holding in coconut tallied with those of Markose and Poduval (1993) and Satyabalan (1994) working on coconut.

Type of family

Type of family is an important social factor. The data presented in Table 5 indicated that majority of the respondents i.e. 72 per cent were from joint family, while 28 per cent were from nuclear family. These present findings regarding joint family and nuclear family are in confirmation with those of Tarpara (1981), Chawkedar (1984), Prajapati (1987), Kulkarni *et al.* (1990) and Desai (1994) who worked on various crops.

TABLE 4

Distribution of the respondents according to their size of land holding.

Sr. No.	Size of land holding	Respondents (No. 50)	
		Number	Per cent
1.	Small holding (up to 2.00 hectares)	06	12
2.	Medium holding (2.1 to 5.00 hectares)	23	46
3.	Large holding (above 5.00 hectares)	21	42
Total		50	100

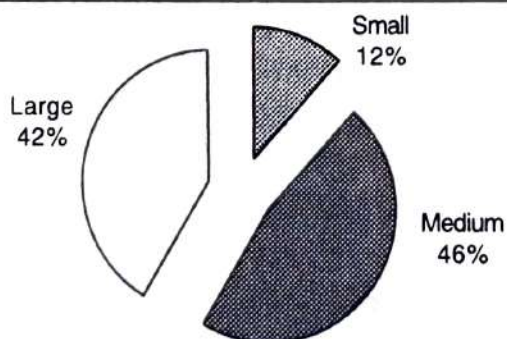


Fig. 3 : Distribution of the respondents in percentage according to their size of land holding.

TABLE 5

Distribution of the respondents according to thier type of family.

Sr. No.	Type of family	Respondents (No. 50)	
		Number	Per cent
1.	Nuclear family	14	28
2.	Joint family	36	72
Total		50	100

Size of family

It is clear from the data presented in Table 6 that 38 and 58 per cent respondents belonged to small and medium size of families, respecitvely ; while only 4 per cent respondents belonged to large size of family. These findings are in accordance with those reported by Tarpara (1981), Chawkedar (1984), Prajapati (1987), Anonymous (1990), Patel (1993) and Desai (1994) working on various crops.

TABLE 6

Distribution of the respondents according to their size of family.

Sr. No.	Size of family	Respondents (No. 50)	
		Number	Per cent
1.	Small (up to 5 members)	19	38
2.	Medium (6 to 10 members)	29	58
3.	Large (above 10 members)	02	04
Total		50	100

TABLE 7

Distribution of the respondents according to their size of coconut garden holding.

Sr. No.	Size of coconut garden	Respondents (No. 50)	
		Number	Per cent
1.	Marginal coconut garden holding (up to 0.2 hectare)	07	14
2.	Small coconut garden holding (0.21 to 1.0 hectare)	23	46
3.	Medium coconut garden holding (1.1 to 2.0 hectares)	10	20
4.	Marginal coconut garden holding (above 2.0 hectares)	10	20
Total		50	100

Size of coconut garden holding

The data presented in Table 7 and graphically shown in Fig. 4 revealed that 46 per cent respondents had small size of coconut garden holding and 14 per cent of the respondents belonged to marginal size of coconut garden holding, while 20 per cent respondents were observed equally for medium as well as large size of coconut holdings. These findings are in agreement

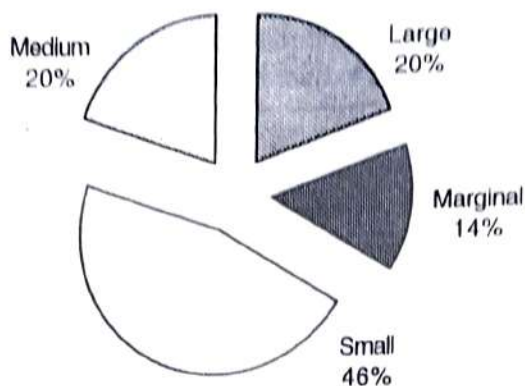


Fig. 4 : Distribution of the respondents in percentage according to their size of coconut garden holding.

with those reported by Thampan (1976 and 1988).

It can be summarized from the findings of this study that socio-economic characters of the farmers have definite role in adoption of improved agricultural technology in coconut cultivation.

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Economic Gain Through Adoption of Drip Irrigation System in Mango Orchard

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ABSTRACT

The present study was carried out in six talukas of Junagadh district in Gujarat to ascertain the extent of economic gain accrued by the mango orchard growers as a result of adoption of drip irrigation system (DIS). 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 majority (71.43 per cent) of the respondents had accrued medium level of overall economic gain of DIS. It is also reflected from the study that majority of the respondents had benefitted 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 fertilizers 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 DIS. Moreover, it is also stated that respondents education, farm power, credit orientation, economic motivation, innovativeness, risk preference, scientific orientation, attitude towards DIS, knowledge level about DIS, satisfaction with DIS, contact with extension agencies and utilization of information sources had positive and significant relationship with their extent of economic gain reaped through adoption of DIS.

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INTRODUCTION

The agriculture sector occupies a prominent place in the economy of Gujarat. The contribution of agriculture sector is around 35 to 40 per cent in state domestic product. However, such contribution is not stable as agriculture in Gujarat mainly depends on its erratic and irregular pattern of rainfall. To solve the above said problem to some extent, drip irrigation system was introduced in Gujarat State with assumption that its wide sprayed adoption will generate a dynamic spark resulting into the techno-economic developments among the mango orchard growers. The consequent effects of drip irrigation system are reflecting in terms of generating more income from agriculture by saving of water, labour, fertilizers and plant protection measures, improving yields

and quality of produce, which ultimately improving the overall economic condition of mango orchard growers. Hence, there is an absolute need to know which benefits of drip irrigation system in terms of economic gain are attained by the mango orchards growers. Looking to the above said facts the present study was carried out to ascertain the extent of economic gain accrued by the mango orchard growers as a result of adoption of drip irrigation 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 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 growers of the twenty four selected villages with the help of interview schedule.

Extent of economic gain

It is operationalised as the degree to which the mango orchard growers accrued the benefits of DIS in terms of economic aspects. A list of seven aspects concerning the economic gain of DIS was prepared in consultation with the agronomists, horticulturists, economists, water management scientists and irrigation engineers. Before and after approach was followed for getting information about each aspect. The scoring procedure adopted for these aspects was as under :

Saving in water

Actual area increased in hectare (s) under irrigation was taken as saving in water after deducting the area under irrigation from the area prior to adoption of DIS. Scoring was done based on $\text{Mean} \pm \text{S.D.}$

Saving in fertilizers cost

Saving in cost of chemical fertilizers was taken as benefit after deducting the cost of chemical fertilizers from the cost prior to adoption of DIS. Scoring was followed on the basis of Mean.

Saving in plant protection cost

Saving in cost of plant protection measures was taken as benefit after deducting the cost towards plant protection measures from the cost prior to adoption of DIS. Scoring was done based on Mean.

Saving in weed control expenses

Saving in expenses towards weed control was taken as benefit after deducting the weed control expenses from the expenses prior to adoption of DIS. Scores were assigned based on $\text{Mean} \pm \text{S.D.}$

Saving in labour utilization

Saving in labour utilization after adoption of DIS was taken as benefit i.e. difference between mandays / year required prior to adoption and after adoption of DIS. Scoring procedure was adopted based on $\text{Mean} \pm \text{S.D.}$

Increase in fruit production

Increase in fruit production after adoption of DIS was taken as benefit i.e. difference between fruit production / ha prior to adoption and after adoption of DIS. Scoring was followed based on $\text{Mean} \pm \text{S. D.}$

Improving quality of produce

- I. Increasing fruit size in terms of volume :
Increase in fruit size after adoption of DIS was taken as benefit. Scoring was done based on $\text{Mean} \pm \text{S. D.}$
- II. Increasing fruit size in terms of weight :
Difference between no. of fruits per 20 kg weight prior as adoption and after adoption of DIS was taken as benefit.

Scoring procedure followed on the basis of Mean $\pm$ S. D.

- III. Early maturity of fruits :
Early maturity of fruits was taken as benefit after adoption of DIS i.e. difference between fruit maturity days prior to adoption and after adoption of DIS. Scores were based on Mean.
- IV. Higher market price of the produce :
Higher market price of the produce was taken as benefit after adoption of DIS. Scoring procedure was followed on the basis of Mean $\pm$ S. D.

In order to obtain overall economic gain of all the seven aspects (combined extent of economic gain) for an individual respondent, the score obtained for each aspect was summed up. The total score obtained by the respondents indicated their 'extent of economic gain'. The respondents were classified into three categories viz., low (below Mean - S. D.), medium (in between Mean $\pm$ S. D.) and high (above $\pm$ S.D.)

TABLE 1

Distribution of respondents according to the extent of economic gain accrued by them.

N = 175

Sr. No.	Category	Score range	Frequency	Per cent
1.	Low	Upto 11	36	20.57
2.	Medium	12 to 20	125	71.43
3.	High	Above 20	14	8.00

Mean = 15.486

SD - 4.879

It can be seen from the data presented in Table-1, that majority (71.43 per cent) of the respondents were having medium level of overall economic gain, followed by 20.57 per cent respondents with low level of overall economic gain. Whereas only 8.00 per cent of respondents had accrued high level of

RESULTS AND DISCUSSION

The extent of economic gain in this study is the degree which the mango orchard growers accrued the benefits of drip irrigation system in terms of economic aspects. The extent of benefits that accrued after adoption of drip irrigation system viz., saving in water, saving in fertilizers and plant protection cost, saving in weed control expenses, saving in labour utilization, increase in fruit production and improving quality of produce with respect to increase in fruit size, early maturity of fruits and higher market price of the produce was considered as extent of economic gain of drip irrigation system. The information on these aspects was collected and the respondents were classified into three categories viz., low (upto 13 score), medium (in between 14 to 18 score) and high (above 18 score). The data presented in Table - 1.

overall economic gain of drip irrigation system.

It can be concluded that majority of the respondents (71.43 per cent) were having medium level of overall economic gain. This finding is in line with the findings of Bankar (1989), Nagare (1989), Rao (1989), Tilekar (1989), Thorat and Bhoite (1992).

Scoring procedure followed on the basis of Mean $\pm$ S. D.

- III. Early maturity of fruits :
Early maturity of fruits was taken as benefit after adoption of DIS i.e. difference between fruit maturity days prior to adoption and after adoption of DIS. Scores were based on Mean.
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Nature of benefits of drip irrigation system

TABLE 2

Distribution of respondents according to the nature of benefits of drip irrigation system accrued by them.

N - 17'

Nature of benefits	Respondents	
	Frequency	Per cent
1	2	3
Saving in water		
(i) Upto 25 per cent saving	1	00.57
(ii) 26 to 50 per cent saving	38	21.72
(iii) 51 to 75 per cent saving	100	57.14
(iv) More than 75 per cent saving	36	20.57
Saving in fertilizers cost		
(i) No saving	76	43.43
(ii) Upto 15 per cent saving	15	8.57
(iii) 16 to 30 per cent saving	22	12.57
(iv) 31 to 45 per cent saving	45	25.72
(v) More than 45 per cent saving	17	9.71
Saving in plant protection cost		
(i) No saving	61	34.86
(ii) Upto 15 per cent saving	20	11.43
(iii) 16 to 30 per cent saving	75	4.86
(iv) 31 to 45 per cent saving	7	4.00
(v) More than 45 per cent saving	12	6.85
Saving in weed control expenses		
(i) Upto 25 per cent saving	9	5.14
(ii) 26 to 50 per cent saving	98	56.00
(iii) 51 to 75 per cent saving	43	24.57
(iv) More than 75 per cent saving	25	14.29
Swing in labour utilization		
(i) Upto 25 per cent saving	2	1.14
(ii) 26 to 50 per cent saving	62	35.43
(iii) 51 to 75 per cent	97	55.43
(iv) More than 75 per cent saving	14	8.00
Increase in fruit production		
(i) No increase	56	32.00
(ii) Upto 10 per cent increase	11	6.29
(iii) 11 to 20 per cent increase	86	49.14
(iv) More than 20 per cent increase	22	12.57

1	2	3
Improving quality of produce		
Increase in fruit size (by volume)		
(i) No increase	34	19.43
(ii) Upto 25 per cent increase	136	77.71
(iii) More than 25 per cent increase	5	2.86
Early maturity of fruits		
(i) No difference	94	53.72
(ii) Upto 5 days early maturity	9	5.14
(iii) 6 to 10 days early maturity	64	36.57
(iv) More than 10 days early maturity	8	4.57
Higher market price of the produce (in Rs. / Quintal)		
(i) No difference	42	24.00
(ii) Upto Rs. 50 higher price	11	6.29
(iii) Rs. 51 to Rs. 100 higher price	58	33.14
(iv) Rs. 101 to Rs. 150 higher price	49	28.00
(v) More than Rs. 150 higher price	15	8.57

The mango orchard growers had reaped many advantages of drip irrigation system. Majority (i.e. 57.14 per cent, 56.00 per cent and 55.43 per cent) of the respondents had benefited by saving of water (51 to 75 per cent), weed control expenses (26 to 50 per cent) and labour for irrigation and inter-culture operations (51 to 75 per cent), respectively. A little more than one-fourth (25.72 per cent) of the respondents availed the benefit in respect of fertilizers economy to the extent of 31 to 45 per cent. Considerable number (42.86 per cent) of them could save in plant protection cost to the tune of 16 to 30 per cent. About half (49.14 per cent) of the

mango orchard growers expressed that the yields could also be increased by about 11 to 20 per cent. As regards the increase in size of mango fruit by volume, in majority (77.71 per cent) cases the fruit size got increased by about 25 per cent. Apart from this, nearly two-fifth (36.57 per cent) of the respondents had obtained early maturity of mango fruits by 6 to 10 days. However, more than 50% of respondent had obtained no difference maturity time of fruits. In case of higher market price of the produce, majority cases (61.14 per cent) received higher price ranged from Rs. 51 to Rs. 150 per quintal under drip system of irrigation.

TABLE 3

Zero order correlation coefficient between the personal - social, agro-economic, psychological, communication characteristics of the respondents and different variables.

N = 175

Sr. No.	Independent variables	Correlation coefficients (<i>r</i> values) Extent of Economic Gain
I.	Personal - Social	
1.	Age	-0.0973
2.	Education	0.2428 **
3.	Caste	0.0680
4.	Type of family	-0.0994
5.	Size of family	-0.0493
6.	Social participation	0.0746
7.	Socio-economic status	0.0930
II.	Agro-Economic	
8.	Occupation	0.0488
9.	Farm power possessed	0.01662 *
10.	Material possession	0.0732
11.	Herd size	-0.1135
12.	Size of land holding	0.0226
13.	Area under DIS	0.0102
14.	Area under mango orchard	0.0030
15.	Irrigation potentiality	-0.0088
16.	Cropping intensity	-0.0864
17.	Annual income	-0.0886
18.	Credit orientation	0.2439 **
III.	Psychological	
19.	Economic motivation	0.2302 **
20.	Innovativeness	0.2176 **
21.	Risk-preference	0.3157 **
22.	Scientific orientation	0.4143 **
23.	Attitude towards DIS	0.6750 **
24.	Knowledge level about DIS	0.5450 **
25.	Satisfaction with DIS	0.5660 **
IV.	Communication	
26.	Contact with extension agency	0.2606 **
27.	Utilization of information sources	0.1484 *

* Significant at 0.05 level of probability.

** Significant at 0.01 level of probability.

Among the selected characteristics of the respondents, education, farm power, credit orientation, economic motivation, innovativeness, risk-preference, scientific orientation, attitude towards drip irrigation system, knowledge level about drip irrigation system, satisfaction with drip irrigation system, contact with extension agencies and utilization of information sources had positive and significant relationship with their extent of economic gain reaped through adoption of drip irrigation system. While, the variables namely age, caste, type of family, size of family, social participation, socio economic status, occupation, material possession, herd size, size of land holding, area under drip irrigation system, area under mango orchard, irrigation potentiality, cropping intensity and annual income of the respondents had no significant relationship with their extent of economic gain of drip irrigation system.

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An Analysis of Consumption Pattern in Rural and Urban Sectors of Amreli District (Gujarat)

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ABSTRACT

The study on the analysis of consumption pattern is a pre-requisite of a planned economy so as to enable the planners to have a precise knowledge of the future demand of different commodities and to match supply with changing pattern of demand. The required data on monthly per capita expenditure for various items of consumption in rural and urban sectors of Amreli district were collected by survey method in three different seasons during the year 1995. For studying the relation between income and consumption, Engel curves were fitted to the consumer expenditure data pertaining to survey method and expenditure elasticities were estimated. For milk and milk products (TM) and total 'food' (TF), relatively higher proportionate expenditure in rural area as compared to urban area was observed. Whereas, for total 'non-food' commodity expenditure groups, it was higher in urban area. A single common form of Engel function could not be identified for 'food' and 'non-food' commodity expenditure groups in various seasons. However, Log Parabolic (LP) and Double Log (DL) functions were most appropriately fitted for different main commodity groups in rural and urban sectors. As expected, total 'food' (TF) expenditure appeared to be slightly inelastic in both the sectors, while total milk and milk products (TM) and total 'non food' (TNF) expenditure. were identified as highly elastic commodities in both the sectors.

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INTRODUCTION

The pace of development determining changes in almost all economic parameters affecting standard of living. The level of consumption is one of the most important indicators of the process of development. A comparative study of consumer's expenditure in rural and urban areas will show light on the rural urban differences in consumption pattern and on some of the growth parameters in rural economy in India. It is, therefore, natural to expect sizeable

variation in the consumption pattern with respect to different consumer goods in different regions. Based on the household budget expenditure data for the one full month in three different rounds (seasons), a number of studies have been conducted by different workers. Most of these studies were mainly aimed at estimating expenditure and income elasticities for food and nonfood items. But there exists a dearth of such literature particularly in Gujarat. In the present study, an attempt has therefore, been made

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to explain the variations observed in the pattern of consumer expenditure in the rural and urban sectors of Amreli district of Saurashtra.

MATERIALS AND METHODS

Consumer expenditure data used in the present analysis have been collected by personal enquiry method through a specially structured schedule for a reference period of 30 days preceding the day of visit. A multistage stratified sampling technique was adopted for the selection of sample households. Amreli district of Gujarat state was purposively selected for the present investigation. The data were collected separately for rural and urban sectors during the year 1995. The survey was carried out in three rounds, each round with the same set of households and in the duration of approximately two months. The family budget data were collected for the one full month i.e. February, May and August, 1995, representing three different seasons viz., Winter (W), Summer (S), Monsoon (M), respectively. The selected households were sub-groups into urban and rural areas and, a sample of 112 households from rural areas and 99 households from urban areas were chosen at random, as the ultimate sampling unit.

The items of expenditure considered in this study were liquid milk, ghee, butter and other milk products i.e. TM (total expenditure on milk and milk products), cereals, pulses, sugar and gur, fruits, oils, spices and vegetables i.e. TF (total expenditure on other food items) and non-food items consisted of fuel and light, housing, clothing, medical expenses, education, social activities, intoxicants etc.

The choice of an algebraic specification of the Engel function is of some importance since different equations imply different behavioural assumptions. Moreover, the expenditure (income) elasticities estimates, may be sensitive to the type of equation fitted to the data. Therefore, in the present study, ten alternative forms of Engel functions were fitted for each commodity in both the sectors (Table - 1). In every case, per capita commodity expenditure has been regressed on total consumer expenditure by the method of least squares. The final choice about the appropriateness of the Engel function was based on sign and significance of the coefficients and adjusted coefficient of multiple determination (R^2). The Gini concentration ratio were used as an index for measuring the inequality in the total expenditure.

The Gini concentration ratio was calculated with the help of following formula :

$$L = 1 - \sum_{i=1}^K P_i(Q_i + Q_i - 1)$$

Where,

L = Gini ratio

P_i = Proportion of persons lying in i th PCTE* class ($i=1, 2, \dots, K$).

$Q_i = \sum_{i=1}^j P_i$ = Cumulative share of expenditure consumed by those with the units in the bottom, classes

Where,

$$Q_i = \frac{\sum_{j=1}^i P_j X_j}{\sum_{j=1}^K P_j X_j} \quad j = 1, 2, \dots, K$$

PCTE* = Per capita monthly total expenditure.

Where,

X_i = Average per capita consumer expenditure on a particular commodity i^{th} PCTE class for each item and total expenditure.

TABLE 1

Alternative forms of Engel function.

Sr. No.	Engel function (Symbol)	Algebraic equation	Elasticity coefficient
Two parameters function			
1.	Linear (L)	$Y_{ij} = a_i + b_i X_j$	$b (X/Y_i)$
2.	Hyperbolic (H) / Inverse (I)	$Y_{ij} = a_i + b_i / X_j$	$(-b/X) (1/Y_i)$
3.	Semi - log (SL)	$Y_{ij} - a_i = b_i \ln X_j$	b/Y_i
4.	Double log (DL) / Log linear (LL)	$\ln Y_{ij} - a_i + b_i \ln X_j$	b
5.	Log inverse (LI)	$\ln Y_{ij} - a_i + b_i / X_j$	$-b/X$
6.	Exponential (E)	$\ln Y_{ij} - a_i + b_i X_j$	bX
Three parameters function			
7.	Parabolic (P)	$Y_{ij} - a_i + b_i X_j + c_i X_j^2$	$(b+2cX) (X/Y_i)$
8.	Semi log inverse (SLI)	$Y_{ij} = a_i + b_i \ln X_j + c_i / X_j$	$(b-c/X) (1/Y_i)$
9.	Log log inverse (LLI)	$\ln Y_{ij} = a_i + b_i \ln X_j + c_i / X_j$	$b - c/X$
10.	Log parabolic (LP)	$\ln Y_{ij} = a_i + b_i X_j + c_i X_j^2$	$(b + 2cX) X$

Where,

Y_{ij} = Per capita monthly consumption / expenditure on i^{th} commodity in the j^{th} household.

X_j = Per capita monthly total expenditure in j^{th} household.

Y_j = Average monthly consumption / expenditure of i^{th} commodity.

X_i = Average total expenditure.

a_i , b_i and c_i are the parameters of a return pertaining to the i^{th} commodity in the equation.

RESULTS AND DISCUSSION

Per Capita Consumer Expenditure on Different Commodity Groups

The average per capita expenditure on different commodity groups along with their relative share in total monthly expenditure for

rural as well as urban sectors for different seasons in Amreli district are presented in Table 2, 3 and 4. The per capita total expenditure in urban areas was relatively higher as compared to rural areas in different seasons. This is possible, presumably because of the higher expenditure on non-food items and the higher prices of consumer goods in the urban areas. Similar

results were obtained by Singh and Patel (1982), Jain (1983) and Prasher *et al.* (1992).

Table 2, 3 and 4 further reveals that the average per capita monthly expenditure on TM and TF commodity groups were relatively higher in rural areas as compared to urban areas while the expenditure on TNF commodities was relatively more in urban areas in different seasons. Food items (TM + TF) accounted for about 76 per cent of the total consumer expenditure (TOT) in rural

area and the remaining 24 per cent was accounted for non-food items (TNF) in winter season. The corresponding figures for urban area was 61 and 39 per cent. A relatively higher proportionate expenditure on food items in the rural sector, and non-food items in the urban sector in summer and monsoon seasons observed in the present study was quite expected and is in agreement with the findings of Jain (1983), Singh and Gangwar (1986) and Prasher *et al.* (1992).

TABLE 2

Average per capita monthly expenditure on different commodity groups during winter season.

Items	Rural		Urban	
	Expenditure (Rs.)	Percentage to total expenses	Expenditure (Rs.)	Percentage to total expenses
A. Food Items				
1. Milk and Milk products				
Liquid milk	78.49	47.41*	82.54	52.37*
Ghee	64.89	38.59*	43.56	27.64*
Other milk products	24.25	14.65*	31.27	19.84*
Total milk and milk products (TM)	165.56	30.83	157.62	26.01
2. Other food items				
Cereals	74.87	13.94	45.78	7.55
Pulses	4.79	0.89	6.54	1.08
Sugar and Gur	26.31	4.90	21.12	3.48
Fruits	16.65	3.10	27.53	4.54
Oils	82.31	15.33	71.08	11.73
Spices	23.07	4.30	18.32	3.02
Vegetables	14.90	2.77	18.68	3.08
Total other food (TF)	242.68	45.19	209.25	34.53
3. Total food items (1+2)	408.24	76.02	366.87	60.53
B. Non Food Items (TNF)	130.86	24.37	237.99	39.27
C. Total Expenditure (TOT)	536.99	100.00	606.07	100.00

* Percentage to the total expenditure on milk and milk products.

TABLE 3

Average per capita monthly expenditure on different commodity groups during summer season.

Items	Rural		Urban	
	Expenditure (Rs.)	Percentage to total expenses	Expenditure (Rs.)	Percentage to total expenses
A. Food Items				
1. Milk and Milk products				
Liquid milk	73.50	48.23*	71.14	52.21*
Ghee	64.78	42.51*	46.68	34.26*
Other milk products	14.12	9.27*	18.52	13.59*
Total milk and milk products (TM)	152.39	29.60	136.25	25.14
2. Other food items				
Cereals	77.37	15.03	44.51	8.21
Pulses	7.74	1.50	7.45	1.37
Sugar and Gur	24.08	4.68	21.76	4.01
Fruits	4.64	0.90	5.95	1.09
Oils	62.85	12.21	75.73	13.97
Spices	21.55	4.19	17.94	3.31
Vegetables	11.48	2.23	12.35	2.28
Total other food (TF)	209.48	40.69	185.98	34.31
3. Total food items (1+2)	361.87	70.29	322.23	59.45
B. Non Food Items (TNF)	153.43	29.80	217.44	40.12
C. Total Expenditure (TOT)	514.82	100.00	541.99	100.00

* Percentage to the total expenditure on milk and milk products.

TABLE 4

Average per capita monthly expenditure on different commodity groups during monsoon season.

Items	Rural		Urban	
	Expenditure (Rs.)	Percentage to total expenses	Expenditure (Rs.)	Percentage to total expenses
A. Food Items				
1. Milk and Milk products				
Liquid milk	74.95	58.72*	70.73	56.44*
Ghee	40.66	31.86*	37.54	29.96*
Other milk products	12.44	9.75*	17.06	13.36*
Total milk and milk products (TM)	127.64	29.38	125.31	24.33
2. Other food itmes				
Cereals	56.95	13.11	39.86	7.74
Pulses	4.26	0.98	6.31	1.23
Sugar and Gur	22.74	5.23	16.96	3.29
Fruits	7.04	1.62	7.99	1.55
Oils	62.09	14.29	46.84	9.09
Spices	13.59	3.13	17.46	3.39
Vegetables	18.68	4.30	20.27	3.94
Total other food (TF)	185.15	42.62	155.70	30.23
3. Total food items (1+2)	312.79	71.99	281.01	54.56
B. Non Food Items (TNF)	122.75	28.25	233.92	45.42
C. Total Expenditure (TOT)	434.47	100.00	515.03	100.00

* Percentage to the total expenditure on milk and milk products.

The Gini coefficients of inequality in consumer expenditure distribution for the rural and urban households of Amreli district for the year 1995 were found to be higher in rural areas (0.1952) than the urban area (0.1950). Similar observations were made by Jain (1983) for Haryana and Prasher *et al.* (1992) for Himachal Pradesh.

Engel Functions for Different Main Commodity Groups

Some preliminary observation about

the basic difference in the pattern of distribution of total consumer expenditure on various main commodity groups for rural and urban sector of Amreli district has been described in the preceding section. However, the changes in proportion of expenditure on a specific item of expenditure with respect to proportionate change in the total consumer expenditure can be precisely studied with the help of Engel elasticities. A perusal of the value of the adjusted

coefficient of determination listed in table 5 reveals that no single form of the Engel function could be found suitable for all commodities. Various research workers e.g. Singh (1979), Jain (1983) and Prasher *et al.* (1992) have also arrived at more or less similar conclusions while examining the suitability of different forms of Engel function related to consumer behaviour. The various forms of production function employed and the results obtained are presented in Table - 5.

Wide variation in the adjusted coefficient of multiple determination (R^2) was observed across different main commodity groups in various seasons for both the sectors. In the rural sector, the highest magnitude of R^2 was observed for TF in winter (90.30%) and monsoon (93.58%) seasons but in summer it was TNF (86.56%). In the urban sector, the highest magnitude of adjusted coefficient of determination (R^2) was observed for TNF commodity groups in winter (93.27%) and summer (91.47%) and monsoon (93.37%). The value of R^2 ranged from 63.53 to 87.60 per cent for TM in rural sector while, in urban, it ranged from 70.02 to 84.84 per cent.

Expenditure Elasticity of Various Main Commodity Groups

The expenditure elasticities were calculated on the basis of the estimates of coefficients obtained from the selected Engel functions. The expenditure on particular commodity was taken as a

dependent variable while total expenditure on all commodities was taken as an independent variable. The expenditure elasticities were worked out for rural and urban areas separately based on the data on consumption pattern obtained by personal enquiry survey method. The results are given in Table - 5. It can be observed from Table - 5 that the expenditure elasticities for TM and TF commodity groups were highly in rural areas as compared to urban areas in all the three seasons. In case of TNF commodity group, higher value of expenditure elasticities in winter and monsoon seasons for urban area were noticed as compared to rural area. Similar results were observed by Jain (1983) and Prasher *et al.* (1992). On the other hand, Swarnlata (1981) and Singh and Patel (1982) reported that for all the items, in general, the TNF expenditure elasticities in urban area were less than the rural area.

Summary and Conclusions

The foregoing discussion leads to the conclusion that the aggregate per capita expenditure on food items (TM and TF Commodity groups) was relatively higher in the rural areas while the per capita expenditure on non-food items (TNF) was higher in the urban sectors. The average per capita monthly total consumer expenditure in urban area was observed to be more than that of rural area during different season.

TABLE 5

Expenditure elasticities for main commodity groups in rural and urban sectors during different seasons.

Season	Main Commodity Groups	Rural		Urban	
		Functional form (R 2)	Expenditure Elasticities	Functional Form (R 2)	Expenditure Elasticities
Winter	A. Food items				
	1. TM	LP (85.83)**	1.2043	LP(84.84)**	1.1945
	2. TF	DL (90.37)**	0.8473	DL (87.81)**	0.6576
	B. Non-Food items				
	3. (TNF)	DL(83.43)**	1.1291	DL (93.27)**	1.2325
Summer	A. Food items				
	1. TM	LP (63.53)**	0.9518	LP(70.02)**	0.8793
	2. TF	DL (84.82)**	0.8336	DL (75.87)**	0.6580
	B. Non-Food items				
	3. (TNF)	DL(86.56)**	1.3757	DL (91.47)**	1.3465
Monsoon	A. Food items				
	1. TM	LP (87.60)**	1.3225	LP(79.38)**	1.1097
	2. TF	DL (93.58)**	0.7896	DL (82.66)**	0.7041
	B. Non-Food items				
	3. (TNF)	DL(88.70)**	1.1051	DL (93.37)**	1.2225

- Note :
1. The abbreviations of different functions are same as in Table -1.
 2. Figures in parenthesis are the values of R2 in percentage.
 3. ** Significant at 1 per cent level of significance.

In general, the log parabolic (LP) form approximated the relationship between per capita specific commodity expenditure and per capita total expenditure for TM commodity groups. For total food (TF) and total non-food (TNF) commodity groups. Double Log (DL) form was found to be the best fit to degree the relationship between

per capita commodity expenditure and total expenditure. Magnitude of elasticity in consumption of TM and TF commodity groups were higher in rural household when compared to urban households. On the other hand, for TNF commodity groups, the reverse was the case, except in summer season.

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An Anthropometry of Saurashtra Region Agricultural Workers for Farm and Industrial Equipment Design

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ABSTRACT

This paper presents the results of an anthropometric survey conducted on agricultural workers from Saurashtra region, Gujarat. Earlier anthropometric surveys carried out in the country were very few and specific to the requirement. A set of 28 body dimensions necessary for the design of these equipment were identified and a sample study was conducted on 108 workmen (aged 18 to 55 years). Data has been analysed statistically and compared with those obtained for the agricultural workers from other parts of the country as well as with those of the American, German and Japanese men and variation was observed. The mean stature of Saurashtra workers was observed 163.8 (± 6.84)cm, while those for Eastern, Southern, Central, Northern and Western regions were 162.1 (± 5.80), 160.7 (± 6.00), 162.0 (± 4.95), 168.5 (± 6.84) and 164.4 cms respectively. This difference needs to be allowed for when considering buying and then using the equipment for agricultural or industrial purpose.

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INTRODUCTION

India is a vast agricultural country having a total cultivated area of about 139 million hectare. The work-force involved in agriculture is about 170 millions. The traditional agriculture utilized mainly manual and animal power whereas the use of mechanical power has come up recently. Anthropometry is one of the most important aspect of ergonomics, which deals with the measurement of the various body dimensions of the group of population of operator which is very useful in the design process. Use of anthropometric data can help in the proper designing of equipment for better efficiency, safety and human comfort. With the advent of technology, such

a disregard for the human factor is no longer possible and a knowledge of man's size and its variability has become progressively more critical in the designing of equipment and workplaces (Woodson and Conover, 1973). Equipment for different agricultural operations and suitable for manual, animal and motor power are commercially available in the country and many more are being developed. Often, it is observed that ergonomic aspects are not given due consideration while designing the equipment and these results in deterioration of system performance and may also lead to ill-health of the operator. Hence to achieve better efficiency, human comfort and safety, it is necessary to design the equipment keeping

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in consideration the operators' capabilities and limitations.

In western countries a large amount of anthropometric data are available for reference (NASA, 1978). Detailed anthropometric survey of Indian population in the different regions of the country is necessary due to the numerous race mixtures in the population (Majumdar, 1972). The number of anthropometric surveys carried out in the country is very small and the dimensions included were specific to the requirement (Sen, 1964; Gupta *et al.*, 1983; Gite and Yadav, 1989; Frenandez and Uppugonduri, 1992; Yadav, 1995; Yadav and Tewari, 1996; and Yadav *et al.*, 1996). Yadav *et al.*, (1996) pointed out that there was considerable difference between the anthropometric data of Indians and Westerns. Variation was also reported within Indian data from different regions. Sen *et al.* (1977) observed that the anthropometric dimensions of the general industrial workers (53% of which were agricultural workers) were very similar to those of other industrial workers. This paper deals with anthropometric data of agricultural workers from Saurashtra region, Gujarat as a reference for the ergonomic design and also to help in modifications of agricultural and industrial equipment.

MATERIALS AND METHODS

Anthropometric measurements were carried out on 80 farm workers chosen randomly among agricultural workers of College of Agricultural Engineering and Technology, Junagadh, agricultural workers from Sagdividi Farm, Junagadh and agricultural workers from National Research

Centre for Groundnut Farm, Junagadh, Dry Farming Research Station, Targhadia, Rajkot and also from three farmers field, Junagadh, Gujarat. In order to measure the various body dimensions of the subjects, and anthropometer, a grip size measuring device, and a bathroom weighing scale were used. The standard anthropometric definition of measurements were adopted from Damon *et al.*, (1966), Pheasant (1986) and Hertzberg (1968).

The body dimensions included stature, body weight, standing eye height, standing shoulder height, standing elbow height, metacarpal III height, sitting height, sitting eye height, sitting shoulder height, elbow rest height, knee height, politeal height, knuckle height, buttock popliteal length, buttock knee length, arm reach from wall, forward grip reach, functional leg length, foot length, thigh clearance, hip breadth (sitting), shoulder-elbow length, shoulder breadth, fore arm-hand length, hand length, grip diameter (inside), chest circumference and hand circumference. The observer was given enough practice to measure all the dimensions in a correct posture and in a precise manner. The subject was asked to stand on the platform of the anthropometer, its arm was adjusted according to his height and measurement was recorded from the vertical scale. Similarly other measurements were recorded in sitting and standing postures with the help of an anthropometer. The grip diameter was measured with the grip measuring device. The data recorded for a subject was taken to be the mean of three readings.

RESULTS AND DISCUSSION

The anthropometric data for the various body dimensions and the estimates of mean, standard deviation, coefficient of variation and percentile values (5th, 50th and 95th) are presented in Table - 1. These anthropometric data were compared with the Eastern, South,

Central, Northern and Western Indian male workers as presented in Table - 2. As evident from table, the farm workers of Northern region (Gupta *et al.*, 1983) are taller and possess higher body weight than those of other regions of the country including farm workers from Saurashtra region.

TABLE 1

Anthropometric data of agricultural workers from Saurashtra region of Gujarat.

Body dimensions	Mean	SD	CV	Range	Percentile		
					5th	50th	95th
Stature	163.8	6.84	4.18	148.6 - 182.3	152.4	164.0	173.1
Body weight, kg	54.2	5.62	10.37	37.0 - 76.5	41.6	54.1	74.2
Standing eye height	152.1	5.66	3.72	138.4 - 166.2	139.3	152.4	161.0
Standing shoulder height	134.6	5.56	4.13	127.0 - 137.2	129.2	134.9	136.5
Standing elbow height	102.1	5.02	4.92	96.2 - 110.3	97.5	102.2	109.1
Metacarpal III height	68.3	3.10	4.54	62.8 - 73.4	63.2	68.5	71.9
Sitting height	82.2	2.91	3.54	73.6 - 88.5	74.1	81.8	85.8
Sitting eye height	70.4	3.17	4.50	61.0 - 76.4	62.9	71.2	75.5
Sitting shoulder height	52.5	2.75	5.24	50.2 - 56.4	51.1	53.0	55.6
Elbow rest height	18.2	1.64	9.01	15.4 - 20.6	16.1	17.9	18.2
Knee height	51.8	2.96	5.71	47.5 - 58.7	49.2	51.8	56.5
Popliteal height	42.2	2.40	5.69	39.3 - 46.5	41.1	42.7	45.8
Knuckle height	69.6	4.22	6.06	63.6 - 73.2	64.4	69.5	71.8
Buttock popliteal length	46.6	2.56	5.49	42.6 - 47.8	43.7	46.2	46.7
Buttock knee length	55.8	3.44	6.16	48.2 - 62.5	50.8	55.6	59.1
Arm reach from wall	82.3	4.23	5.14	72.8 - 92.4	76.7	82.3	83.6
Forward grip reach	72.6	4.17	5.74	61.1 - 85.7	70.8	73.2	77.2
Functional leg length	98.1	4.38	4.46	90.6 - 110.3	92.6	97.8	107.8
Foot length	24.8	1.58	6.37	19.4 - 27.5	21.8	24.9	25.5
Thigh clearance	12.8	1.22	9.53	11.5 - 18.2	12.6	13.2	15.1
Hip breadth (sitting)	32.8	2.19	6.68	27.5 - 36.8	29.2	32.5	36.0
Shoulder elbow length	30.7	2.25	7.73	27.8 - 35.2	28.0	31.1	34.3
Shoulder breadth	43.2	2.68	6.20	35.5 - 48.8	41.2	42.8	44.0
Fore arm-hand length	45.2	1.88	4.16	41.0 - 50.0	42.1	44.7	48.5
Hand length	18.3	1.36	7.43	16.2 - 21.1	17.2	18.5	20.0
Grip diameter (inside)	04.4	0.25	5.68	03.8 - 05.9	03.8	04.5	05.2
Chest circumference	82.9	5.57	6.72	66.7 - 92.8	77.4	83.1	91.8
Hand circumference	19.4	1.65	8.51	16.2 - 24.0	16.8	19.5	22.4

(Measuring unit : cm unless otherwise specified)

TABLE 2

Comparison of anthropometric data from different regions in India.

Body dimensions	Saurash Gujarat	1** Eastern India	2** Southern India	3** Central India	4** Northern India	5** Western India
1.	2.	3.	4.	5.	6.	7.
Stature	163.8 (± 6.84)	162.1 (± 5.80)	160.7 (± 6.00)	162.0 (± 4.95)	168.5 (± 6.84)	164.4
Body weight, kg	54.2 (± 5.62)	53.6 (± 6.73)	56.6 (± 5.14)	49.3 (± 5.95)	61.8* (± 8.68)	54.7
Standing eye height	152.1 (± 5.66)	150.8 (± 5.10)	149.7 (± 6.1)	151.0 (± 5.22)	NA	NA
Standing shoulder height	134.6 (± 5.56)	131.2 (± 4.80)	130.1 (± 4.6)	134.6 (± 4.87)	NA	NA
Standing elbow height	102.1 (± 5.02)	101.88 (± 3.80)	98.9 (± 3.80)	102.6 (± 2.89)	NA	NA
Metacarpal III height	63.3 (± 3.10)	67.8 (± 2.70)	NA	68.5 (± 2.89)	NA	NA
Sitting height	82.2 (± 2.91)	80.9 (± 2.20)	79.1 (± 4.00)	83.8 (± 2.52)	NA	86.2*
Sitting eye height	70.4 (± 3.17)	71.4 (± 2.00)	70.3 (± 4.60)	73.9 (± 2.62)	NA	NA
Sitting shoulder height	52.5 (± 2.75)	53.4 (± 2.12)	52.9 (± 3.90)	55.7 (± 2.08)	59.0*	NA
Elbow rest height	18.2 (± 1.64)	17.5 (± 1.58)	15.4 (± 0.60)	20.3 (± 2.02)	21.0* (± 1.86)	NA
Knee height	51.8 (± 2.96)	51.5 (± 2.87)	54.2 (± 3.80)	50.9 (± 2.70)	NA	NA
Popliteal height	42.2 (± 2.40)	42.0 (± 1.74)	47.1 (± 3.5)	41.6 (± 2.07)	41.8 (± 2.60)	42.0
Knuckle height	69.6 (± 4.22)	68.8 (± 3.95)	68.0 (± 5.3)	NA	NA	NA
Buttock popliteal length	46.6 (± 2.56)	46.2 (± 2.28)	44.7 (± 2.3)	46.6 (± 1.75)	48.3 (± 3.17)	45.6
Buttock knee length	55.8 (± 3.44)	55.1 (± 3.10)	51.6 (± 2.90)	55.6 (± 2.10)	NA	54.6
Arm reach from wall	82.3 (± 4.23)	82.8 (± 3.90)	NA	83.1 (± 3.91)	NA	82.8
Forward grip reach	72.6 (4.17)	73.7 (4.46)	73.2 (3.90)	70.9 (3.21)	NA	NA
Functional leg length	98.1 (4.38)	97.6 (4.24)	NA	96.6 (5.51)	NA	NA
Foot length	24.8 (1.58)	23.9 (1.24)	21.9 (2.00)	25.0 (1.00)	NA	NA
Thing clearance	12.8 (1.22)	12.9 (2.24)	12.5 (0.60)	13.4 (1.32)	NA	NA

1.	2.	3.	4.	5.	6.	7.
Hip breadth (sitting)	32.8 (2.19)	31.7 (2.30)	33.4 (2.10)	30.8 (1.56)	31.3 (1.99)	NA
Shoulder elbow length	30.7 (2.25)	30.2 (1.80)	29.6 (2.20)	NA	NA	NA
Shoulder breadth	43.2 (2.68)	42.3 (2.60)	NA	NA	NA	NA
Forearm-hand length	45.2 (1.88)	44.6 (1.96)	40.1* (2.50)	45.9 (2.00)	NA	NA
Hand length	18.3 (1.36)	17.8 (1.61)	16.4 (1.40)	18.3 (0.84)	NA	19.1
Grip diameter (inside)	04.4 (0.25)	4.3 (0.39)	NA	4.1 (0.3)	NA	NA
Chest circumference	82.9 (5.57)	81.3 (4.87)	NA	83.1 (4.48)	NA	84.3
Hand circumference	19.4 (1.65)	19.2 (1.40)	NA	19.9 (0.80)	NA	NA

(Measuring unit : cm unless otherwise specified).

*Significantly different at $p < 0.05$ from Saurashtra workers, Gujarat 1** Yadav *et al.* (1996), 2** Fernandez and Uppugonduri (1992), 3** Gite and Yadav (1989) 4** Gupta *et al.* (1983), 5** Sen (1964)

The sitting shoulder height and the elbow rest height of North Indians were significantly different than Saurashtra workers. The fore arm-hand length for south Indians were also significantly different from Saurashtra workers. The anthropometric data were also compared with median values of three different ethnic groups as presented in Table - 3. This comparison indicates that the Saurashtra workers are smaller than German, USA and Japanese males, in all body dimensions. This variation could be due to

the differences in body build-up of Indians and Westerns. The ratio between stature and other body dimensions were also calculated and compared with the ratio given by Barkla (1961) for the British population (Table - 4). Thus, if the stature is known, dimensions not available in the sample can be observed by proportion. Comparison of sitting height to stature ratio of present survey with different population is also presented in Table - 5. Table shows almost similar ratio of stature to sitting height among different populations.

TABLE 3

Comparison of Saurashtra workers anthropometric data with three different ethnic groups of population.

Body dimensions	1* 2* 3*			
	Indian	German	US	Japanese
Stature	163.8	174.5	175.5	165.8
Shoulder height	134.6	146.4	143.5	134.5
Sitting height	82.2	91.9	91.3	90.4
Sitting eye height	70.4	80.2	79.9	78.5
Elbow rest height	18.2	23.7	23.2	26.0
Popliteal height	42.2	45.4	43.1	40.2
Arm reach from wall	82.3	NA	84.6	NA
Buttock leg length	98.1	NA	108.5	NA
Foot length	24.8	26.0	26.7	NA
Thigh clearance	12.8	15.1	14.3	NA
Shoulder elbow length	30.7	NA	36.4	NA
Fore arm hand length	45.2	NA	47.8	NA

(Measuring unit : cm unless otherwise specified)

1* Jurgens *et al.* (1972), 2* Hertzberg *et al.* (1954)

3* Yokohori (1972).

TABLE 4

Some body dimensions expressed as proportions of stature.

Body dimensions	Proportion of stature	
	Barkla (1961)	Present study
Standing eye height	0.936	0.929
Standing shoulder height	0.811	0.822
Standing elbow height	0.608	0.623
Sitting height	0.525	0.502
Sitting eye height	0.477	0.430
Sitting shoulder height	0.340	0.321
Elbow rest height	—	0.111
Knee height	0.315	0.316
Popliteal height	0.245	0.258
Buttock popliteal length	0.280	0.284
Buttock knee length	0.342	0.341
Functional leg length	—	0.599
Hip breadth (sitting)	0.205	0.200
Shoulder elbow length	—	0.187
Shoulder breadth	0.260	0.264
Forearm hand length	0.272	0.276
Hand length	—	0.112

(Measuring unit : cm unless otherwise specified)

TABLE 5

Comparison of sitting height to stature ratio with different populations.

<i>Ethnic group men</i>	<i>Ratio</i>	<i>Source</i>
Saurashtra workers, Gujarat	0.5018	Present study
Eastern Indian	0.4991	Yadav <i>et al.</i> (1996)
South Indian	0.4922	Fernandez and Uppugonduri (1992)
Central Indian	0.5173	Gite and Yadav (1989)
Western Indian	0.5243	Sen (1964)
German	0.5266	Jurgens <i>et al.</i> (1972)
U S	0.5202	Hertzberg <i>et al.</i> (1954)
Japanese	0.5452	Yokohori (1972)
South Eastern African	0.5096	Jurgens <i>et al.</i> (1990)

Ergonomic approach to farm equipment design

Manually operated equipment are extensively used in Indian agriculture for various farm operations like digging, weeding and harvesting. The design of the handles of these tools depends on the mode of operation, amount of effort required, and the anthropometric data of the working population. The median value of internal grip diameter for Saurashtra workers is 4.4 cm while that of other parts of India varied from 4.1 to 4.3 cm. For design of a handle, its diameter should not exceed the internal grip diameter. For animal drawn equipment the handle is one of the most important components with which the operator controls and guides the implement properly during field operations. The operator may have to apply more force on the equipment for better maneuverability and proper control on it. If the height is too low (i.e. 63.0 cm), the operator has to bend excessively and it strains the operator. If the height is more (i.e. 98.0 cm), the maneuverability of the implement is affected and operation will not be proper. The elbow height (standing) data

is helpful for designing proper handle height. For better operation and human comfort, a proper handle height will be between 5th percentile value of metacarpal III height and 5th percentile standing elbow height (i.e. 63.0 to 98.0 cm). The optimum handle height, however, depends upon type of equipment and will have to be determined separately through experiments. Similarly proper power tiller handle height is also based on anthropometric data of the target population. Adjustable handle height is preferred but is not always practically possible.

The maximum permissible height for the feeding chute of a thresher should be decided considering the 5th percentile value of shoulder height. The placement of different controls in tractor is a complex task for the designer and requires the anthropometric characteristics of the target population. The efficiency and comfort of the operator can be improved with properly designed tractor workplace (Yadav *et al.* 1997). The dimensions of seat, location of controls and access/ exit provisions are the parameters where anthropometric data can provide help

TABLE 5

Comparison of sitting height to stature ratio with different populations.

<i>Ethnic group men</i>	<i>Ratio</i>	<i>Source</i>
Saurashtra workers, Gujarat	0.5018	Present study
Eastern Indian	0.4991	Yadav <i>et al.</i> (1996)
South Indian	0.4922	Fernandez and Uppugonduri (1992)
Central Indian	0.5173	Gite and Yadav (1989)
Western Indian	0.5243	Sen (1964)
German	0.5266	Jurgens <i>et al.</i> (1972)
U S	0.5202	Hertzberg <i>et al.</i> (1954)
Japanese	0.5452	Yokohori (1972)
South Eastern African	0.5096	Jurgens <i>et al.</i> (1990)

Ergonomic approach to farm equipment design

Manually operated equipment are extensively used in Indian agriculture for various farm operations like digging, weeding and harvesting. The design of the handles of these tools depends on the mode of operation, amount of effort required, and the anthropometric data of the working population. The median value of internal grip diameter for Saurashtra workers is 4.4 cm while that of other parts of India varied from 4.1 to 4.3 cm. For design of a handle, its diameter should not exceed the internal grip diameter. For animal drawn equipment the handle is one of the most important components with which the operator controls and guides the implement properly during field operations. The operator may have to apply more force on the equipment for better maneuverability and proper control on it. If the height is too low (i.e. 63.0 cm), the operator has to bend excessively and it strains the operator. If the height is more (i.e. 98.0 cm), the maneuverability of the implement is affected and operation will not be proper. The elbow height (standing) data

is helpful for designing proper handle height. For better operation and human comfort, a proper handle height will be between 5th percentile value of metacarpal III height and 5th percentile standing elbow height (i.e. 63.0 to 98.0 cm). The optimum handle height, however, depends upon type of equipment and will have to be determined separately through experiments. Similarly proper power tiller handle height is also based on anthropometric data of the target population. Adjustable handle height is preferred but is not always practically possible.

The maximum permissible height for the feeding chute of a thresher should be decided considering the 5th percentile value of shoulder height. The placement of different controls in tractor is a complex task for the designer and requires the anthropometric characteristics of the target population. The efficiency and comfort of the operator can be improved with properly designed tractor workplace (Yadav *et al.* 1997). 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 and to the physiological reach of the operator. Yadav and Tewari (1996) also highlighted the use of anthropometric data in the design of tractor operator seat. For design purposes, either one of the boundry value (5th or 95th percentile) or the mean value is used depending upon to dimensional element. Anthropometrically, seat height from foot rest to suit Indian farm workers, 5th and 95th percentile population would be within the range of 41.1 to 45.8 cms. Therefore, anthropometric data can be useful in design of agricultural and industrial equipment.

Conclusions

Ergonomics is still a new concept in Indian agriculture. This survey presents a useful compilation of anthropometric data of farm workers from Saurashtra region. This could be taken as a guide to designing and modifying the agricultural as well as industrial equipment and machinery suiting to the human capabilities and limitations. In case of large variations in the size, adjustable designs could be created and the anthropometric data could be used for designing the range of adjustment to be provided. It is necessary to create great awareness about its contribution in improving the quality of life of workers.

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Effect of Feeding *Lactobacillus acidophilus* V₃ on the Lipemic Status of Humans of Different Age Groups

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ABSTRACT

The effect of a probiotic strain, *Lactobacillus acidophilus* V₃, a human vaginal isolate, was studied on the lipemic status of 27 human subjects of varying age groups, namely, 20-40 years (A₁), 40-60 years (A₂) and 60-80 years (A₃). Acidophilus milk prepared using this culture was fed to all the subjects at the rate of 200 ml per day for 20 consecutive days. Their fasting blood samples were analysed for lipid profile six times: twice each before, during and after feeding acidophilus milk, keeping a gap of 10 days between two subsequent collections. Analysis of data indicated that total cholesterol significantly ($P < 0.05$) reduced in group A₁, while ratios of LDL/HDL and total / HDL cholesterol declined in group A₂. In A₃ group, no significant change was found in any of the parametric values. The feeding did not alter significantly the values of serum triglycerides, LDL cholesterol and VLDL cholesterol in any group of volunteers. The changes in lipid profile parameters followed either a linear or quadratic trend over the study period.

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INTRODUCTION

Selected species of lactobacilli and bifidobacteria constitute the autochthonous beneficial microflora in human and higher animals (Alm, 1991). Their use as probiotics and their role in intestinal therapy is well established in therapeutic medicine (Clements *et al.*, 1983, Fernandes and Shahani, 1989, Alm, 1991).

The role of dietary lactobacilli in cholesterol reduction is currently being debated by scientists world-wide as one of the therapeutic aspect. Several reports have shown their potential as hypocholesterolemic agents *in vitro* and *in vivo* (Hepner

et al. 1979, Khedkar *et al.* 1993a, 1993b). However, some workers did not observe such an effect (Lin *et al.* 1989, Mc Namara *et al.* 1989). Such variations can be attributed to the strain of culture, lipemic status of subjects, exercise, diet, sex, alcoholism, smoking, age, etc.

The incidence of atherosclerotic heart diseases involving the build-up of fatty substances on the inside of artery wall is high in patients with hypercholesterolemia (Hepner *et al.* 1979, Mayes, 1988). Age is considered to be an irreversible risk factor governing the occurrence of coronary heart diseases (CHD). According to the National

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Health Examination Survey, ischemic heart disease is the leading cause of death in males after age 35 and in all persons after 45. For both sexes, there is more than fivefold increase in the average annual incidences of myocardial infarction between ages 40 and 60 (Bierman, 1991). Considering the importance of age factor in prevalence of coronary heart diseases, the present study was undertaken to evaluate the effect of feeding *Lactobacillus acidophilus* V₃ on the blood lipid profile of hyperlipemic and normolipemic subjects falling under different age groups.

MATERIALS AND METHODS

Culture

Lactobacillus acidophilus V₃, a human vaginal isolate was obtained from culture collection of our Department. The strain was maintained by weekly sub-culturing in sterile reconstituted skim milk tubes. Prior to its use in preparing acidophilus milk, it was activated by two daily transfers in reconstituted skim milk. In the earlier studies this strain has been found to yield good quality fermented milk (Khedkar, 1988) and possess special properties like bile deconjugation, bile tolerance, antibacterial activity against some pathogens and cholesterol assimilation *in vitro* (Ashar and Prajapati, 1998). Hence, this strain was selected for the experiment.

Preparation of acidophilus milk

Low fat milk (1.6% fat, 8.5% SNF) in batch size of 10-20 liters was heated to 120°C for 10 minutes, cooled, inoculated with

the active culture of *Lactobacillus acidophilus* V₃ and incubated at 37°C till setting (16-18 h). The curd was then broken, added with pineapple essence and lemon yellow color, homogenized and packed in 200 ml aliquots in sanitized polyethylene pouches. The product was stored at 2-8°C till use.

Experimental protocol

Twenty seven human subjects enrolled in the feeding trial were selected from either Hospital OPD's or the University campus. Majority of subjects were patients suffering from primary hypercholesterolemia or that secondary to hypertension, diabetes, hypothyroidism, etc. Their personal data regarding dietary habits and medical history were recorded in a separate proforma. No restriction was put on the normal dietary habits of participants. They were also allowed to take regular medicine prescribed by doctor for treating secondary ailments, if any. However, none of the volunteers were taking cholesterol reducing drugs. They were classified into three groups on the basis of age, viz., 20-40 years (A₁), 40-60 years (A₂) and 60-80 years (stat), which consisted of 8, 12 and 7 volunteers, respectively. The blood samples of each volunteer were collected by veinpuncture six times, i.e. 10 days before start of the experiment, on the day of starting feeding, two times during feeding and two times after stoppage of feeding. All the samples were analysed for lipid profile parameters and the data obtained were statistically analysed.

Lipid profile analysis

Total cholesterol, serum triglycerides and HDL-cholesterol were estimated with the help of commercial kits manufactured by M/S Bayer Diagnostics India Ltd., Baroda as per the methods suggested by them. The values of VLDL cholesterol, LDL cholesterol, LDL/HDL cholesterol ratio and total/HDL cholesterol ratio were derived from result of the former three parameters.

Total cholesterol estimation

Total cholesterol was estimated by an enzymatic method according to the procedure given in reagent kit manual (M/S Bayer Diagnostics India Ltd., Baroda, India). Daily working solution was prepared by mixing equal volumes of solution (1) i.e. buffer / enzyme / chromogen and reagent (2) i.e. phenol, supplied in the kit. To one ml of this working reagent, 10 μ l of test serum sample was added. Blanks and standards were also run along with the test. Subsequently, the tubes were incubated at 37°C in a waterbath for five minutes. Thereafter, the absorbance of test as well as the standards were read on Hitachi 220S spectrophotometer at 505 nm against a reagent blank. The concentration of total serum cholesterol was expressed in mg/dL.

Triglycerides determination

Serum triglycerides were estimated by enzymatic Dichloro-2-Hydroxy Benzene Sulfuric acid (DHBS) colorimetric method given in the reagent kit manual (M/S Bayer Diagnostics India Ltd., Baroda, India). The reagent 1 containing enzyme/chromogen was reconstituted by adding equal volumes of reagent 2 (buffer/chromogen) and reagent 3 (stabilizer) in the required quantity. This

reconstituted solution was used as working reagent. One ml of this working reagent was taken in a test tube to which 10 μ l of serum sample was added. Incubation of the tubes was carried out for 15 minutes at room temperature. Finally, the OD of standard as well as test was measured against reagent blank at 505 nm. The concentration of serum triglycerides was expressed in mg/dL.

HDL cholesterol estimation

HDL cholesterol was estimated by phosphotungstate method as given in the kit manual (M/S Bayer Diagnostics India Ltd., Baroda, India). Chylomicrons, VLDL and LDL fractions in serum were separated from HDL by precipitating with phosphotungstic acid-magnesium chloride. In this step, 200 μ l of serum and 200 μ l of precipitating reagent (phosphotungstic acid) were centrifuged for 10 minutes at 3500-4000 RPM. The clear supernatant obtained thus was taken as sample. The remaining procedure was similar to estimation of total cholesterol except that instead of 10 μ l serum, 20 μ l supernatant obtained thus was taken in one ml of working reagent. The concentration of HDL - cholesterol was calculated and expressed in mg/dL of sample.

The other parameters were calculated as follows :

$$VLDL \text{ cholesterol} = \text{Triglycerides} / 5,$$

$$LDL \text{ cholesterol} = \text{Total cholesterol} - \text{HDL cholesterol} - \text{VLDL cholesterol}$$

$$LDL / HDL \text{ cholesterol ratio} = \frac{LDL \text{ cholesterol}}{HDL \text{ cholesterol}}$$

$$\text{Total} / HDL \text{ cholesterol ratio} = \frac{\text{Total cholesterol}}{HDL \text{ cholesterol}}$$

Statistical analyses

Individual grouped and pooled data were analyzed by Randomized Block Design for analysis of variance by taking test periods (days) as treatments and individuals as replications. The baseline values used for the analysis purpose were the average of two observations taken 10 days prior to feeding (-10d) and on the day of starting feeding (0d). The significant differences between treatment means for respective parameters were tested by the Critical Difference (CD) test. Regression analysis was also done for individual groups to statistically assess the trend of lipid profile parameters. Linear equation $y = a + bx$ and quadratic equation $y = a + bx + cx^2$ were applied as per the method suggested by Snedecor and Cochran (1967). The best fit equation was selected on the basis of significance of value of coefficient of determination (R^2) to explain the trend of lipid profile parameters over time.

RESULTS AND DISCUSSION

Analyses of fresh acidophilus milk revealed that it has 1.6 % fat, 3.5 % protein, 3.6×10^9 viable cells of lactobacilli / ml and 0.66 % titratable acidity. Speck (1976) suggested to consume about 10^8 - 10^9 live cells of lactobacilli daily to get maximum therapeutic benefits. Accordingly, a daily dose of 200 ml of our fresh acidophilus milk was able to provide about 10^{11} viable cells which are sufficient to give therapeutic benefits.

The average values of lipid profile parameters in the volunteers belonging to groups A_1 , A_2 and A_3 are given in Table - 1. Analysis of the data revealed a significant

($P < 0.05$) reduction of total cholesterol in group A_1 . The average total cholesterol reduced maximally by 25 mg/dL during twenty days after stoppage of acidophilus milk consumption. In the A_2 group, a significant reduction ($P < 0.05$) in the LDL/HDL and total / HDL cholesterol ratios as well as a non-significant decrease in total cholesterol was found. These favourable changes were, however, accompanied by a non-significant rise in the average serum triglycerides and VLDL cholesterol levels. HDL cholesterol remained unchanged in A_1 and A_3 groups but had shown erratic behaviour in A_2 . In the A_3 group, no significant change was found with respect to any of the parameters during study.

Table - 2 indicates the composite results of RBD and regression analyses carried out on the grouped data to detect the trend of lipid profile parameters over the test periods. Linear as well as quadratic trends were fitted taking all the seven parameters as dependent variables and the test periods as independent variables. The significance of the value of coefficient of determination (R^2) was kept as a criterion for selection of the best fit linear or quadratic trend. A high R^2 value above 0.7 indicates a good correlation between two variables. Table - 3 indicates the trend equations for the groups of volunteers showing R^2 value of more than 0.7. With respect to the total cholesterol, a non-significant quadratic trend of final decline was seen in A_1 as well as A_2 groups. In the A_3 group, neither linear nor quadratic trend fitted with respect to total cholesterol indicating a poor correlation with test period. The triglycerides and VLDL cholesterol values showed a significant quadratic trend of final

increase in the A_2 group. In the A_3 group, a significant linear trend of increase in the averages of triglycerids as well as quadratic trend of final increase in VLDL cholesterol values was found (Table - 3). The HDL cholesterol values of A_1 group showed a quadratic trend decreasing initially followed by subsequent rise. A significant quadratic trend ($P < 0.05$) of final decline in average LDL cholesterol level was seen in A_1 group. In the A_2 group, a linear significant trend of continuous decline was detected, whereas the A_3 group showed a non-significant trend of quadratic decline in LDL cholesterol levels. With respect to the cholesterol ratios, the A_1 group exhibited a quadratic trend of initial increase followed by a final decline in the average LDL/HDL and total / HDL cholesterol ratios. However, in groups A_2 and A_3 the ratios did not show any specific trend.

The results indicated that the feeding of acidophilus milk made favourable changes in lipemic profile of volunteers of group A_1 (20-40 years) and A_2 (40-60 years). The A_3 group, consisting of 60-80 years aged individuals showed no significant change in the lipemic status probably because their initial cholesterol was low. Amongst the three age groups, A_2 showed a change with respect to every parameter of lipid profile (Table - 2) and was maximally affected by *Lb. acidophilus* feeding.

Ratios of LDL / HDL cholesterol and total / HDL cholesterol are indicative of the risk of developing coronary heart disease (Kaplan *et al.* 1988). Both these ratios were found to decrease significantly in the age group A_2 in the present study. This is an important observation as the incidence of coronary heart diseases, too, is the most

pronounced during the age of 40-60 years. Khedkar *et al.* (1993b) found a significant reduction in the serum total cholesterol of 20 male volunteers aged 40 to 50 years on consumption of acidophilus milk in the dose of 200 g/day for 30 days. In a similar study by the same researchers (Khedkar *et al.* 1993a) taking 20 healthy human volunteers aged 50-60 years, too, a significant reduction of total cholesterol levels was found. They noted that the initial baseline mean value (226.5 mg/dL) reduced on days 15 and 30 during feeding (213.1 and 192.4 mg/dL, respectively) and remained almost same after 15 days post feeding (193.2 mg/dL).

Agerbek *et al.* (1995) have also reported a significant reduction in total cholesterol levels after 6 weeks daily feeding of 200 ml of cultured milk *Gaio* in 58 Danish male participants of 44 years age. Hruby *et al.* (1992) have reported decrease in total cholesterol and low density lipo proteins accompanied by a moderate increase in the HDL fraction and frequently a decrease in triglycerides on feeding two different low fat fermented milks to 25 women and 18 men lying in the age group of 26-60 years.

In A_2 group, both the cholesterol ratios showed lowest values at the end of feeding and maintained low during post feeding period too. The significant decline in average total cholesterol level of A_1 group was observed in the post feeding periods of + 10 and + 20 days after stoppage of acidophilus milk consumption, indicating a gradual effect. To check how long this favourable effect persists, perhaps, it would be necessary to include one or two additional post feeding test periods in future studies.

TABLE 1

Average lipid profile parameters in test subjects over the study period.

Parameter	Group	Baseline 0 day*	Feeding		Post feeding		S.Em.	C.D.	C.V. %
			10 d	20 d	+10 d	+20 d			
Total Cholesterol (mg/dL)	A ₁	213	217	219	198	188	7.8	22.6	10.7
	A ₂	215	198	197	198	194	8.2	NA	14.3
	A ₃	190	191	190	183	200	8.1	NA	11.2
Serum Triglycerides (mg/dL)	A ₁	160	154	152	135	166	19.7	NA	36.3
	A ₂	166	153	155	171	194	12.3	NA	25.4
	A ₃	122	140	143	150	158	21.1	NA	22.4
HDL Cholesterol (mg/dL)	A ₁	54	52	48	47	50	4.7	NA	26.8
	A ₂	44	38	53	46	45	3.3	9.4	25.3
	A ₃	39	41	43	31	43	3.9	NA	26.2
VLDL Cholesterol (mg/dL)	A ₁	32	31	30	27	33	3.9	NA	36.3
	A ₂	33	30	31	34	39	2.5	NA	25.4
	A ₃	24	28	29	30	31	2.4	NA	22.4
LDL Cholesterol (mg/dL)	A ₁	127	135	140	125	105	9.9	NA	22.1
	A ₂	138	129	112	117	109	8.6	NA	24.5
	A ₃	126	122	119	123	126	8.6	NA	18.5
LDL/HDL ratio **	A ₁	2.3	2.6	2.9	2.6	2.1	0.12	NA	20.9
	A ₂	3.1	3.4	2.1	2.5	2.4	0.1	0.28	20.3
	A ₃	3.2	3.0	2.8	4.0	2.9	0.1	NA	20.9
Total / HDL ratio **	A ₁	4.0	4.2	4.6	4.2	3.8	0.1	NA	14.2
	A ₂	4.9	5.2	3.7	4.3	4.3	0.08	0.24	13.3
	A ₃	4.9	4.6	4.4	5.9	4.6	0.10	NA	16.3

* Average of two baseline estimations i.e. 10 days before feeding and on zero day.

** The original values given above were transformed to square root for statistical analysis.

NS : Non significant, A₁ : 20-40 years, A₂ : 40-60 years, A₃ : 60-80 years.

TABLE 2

Maximum decrease / increase in lipid profile parameters during the study.

		Change in lipid profile parameters as compared to base line values						
Group		Total cholesterol (mg/dL)	Triglycerides (mg/dL)	HDL cholesterol (mg/dL)	VLDL cholesterol (mg/dL)	LDL cholesterol (mg/dL)	LDL/HDL ratio	Total/HDL ratio
n = 8	A ₁	↓25.0*	=	↓7.0	=	↓22.0*	↓0.2*	↓0.2*
n = 12	A ₂	↓21	↑28.0*	↓6.0*	↑6.0*	↓29*	↓1.0*	↓1.2*
n = 7	A ₃	↑10.0	↑36.0*	=	↑7.0*	↓7.0	=	=

A₁ : 20-40 years, A₂ : 40-60 years, A₃ : 60-80 years.

* : Significant as 5% by R.B.D., • : Significant at 5% by regression analysis

= : No change, ↓ : Decrease, ↑ : Increase

TABLE 3

Best fit trend equations for lipid profile parameters in different age groups.

Parameter	Group	Constant (a)	Rate of Change		Coefficient of Determination (R ²)	Significance at 5 % level
			(b1)	(b2)		
Total	A ₁	203	14.70	-3.60	0.93	NS
Cholesterol	A ₂	227	-16.20	2.00	0.84	NS
Triglycerides	A ₂	192	-31.00	6.30	0.98	*
	A ₃	118	8.20	0.00	0.93	*
HDL	A ₁	61	-7.00	0.90	0.91	NS
Cholesterol	A ₂	38	-6.10	1.30	0.99	*
VLDL	A ₃	21	4.20	-0.40	0.96	*
Cholesterol	A ₁	106	26.10	-5.30	0.98	*
LDL	A ₂	142	-7.00	0.00	0.82	*
	A ₃	133	-8.90	1.50	0.91	NS
LDL/HDL	A ₁	1.7	1.00	-0.20	0.97	*
TC/HDL	A ₁	3.2	1.10	-0.20	0.91	NS

A₁ : 20-40 years, A₂ : 40-60 years, A₃ : 60-80 years

NA : Not Significant, * : Significant at 5 % level

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Short Communications

Physico-Biochemical Composition of Wheat During Storage on Seed Treatment

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Quality seed is a basic input to boost the crop yield. The demand for seed is fluctuating and very often there are large surplus stocks of seed which needs to be stored for 1-2 years. Such left over seeds pass through the hot and humid monsoon period which may affect the physico-biochemical properties and quality of seed. Cereal seeds loose their viability in a short period if stored under ambient storage conditions. Leaching of sugar and electrical conductivity increase during storage (Shelar and Bapat, 1991). Due to scarcity of ideal storage godowns in Indian conditions, emphasis on alternatives such as seed treatment become more suitable and economic substitute. However, information on change in wheat seeds stored under ambient conditions especially, in relation to seed treatments is scarce. Hence, this investigation was carried out.

Seeds of four wheat varieties viz., Sonalika (V_1), Lok-1 (V_2), Kalyan Sona (V_3) and GW 496 (V_4) sun dried to adjust the

moisture to 10 per cent were divided into the units of 5 kg each and treated with Carbendazim (50%) and Thiram (75% WDP) each @ 2 g/kg seed, Methyl Parathion (2% dust) and Castor oil each @ 10 g/kg seed alongwith a control (without seed treatment). Seed samples were stored from May, 1992 in polythene bags of 400 gauge in the Seed Technology Laboratory under ambient conditions of Sardar Krushinagar, in completely randomized design with four replications for a period of twelve months. Seeds were tested for electrical conductivity of the leachate, germination per cent and vigour index at monthly intervals as described below.

Electrical conductivity

5g seeds from each treatments were taken in a beaker and surface sterilized with 0.1 % mercuric chloride solution for 5 minutes. After washing it thoroughly with tap water and then with distilled water, 25 ml distilled water was added to it and kept for 18 hours. Again, 25 ml distilled water was added and the leachate was filtered. EC (micromhos / cm at 25°C) of the leachate was measured on EC meter (Bradnock and Matthews, 1970).

TABLE 1.

Physico-biochemical composition of wheat as influenced by varieties and seed treatments during storage.

Treatments	EC (micromhos / cm)	Germination (%)	Vigour index
STORAGE PERIOD (S)			
(in months)			
1	252.5	79.80 (96.59)	2051
2	246.3	79.32 (96.24)	2103
3	248.1	79.09 (96.06)	2162
4	249.5	78.35 (95.75)	2207
5	253.3	76.71 (94.53)	2252
6	257.1	75.62 (93.66)	2253
7	261.8	73.65 (91.91)	2175
8	264.5	72.46 (90.82)	2076
9	268.1	71.11 (89.47)	1965
10	273.8	68.93 (87.02)	1815
11	277.5	67.63 (85.47)	1729
12	279.0	67.32 (85.11)	1644
S.Em. +	0.88	0.18	5.74
C. D. (P=0.05)	2.43	0.49	15.92
VARIETIES (V)			
Sonalika	286.8	72.75 (98.69)	2040
Lok-1	276.2	73.39 (91.24)	1983
Kalyan Sona	246.0	74.61 (92.36)	1920
GW 496	231.8	75.92 (93.96)	2202
S.Em. +	0.51	0.18	3.32
C. D. (P=0.05)	1.40	0.49	9.19
SEED TREATMENT (T)			
Carbendazim	239.8	74.88 (92.59)	2168
Thiram	236.8	76.70 (93.86)	2233
Methyl Parathion	266.3	73.90 (91.70)	1986
Castor oil	289.1	71.34 (89.38)	1812
Control	269.8	74.01 (91.83)	1982
S.Em. +	0.57	0.24	5.52
C. D. (P=0.05)	1.57	0.69	15.76
INTERACTION (V X T)			
S.Em. +	1.13	0.23	8.92
C. D. (P=0.05)	3.16	0.64	24.73

N. B. : Figures in the parentheses are untransformed values.

TABLE 2

Interaction effect of varieties and seed treatments on EC, germination (%) and vigour index during storage.

Varieties	Seed treatments				
	T_1	T_2	T_3	T_4	T_5
Electrical conductivity					
V_1	268.3	264.9	289.6	318.8	293.1
V_2	258.8	257.7	279.2	302.7	282.5
V_3	222.7	220.6	254.6	273.3	258.5
V_4	209.4	201.5	241.7	261.7	245.0
C.D.(P=0.05) : 3.16					
Germination (%)					
V_1	73.72 (92.00)	75.29 (93.00)	73.25 (91.00)	68.06 (86.00)	73.45 (91.00)
V_2	74.19 (92.00)	75.70 (93.00)	72.82 (91.00)	71.10 (89.00)	73.12 (91.00)
V_3	75.31 (93.00)	76.87 (94.00)	74.46 (92.00)	72.46 (91.00)	74.29 (92.00)
V_4	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					
Vigour Index					
V_1	2118	2155	2035	1856	2035
V_2	2054	2129	1946	1846	1947
V_3	2032	2093	1928	1627	1919
V_4	2470	2563	2033	1917	2026
C. D. (P=0.05) : 24.73					

N.B. : Figures in the parentheses are untransformed values.

Germination (%)

100 seeds from each treatment were germinated at $30 \pm 1^\circ \text{C}$ for 7 days in seed germinator using rolled paper towel method (Anon., 1985). The seedlings were categorised as normal and abnormal. Germination (%) was expressed on the basis of normal seedlings only employing Arc Sin transformation.

Vigour index

Vigour index was determined by multiplying the germination (%) with the sum of root and shoot length of seedling in cm (Woodstock, 1969).

Electrical conductivity, germination and vigour differed significantly during storage (Table -1) EC of the seed leachate was the lowest in the beginning of the experiment and increased with storage. As the seed moisture increase, the cell membrane become less rigid and more water permeable allowing the cell contents to escape into the solution, increasing its EC (Copeland, 1976). Increase in EC with storage in sorghum have been observed by Aswathaiah and Murthy (1986). In contrary to EC, germination decreased significantly and progressively during the storage. This may be explained by the increased seed respiration due to increased temperature and relative humidity. Decrease in seed germination with storage have been reported by Singh and Borikar (1985). Vigour index increased with storage upto six months and thereafter, it decreased upon further storage. Vigour index being a dependent character on root and shoot lengths of seedling,

followed the pattern of change in these characters. Singh and Borikar (1985) reported that vigour index of sorghum was good upto four months and then there was a gradual reduction upon further storage. However, Mehta and Patel (1990) reported decrease in vigour with storage.

Significant differences in EC, germination and vigour due to varieties indicated genotypic variation for these characters. Variety GW 496 recorded the lowest EC and highest germination as well as vigour indicating its superiority over other varieties for these characters. Genotypic variation for each traits have been reported by Singh (1986) and Singh (1987).

Effect of seed treatments was significant. Seed treatment with Thiram helped to record the lowest EC and higher germination percentage and vigour. This might be attributed to the longer persistence of Thiram on seed (Vyas and Nene, 1975). Beneficial effect of Thiram in maintaining seed viability of pearl millet have been reported by Dakshinamoorthy and Sivaparkasam (1988).

The interaction effect (Table - 2) revealed that variety x seed treatment interaction was significant for EC, germination (%) and vigour index. Seeds of GW 496 when treated with Thiram recorded significantly higher seed germination and vigour index. The viability of GW 496 was better enough and in presence of Thiram it was enhanced. This combination recorded significantly lower EC suggesting antagonistic relationship of EC with seed viability.

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Effect of Sowing Dates, Nitrogen and Phosphorus on Growth and Yield of Isabgul (*Plantago ovata* Forsk)

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Isabgul (*Plantago ovata* Forsk) is an important medicinal crop and plays vital role in agricultural economy in India and holds a monopoly in production and trade in the world. Gujarat and Rajasthan are major isabgul producing states in the country. In Gujarat, it is cultivated on an area of 28,900 hectares producing 20,000 tonnes of seeds annually yielding 691 kg/ha (Anonymous, 1997). Though, it is a traditional cash crop of North Gujarat, its cultivation is extended to Saurashtra region. Hence, a replicated field experiment was conducted at the Instructional Farm of Gujarat Agricultural University, Junagadh during the *rabi* season of 1993-94. The experiment was laid out in a split plot design with three dates of sowing (5th & 20th November and 5th December) in main plots and six treatment combinations consisting three levels of nitrogen (0.10 and 20 kg N ha⁻¹) and two levels of phosphorus (0 and 20 kg P₂O₅ ha⁻¹) in sub plots. Isabgul var. Guj. Isabgul-2 was sown as per treatments and harvested accordingly. The soil of the experimental site was clayey in texture, low in available nitrogen (231 kg ha⁻¹), medium in

available phosphorus (31.62 kg ha⁻¹) and high in potash (371.0 kg ha⁻¹) with pH 7.7 and EC 0.29 dS m⁻¹.

The morphological parameters, yield attributes and yield were recorded and N and P₂O₅ content for uptake by grain and straw were determined by micro-kjeldahl's method and vanadomolybde phosphoric acid yellow colour method, respectively (Jackson, 1967) during the course of experimentation.

Different sowing dates (Table 1 & 2) significantly influenced the grain and straw yields and N and P₂O₅ uptake as well as growth and yield attributes. Significantly the highest grain (1032 kg ha⁻¹) and straw (4552 kg ha⁻¹) yields were produced when the crop was sown on 20th November than earlier (5th November) and later (5th December) sowing. As compared to earlier or later sowing the higher yield under 20th November sowing might be resulted from significant improvement in growth viz., plant height (33.32 cm) and yield attributes viz., number of spikes/plant (15.87), spike length (4.04 cm) and grain yield/plant (2.78 g) as well as N (15.07 and 18.10 kg ha⁻¹) and P₂O₅ (3.17 and 1.80 kg ha⁻¹) uptake through grain and straw, respectively. 20th November sowing also resulted in the highest net realization of Rs. 6384 ha⁻¹. This results indicated that 20th

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TABLE 1

Effect of different treatments on yield, economics and N & P₂O₅ uptake by isabgul.

Treatment	Yield (kg ha ⁻¹)		Net realization (Rs ha ⁻¹)	Uptake (kg ha ⁻¹)			
	Grain	Straw		N		P ₂ O ₅	
	Grain	Straw		Grain	Straw	Grain	Straw
Date of sowing							
5th Nov.	934	3652	5406	14.01	16.83	2.22	1.51
20th Nov.	1032	4552	6384	15.07	18.10	3.17	1.80
5th Dec.	911	3702	5186	13.84	15.57	2.09	1.46
S.E.m.±	21	120	-	0.14	0.25	0.06	0.04
C.D. at 5%	80	470	-	0.57	0.99	0.25	0.14
C.V. %	9.05	12.80	-	4.29	6.35	10.74	9.53
Nitrogen (kg ha⁻¹)							
0	792	3798	4138	13.76	15.70	2.12	1.42
10	1006	3952	6113	14.34	16.02	2.38	1.48
20	1080	4155	6765	14.82	18.79	2.99	1.87
S.E.m.±	18	69	-	0.13	0.21	0.06	0.02
C.D. at 5%	53	200	-	0.38	0.61	0.17	0.07
Phosphorus (kg ha⁻¹)							
0	901	3885	5252	14.01	16.28	2.23	1.49
10	1017	4051	6092	14.60	17.39	2.76	1.69
20	15	56	-	0.11	0.17	0.05	0.02
S.E.m.±	43	163	-	0.31	0.50	0.14	0.06
C.D. at 5%	8.11	7.38	-	3.92	5.34	10.20	6.52
Interaction							
D X N							
S.E.m.±	32	120	-	0.23	0.37	0.10	0.04
C.D. at 5%	NS	NS	-	NS	NS	NS	NS
D X P							
N X P							
S.E.m.±	26	98	-	0.19	0.30	0.09	0.03
C.D. at 5%	NS	NS	-	NS	NS	NS	NS
D X N X P							
S.E.m.±	45	169	-	0.32	0.52	0.15	0.06
C.D. at 5%	NS	NS	-	NS	NS	NS	NS

NS = Non Significant.

TABLE 2

Effect of different treatments on growth and yield attributes of isabgul.

<i>Treatment</i>	<i>Plant height (cm)</i>	<i>No. of spikes / plant</i>	<i>Spike length (cm)</i>	<i>Grain yield/ plant (g)</i>	<i>1000 grain weight (g)</i>
Date of sowing					
5th Nov.	31.90	13.86	2.28	2.35	1.52
20th Nov.	33.32	15.87	4.04	2.78	1.61
5th Dec.	30.11	12.76	2.20	1.95	1.48
S.Em.±	0.60	0.40	0.09	0.07	0.02
C.D. at 5%	2.37	1.56	0.34	0.29	NA
C.V.%	8.06	11.93	12.89	13.08	4.50
Nitrogen (kg ha⁻¹)					
0	31.04	13.00	2.48	1.90	1.47
10	31.37	13.71	2.84	2.32	1.52
20	32.92	15.77	3.21	2.86	1.52
S.Em.±	0.50	0.31	0.07	0.07	0.02
C.D. at 5%	1.45	0.91	0.21	0.20	0.05
Phosphorus (kg ha⁻¹)					
0	31.06	13.49	2.74	2.17	1.49
20	32.49	14.83	2.95	2.55	1.51
S.Em.±	0.41	0.26	0.06	0.06	0.01
C.D. at 5%	1.18	0.74	0.17	0.16	NS
C.V.%	6.68	9.41	10.68	12.20	4.44
Interaction					
D X N					
S.Em.±	0.87	0.54	0.12	0.12	0.03
C.D. at 5%	NS	NS	NS	NS	NS
D X P					
N X P					
S.Em.±	0.71	0.44	0.10	0.10	0.02
C.D. at 5%	NS	NS	NS	NS	NS
D X N X P					
S.Em.±	1.23	0.77	0.18	0.17	0.04
C.D. at 5%	NS	NS	NS	NS	NS

NS = Non Significant

November is the optimum time for sowing Isabgul in this region. Similar effect of normal sowing (21st October) of Isabgul was earlier reported by Randhawa *et al.*, (1978) for Ludhiana, Punjab.

Increasing the nitrogen from 0 to 20 kg ha⁻¹ increased grain as well as straw yield of Isabgul (Table-1). Application of 20 kg N ha⁻¹ produced significantly the highest grain (1080 kg ha⁻¹) and straw (4155 kg ha⁻¹) yields. Significant improvement in growth viz., plant height (32.92 cm) and yield attributes viz. number of spikes/plant (15.77), spike length (3.21 cm), grain yield/plant (2.86g) and test weight (1.52 g) has enhanced the yield under the application of 20 kg N ha⁻¹ which also realized the highest net return (Rs. 6765 ha⁻¹) over control and 10 kg N ha⁻¹ (Table - 2). These findings are in accordance with those of Tandel (1989).

Application of phosphorus (20 kg ha⁻¹) produced significantly higher grain (1017 kg ha⁻¹) and straw (4051 kg ha⁻¹) yields than the control (Table - 1). Significant enhancement in growth viz. plant height (32.49 cm) and yield attributes viz., number of spikes / plant (14.83), spike length (2.95 cm) and grain yield/plant (2.55 g) as well as N (14.60 and 17.39 kg ha⁻¹) and P₂O₅ (2.76 and 1.69 kg

ha⁻¹) uptake by grain and straw, respectively (Table - 2) under phosphorus application might have resulted in higher yield of Isabgul than control. Phosphorus application (20 kg ha⁻¹) also recorded higher net realization of Rs. 6092 ha⁻¹ over the control. The results corroborate with those of Tandel (1989).

Thus, it is evident from this investigation that the higher production and profit from isabgul can be secured by sowing the crop on 20th November with an application of 20 kg N and 20 kg P₂O₅ ha⁻¹.

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Integrated Weed Management in Rabi Maize

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The integrated weed management study in rabi maize revealed that weed free treatment produced highest grain yield and net profit (45.6 q/ha & Rs. 18400 /ha) followed by atrazin 1. kg + H. W. 45 DAS (42.8 q / ha Rs. 17900 / ha) with 2.23 C. BR.

Maize is sensitive to weed competition and yield losses due to weeds may range from 29 to 70 % (Mani *et al.*, 1968). For harvesting reasonably maize yield effective weed management can be had by using chemicals, manual methods or by integrating them. Further Johenson *et al.* (1998) have reported that it possible to reduce quantity of herbicides in having effective weed management by 50 % if there are integrated with cultivation practices. Integrated weed management (IWM) can be thought of as a component of Integrated Pest Management (IPM). Now a days development and implementation of IWM Strategies are becoming more important, considering recent environmental and social realities associated with traditional cropping system. The key IWM programme is to substitute ecological principles and bio economics for weedicide use (Elmore, 1996). The present

study was carried out to elicit the effect of IWM on grain production of rabi maize.

A field experiment was carried out at the Main Maize Research Station, Gujarat Agricultural University, Godhra during *rabi* 1994 to 1996, in a randomized block design with fifteen treatments. Maize variety Ganga Safed-2 was sown on No. 16, 1994, No. 8, 1995 and Oct. - 25, 1996. A basal dose of 50 kg N, 50 kg P₂O₅/ha was applied at sowing and 50 kg N/ha was applied in two equal splits (at knee height and tasselling stages). All the herbicides were applied in a spray volume of 500 litre of water / ha using knapsack sprayer fitted with a flat fan nozzle a pre-emergence within two days after sowing except 2-4 D (30 DAS) as per treatments.

Weed population

The crop was infested with Manocot and Dicot weeds viz., Tandulja (*Ameranthus polygeimus* L.), Chil (*Chenopodium album*, L.), Arotaro (*Digitaria sanguinalis*), Chidhi (*Cyperus rotundus*), Dharo (*Cynodon dactylon*), Bhangra (*Ecliptaalba*, Dhudheli), (*Euphorbia pilulifera*, L.) and Luni (*Portulaca oleracea*) were pre dominant weed species.

All these herbicides were effective against different weed species. Application of atrazine 1.0 kg / ha + hand weeding at 45 DAS was the most effective in reducing the total number of weeds. HW at 15, 30, 45 and 60 (weed free check) was also effective to reduce the weed population.

TABLE 1

Effect of integrated weed management on growth, yield attributes and net profit in maize crops.

Sr. No.	Treatments	Cobs (000/ha.)	Plant height (cm)	Dry weed wt. (kg/ha)	Grain yield (a/ha)	Fodder yield (a/ha)	WCF (%)	Net profit 1000 Rs./ha	CBR
1.	Atrazine 0.5 kg/ha pre. em.	66.7	150	654	22.8	32.0	47.2	6.5	0.88
2.	Atrazine 0.5 kg/ha + H. W. 45 DAS	64.2	158	181	33.3	44.2	85.4	11.8	1.44
3.	Atrazine 1.0 kg/ha pre. em.	61.7	157	194	36.1	50.6	84.3	14.2	1.85
4.	Atrazine 1.0 kg. ha + H. W. 45 DAS	70.0	170	98	42.8	59.9	92.1	17.9	2.23
5.	Pendimethalin 0.5 kg/ha pre em.	55.0	144	635	23.3	32.0	48.8	6.5	0.85
6.	Pendimethalin 0.5 kg/ + H. W. 45 DAS	63.3	147	296	30.1	42.0	76.1	9.6	1.11
7.	Pendimethalin 0 kg/ ha pre. em.	62.5	159	329	28.1	39.0	73.4	8.8	1.07
8.	Pendimethalin 1.0 kg/ha + H. W. 45 DAS	64.2	164	198	37.3	51.0	84.0	13.8	1.58
9.	Atrazine 0.5 kg/ha + Pendimethalin 0.5 kg/ha preem.	61.7	165	296	29.4	41.1	76.1	9.8	1.24
10.	Atrazine 0.5 kg/ha + pendimethalin	67.5	170	319	34.3	48.1	71.2	12.2	1.42
11.	2-4 D 0.5 kg/ha 30 DAS	60.8	165	380	33.2	46.9	69.5	12.5	1.66
12.	Local practice (2 H.W. + 2 H.H.)	61.7	155	637	27.7	39.8	48.6	8.9	1.12
13.	2 H. W (3 & 6 weeks)	61.7	149	621	23.5	33.0	49.9	5.8	0.67
14.	Weed free (15, 30 45 & 60 DAS)	61.7	157	22	45.6	53.9	98.2	18.4	2.01
15.	Weedy check	50.0	130	1240	13.3	16.7	-	0.9	0.13
	C.D. at 5%	9.1	19.9	80.4	3.8	5.8	-	-	-

Cost of labour Rs. 34/-

Common cost Rs. 6950/-

Atrazine Rs. 320/kg

Pendimethalin Rs. 390/ kg.

2-4 D Rs. 350 /kg

Bullock pair / Rs. 100/day

with hoeing

Maize grain price Rs. 5 / kg.

Maize fodder price 0.75 / kg.

WCE : Weed Control Efficiency.

Dry matter production by weeds

Dry matter accumulation by weeds was minimum in weed free check (22 kg / ha) having weed control efficiency of 98.2%. Atrazine 1.0 kg/ ha + H. W. at 45 DAS also proved effective with WCE of 92.1 % as against weed biomass under unweeded (1240 kg/ha) plot. Singh and Prasad (1991) also reported similar results.

Yield and yield attributes

On the basis of pooled data for grain yield, the loss in grain under weedy control was 32.4 q/ha compared with weed free. The results are in conformity with the findings of Varshney (1991). Highest grain yield of maize (45.69/ha) was recorded from weed free treatment, which was at par to atrazine 1.0 kg/ha + H. W. at 45 DAS (42.8 q/ha) Dixit and Gautam (1996) revealed that atrazine as pre emergence effectively controlled the weeds, resulting in 70 % increase in winter maize grain yield over weedy check. The lowest grain yield of 13.3 g/ha was recorded in weedy check.

The yield components viz. cobs/ ha and plant highest were considerably improved under weed control treatments. Atrazine 1.0 kg/ha + H. W. at 45 DAS was found effective in increasing the number of cobs / ha (70,000) and plant height (170 cm) similar to weed free treatment. Varshney (1991) also obtained similar results.

The higher net profit of Rs. 18400/ha was obtained in weed free treatment, followed by atrazine 1.0 kg/ ha + H. W. at 45 DAS (Rs. 17900 / ha) with highest cost benefit ratio of 1:2.23. Weedy check resulted in a net loss of Rs. 900/ha.

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Effect of Irrigation Levels and Mulch on Cotton Hybrid - 6

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Cotton is a major *kharif* crop grown on clayey soils of Region I of Narmada Command. Irrigation to cotton crop after cessation of monsoon definitely increases the yield and use of mulch may minimize the water requirement of crop (Ghildyal and Tripathi, 1987; Das and Maliwal, 1996). With these views, an experiment was planned to workout scheduling of irrigation with and without the use of mulch in cotton crop.

A field study was conducted in 1990-91 to 1992-93 at Narmada Irrigation Research Farm at Khandha, Gujarat Agricultural University with cotton variety Hybrid-6. During cropping season of 1990-91, 1991-92 and 1992-93, the rainfall received was 1104, 1022 and 735 mm, respectively and most rain (90%) being received during the period June to September. The soil is clayey in texture having pH 7.5; EC_2 5 1.04 dsm^{-1} , total N 0.032 per cent, Olsen's P_2O_5 28.4 kg/ha and available K_2O 1219 kg/ha. The crop was sown in third week of June with intra and inter row spacing of 90 and 30 cm, respectively. The crop was harvested in first week of December every year. Three levels of IW/CPE ratio i.e. 0.3, 0.5 and 0.7 and four levels of mulch i.e. no mulch, soil mulch (stirring surface soil with Wheel Hoe once a week),

black plastic of 200 micron with 80 per cent coverage and wheat straw @ 10 t/ha in factorial randomized block design with four replications. The nitrogen @ 320 kg/ha in the form of urea was applied in three equal splits i.e. before sowing, one month after sowing and one month after 2nd application. No phosphorus and potash was applied. The water expense efficiency was computed as yield divided by total water (mm) applied and rainfall received during the crop season. Irrigation each of 80 mm depth was imposed in respective IW/CPE ratio after the cessation of monsoon.

The effects of irrigation and mulching on yield of cotton are presented in Table - 1. Among various irrigation treatments, irrigation at 0.7 IW: CPE ratio (with require 5 irrigations of 80 mm depth after the cessation of monsoon) gave significantly higher seed cotton yield (1744 kg/ha) over other treatments (Table - 1). The effect of irrigation levels was non significant in 1990-91 while significant effect was observed during 1991-92 and 1992-93. The significantly higher yield was observed with 0.7 IW : CPE ratio during both the years. The effect of mulching was non significant during 1990-91 while significant effect was observed during other two years as well as in pooled. The application of wheat straw @ 10 t/ha after ceassation of monsoon gave significantly higher yield over no mulch and soil mulch but at par with plastic mulch covering 80 per cent area (Table - !). The interaction of irrigation and mulch was non significant.

**Host Preference of Epilachna Beetle,
Henosepilachna vigintioctopunctata (Fabr.)***

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The general survey made for the determining the host range of epilachna beetle during 1996-97 at College Farm, Navsari indicated that the pest damaged mainly brinjal (*Solanum melongena* L.) and tomato (*Lycopersicum esculentum* L.). However, information about the preference among these two hosts viz., brinjal and tomato by this pest is lacking. In order to compare these two hosts for the preference

of the epilachna beetle the study was undertaken in the laboratory of Department of Entomology, N. M. College of Agriculture, Navsari during 1996-97. The neonate larvae, collected from Laboratory reared culture, were reared singly on the fresh leaves of respective food materials (for each host 40 larvae) until pupation. The emerged adults were also fed on their respective food leaves. The effect of host plants were compared on the basis of larval period, pupal period, weight of full grown larva and pupa and adult longevity. The result revealed that larval and pupal period was not significantly influenced by the food plants (Table-1). However, the average number of days required to

TABLE 1

Effect of food plant on different growth parameter of *H. Vigintioctopunctata*.

Host. plant	Duration (days)		Longivity (days)		Mean weight (mg.)		
	Larval	Pupal	Male	Female	Larva	Pupa	Adult
Brinjal	15.60±0.73	4.10±0.30	34.00±1.51	46.15±0.46	27.55±0.511	28.65±0.52	27.72±0.52
Tomato	15.95±0.86	4.30±0.46	37.00±1.15	48.00±0.65	23.40±0.65	25.19±0.66	26.31±0.74
't' value	1.35	1.54	2.20	2.06*	23.00*	18.21*	16.24*
	N.S.	N.S.	Sig.	Sig.	Sig.	Sig.	Sig.

*'t' value significant at 5% level significance.

N.S. = Non significant.

complete entire larval stage was slightly longer (15.95 ± 0.86 days) on tomato leaves as compared to brinjal leaves (15.60 ± 0.73). The adult longevity, significantly influenced by food plants, was higher on tomato as

compared to brinjal. The larva grow faster and obtained heavier weight when fed with brinjal leaves (27.55 ± 0.51 mg.) than on tomato leaves (23.40 ± 0.65 mg.) The corresponding data for pupal weight was

* Part of M. Sc. (Agri.) thesis submitted to GAU by Sr. author.

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28.65 $\pm$ 0.52 mg. and 25.19 $\pm$ 0.66 mg. Brinjal leaves also enhanced the development and body weight of adults. These results clearly indicated that the brinjal leaves was preferred by larva and adult which in turn supported the development in shorter period and also helped in gaining heavier weight of both damaging stages. Such preference of brinjal over tomato by H.

vigintioctiopunctata was reported by Rao and Azam (1973).

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Susceptibility of Mustard Genotypes to Mustard Sawfly,

(*Athalia lugens proxima* Klug.)

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Mustard sawfly is a serious pest of rapeseed and mustard in the seedling stage (Narayanan, 1958). The larva feeds voraciously on young plants, and the plants either dry up or remain stunted. In case of severe infestation, all the leaves are eaten and plants die (Mathur and Upadhyay, 1996).

Field trials were conducted at the College Farm, College of Agriculture, Gujarat

Agricultural University, Junagadh during 1995-96 and 1996-97. The experiment was laid in randomized block design with eight genotypes viz. Gujarat Mustard 1, Varuna, Bio 902, MJ-91-149, MJ-93-97, MJ-94-205, SKM-93-46, and SKM-92-66 each replicated three times. The plot size was 4.00 x 0.90 m. Row to row and plant to plant distance were maintained at 45 cm x 25 cm. by thinning at 15 days after sowing. Observations were recorded at weekly interval starting from germination till the maturity of the crop. Ten plants were selected randomly from each net plot to record the larval population of mustard sawfly.

TABLE 1

Population of sawfly, *A. lugens proxima* in different genotypes of mustard (Mean of 1995-96 and 1996-97).

Sr. No.	Genotype	Larval Population / 10 plants at different week after sowing					
		4 th	5 th	6 th	7 th	8 th	Average population
1.	GM-1	2.62* (6.36)	2.06* (3.74)	1.34* (1.29)	1.31* (1.21)	0.79* (0.12)	1.62* (2.12)
2.	Varuna	2.48 (5.65)	2.26 (4.60)	1.36 (1.35)	1.37 (1.38)	1.14 (0.80)	1.69 (2.36)
3.	Bio-902	2.94 (8.14)	2.58 (6.15)	0.79 (0.12)	1.03 (0.56)	0.79 (0.12)	1.76 (2.60)
4.	MJ-91-149	2.00 (3.50)	1.41 (1.49)	0.71 (0.00)	0.79 (0.12)	0.79 (0.12)	1.04 (0.58)
5.	MJ-93-197	2.51 (5.80)	2.28 (4.70)	1.20 (0.94)	1.22 (0.99)	0.88 (0.27)	1.58 (2.00)

1	2	3	4	5	6	7	8
6	MJ-94-205	2.89 (7.85)	2.44 (5.45)	1.53 (1.84)	1.71 (2.42)	0.79 (0.12)	1.90 (3.11)
7	SKM-93-46	2.69 (6.68)	2.24 (4.52)	1.31 (1.21)	1.25 (1.06)	1.05 (0.60)	1.71 (2.42)
8	SKM-92-66	2.18 (4.25)	1.72 (2.46)	0.79 (0.12)	1.03 (0.56)	0.79 (0.12)	1.28 (1.14)
	Treatment S.Em $\pm$	0.17	0.16	0.12	0.14	0.09	0.08
	Treatment C. D at 5%	0.50	0.47	0.36	0.39	0.26	0.24
	Y x T S.Em $\pm$	0.26	0.24	0.19	0.20	0.13	0.12
	Y x T C. D. at 5%	NS	NS	NS	NS	NS	NS
	C. V. %	18.14	19.85	29.27	29.01	26.24	13.01

* $\sqrt{X + 0.5}$ transformation

Figures in parentheses are retransformed values

Pooled data of two rabi seasons (Table-1) revealed that the number of mustard sawfly larvae per 10 plants in different genotypes of mustard showed the genotype MJ-91-149 recorded significantly lowest sawfly population i.e. 1.04 larvae/10 plants and it was at par with genotype SKM-92-66 (1.28 larvae).

The genotype MJ-94-205 showed significantly higher number of sawfly larvae (3.11 larvae/10 plants) and was at par with the genotype Bio-902, SKM-93-46 and Varuna. It is thus clear that none of the genotypes tested was found resistant to this

pest. But, MJ-91-49 and SKM-92-66 were found least susceptible, Whereas, Varuna, bio -902, MJ-94-205 and SKM-93-46 were comparatively more susceptible to mustard sawfly.

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Screening of Mango Cultivars to Postharvest Fruit Rots and Biochemical Changes During Decay

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Stem end rot (*Lasiodiplodia theobromae* (Pat.) Griffon & Maul.) and black rot (*Aspergillus niger* Van Tiegh.) were found major postharvest diseases of mango fruits on Kesar cultivar (Jadeja, 1991). Kesar is the pride cultivar of Gujarat State. No information was available about disease reaction of another popular cultures of mango in Gujarat against these rots. The present study was undertaken with ten mango cultivars viz., Kesar, Alphonso, Rajapuri, Totapuri, Langra, Asadio, Vanraj, Sardar, Makaram and Badami. Simultaneously in all the cultivars biochemical changes due to these rots were also studied.

Unripe, mature fruits were carefully harvested with intact pedicel and brought to the laboratory. After surface sterilization, fruits of each cultivar were inoculated separately with both the pathogens. Twelve fruits were kept in each of the cultivar for respective pathogen which were divided in to four replications, keeping three fruits in each one. One set of uninoculated healthy fruits for each cultivar was also kept for

incubation. The inoculated fruits were placed in sterilized polythene bags separately. A piece of sterilized wet absorbent cotton was placed inside the bag keeping loosely tied open end. The bagged fruits were incubated at $30\pm 1^{\circ}\text{C}$ for seven days. The fruit rot incidence and intensity were recorded on 3rd, 5th and 7th day. The intensity of fruit rot was recorded on the basis of per cent fruit area infected. After 7 days of incubation, pH, ascorbic acid, reducing sugar and total sugar of healthy and diseased tissues were assessed by titrametric method described by Ranganna (1979). The scoring of disease reaction in respective cultivar was decided after 7 days of incubation on the basis of per cent fruit area infected (PFal), where, 1-5 PFal = Resistant (R), 5.1-10 PFal = Moderately Resistant (MR), 10.1 - 20 PFal = Moderately Susceptible (MS), 20.1 - 50 PFal = Susceptible (S) and >50 PFal = Highly Susceptible (HS). Sixty per cent rot was taken as maximum of rotting.

The results presented in Table - 1 revealed that after 7 days of incubation fruits of Makaram (5.0%) and Sardar (6.1%) showed lower intensity of stem end rot disease, hence rated as resistant (R) and moderately resistant (MR) respectively. Stem and rot intensity in Vanraj, Rajapuri, Asadio and Totapuri was 22.8, 23.3, 42.2 and 46.7 per cent respectively which falls under

TABLE 1

Reaction of mango cultivars to the fruit rot diseases (after 7 days of incubation).

Cultivar	Stem end rot disease		Black rot disease	
	Per cent*	Disease	Per cent*	Disease
	disease	reaction	disease	reaction
	intensity		intensity	
Kesar	60.0	HS	26.7	S
Alphonso	60.0	HS	19.5	MS
Badami	60.0	HS	17.8	MS
Langra	51.1	HS	13.3	MS
Totapuri	46.7	S	8.9	MR
Asadio	42.2	S	7.2	MR
Rajapuri	23.3	S	6.5	MR
Vanraj	22.8	S	4.7	R
Sardar	6.1	MR	3.9	R
Makaram	5.0	R	3.1	R

Note : uninoculated fruits remained disease free after 7 days of incubation.

* Mean of four replications.

TABLE 2

Biochemical changes in mango fruits of different cultivars to stem end rot and black rot diseases.

Cultivar	Per cent decrease in diseased tissues							
	pH		Ascorbic acid		Reducing sugar		Total sugar	
	1	2	1	2	1	2	1	2
Kesar	09.2	10.6	74.4	47.4	49.3	56.6	54.5	62.0
Alphonso	23.3	20.8	76.5	52.0	49.6	52.2	53.7	60.2
Badami	06.2	06.6	71.8	35.7	50.9	31.2	48.3	55.6
Langra	26.3	32.5	87.4	68.9	47.6	31.5	44.7	46.9
Totapuri	14.6	03.4	41.1	27.8	45.3	14.4	54.8	26.4
Asadio	05.3	02.9	42.0	33.4	39.8	20.8	49.7	13.8
Rajapuri	12.3	03.8	50.5	24.4	33.0	19.8	49.2	13.2
Vanraj	07.8	00.9	38.0	23.5	36.3	38.9	40.5	14.5
Sardar	02.9	01.8	19.5	17.5	17.9	11.9	25.8	10.1
Makaram	00.8	00.8	15.9	11.8	14.4	12.2	19.9	12.4

1 = Stem end rot

2 = Black rot

susceptible (s) reaction. Above fifty per cent stem end rot intensity was observed in Langra, Badami, Alphonso and Kesar and marked as highly susceptible (HS). In case of black rot disease, less than five per cent fruit rot intensity was recorded in Makaram, Sardar and Vanraj. These cultivars were categorised as resistant (R) against black rot. Moderate resistant (MR) reaction was observed in Rajpuri, Asadio and Totapuri against black rot disease. The black rot intensity in Langra, Badami and Alphonso was 13.3, 17.8 and 19.5 per cent respectively, rated as moderately susceptible (MS). Highest black rot intensity (26.7%) was recorded in Kesar fruits and rated as susceptible (S). Stem end rot intensity was high in the fruits of all the cultivars in comparison to black rot due to its faster rotting rate. The fruits of most popular cultivars of Gujarat viz. Kesar and Alphonso showed maximum susceptibility against both the diseases. Although Patel (1972) observed maximum loss of 16 per cent in Totapuri fruits in Ahmedabad market against *Aspergillus* rot, this may be due to high inoculum load during transit in this particular cultivar and other injury causing factors therein.

The fruits of all the cultivars under investigation infected with *L. theobromae* and *A. niger* showed depletion in pH, ascorbic acid, reducing sugar and total sugar (Table-2). Similar trend was observed by various workers (Ghosh *et al.* 1966,

Tondon, 1970, Desai and Pathak, 1971, Majmudar and Modi, 1980). Maximum reduction in pH and ascorbic acid due to both the rots was recorded in Langra, followed by Alphonso. Reduction in reducing sugar due to stem end rot and black rot was highest in Badami and Kesar, respectively. Total sugar reduction under stem end rot infection was maximum in Totapuri, which closely followed by Kesar and Alphonso, while it was higher in Kesar and Alphonso when infected with black rot.

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Screening of Chilli Varieties Against Fusarium Wilt*

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Wilt of chilli caused by *Fusarium solani* was observed in moderate to severe form in some talukas of Rajkot district (Gujarat) during *kharif* and *rabi* season of 1996-97.

Fusarium wilt is a soil-borne disease and the organism persists in the soil for several years. Hence the cultivation of resistant varieties is the most economic and feasible method of control. Earlier Camino *et al.* (1987) identified Keystone cultivar as resistant and California Wonder as susceptible to capsicum wilt caused by *F.solani*.

TABLE 1

Reaction of different chilli cultivars against *Fusarium solani* under artificial inoculation in the green house.

Sr. No.	Reaction*	Cultivars
1.	Immune (I)	None
2.	Resistant (R)	GC-1, GC-2
3.	Moderately resistant (MR)	Jwala, HC-9, HC-1, PBS-86-1, PBS-86-2
4.	Susceptible (S)	HC-4, HC-10, HC-12, HC-5, HC-7, HC-13, HC-15, HC- 11, HC-2, HC-3, HC-6.
5.	Highly susceptible (HS)	Reshampatto, Gholar.

* Based on per cent mortality :

I = 0%

R=1-10%

MR = 11-30%

S = 31-70%

HS = Above 70%

* A part of M. Sc. thesis.

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Twenty varieties of chilli were screened against the most virulent isolate. The evaluation was done in post filled with sterilized soil. Culture of the pathogen (*F.solani*) multiplied on soil maize medium was added in the ratio of 1:10 five plants of each variety were kept per pot and replicated thrice.

Observations were recorded regularly and the disease reactions were calculated based on the per cent mortality following Gaur and Sharma (1988).

None of the varieties tested here was free from infection (Table - 1). However GC-1 and GC-2 were resistant. Five varieties

viz, HC-9, HC-1, PBS 86-1, PBS - 86-2 were moderately resistant. Eleven varieties namely HC-4, HC-10, HC-12, HC-5, HC-7, HC-13, HC-15, HC11, HC-2, HC-3 and HC-6 were susceptible. While the two varieties Reshampatto and Gholar were highly susceptible.

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Abstracts of Ph. D. Thesis

Diagnostic Survey Study of Coconut (*Cocos nucifera* L.) for Cultural Practices and Economics in Valsad District (South Gujarat)

Submitted to Gujarat Agricultural University

Name of Student

Major Guide

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A diagnostic survey study was carried out on coconut cultivation in South Gujarat to study the existing farming, cultural practices and economics, selecting 50 respondents from 6 talukas. Mostly the coconut cultivar 'West Coast Tall' was in use for planting and the growers were aware of Dwarf Green. Almost half of the respondents had adopted recommended spacing and purchased seedlings from private nurseries. Most of the respondents had adopted regular planting method, two third respondents had obtained bearing stage in coconut which belonged to medium group. Most of the respondents had adopted basin method of irrigation and plant protection measures. The maximum 96 and 84 per cent of the respondents had applied FYM and chemical fertilizers to coconut palms, respectively. Nearly three fourth of the respondents had applied common salt around coconut stem. About 59.32 per cent respondents sold their coconuts

in retail market. It was interesting to note that though most of the coconut garden holders faced the problem of marketing, 94 per cent of them were of the positive opinion for adopting coconut cultivation.

Majority of the respondents were from middle age group, literate upto secondary level and possessed coconut garden holding < 2 ha. Age was found to be significantly related with the level of coconut cultivation knowledge. Nearly 44 per cent respondents were motivated by other farmers for coconut cultivation.

The total investment including maintenance of coconut garden and cost of cultivation per hectare amounted to Rs. 12000 and Rs. 9200, respectively. The overall average yield per hectare was obtained 5700 nuts and profit worked out at Rs. 10280/ha (average of 1996-97 and 1997-98). The highest costs were observed for fertilizers and lowest for plant protection. Input wise cost of cultivation did not show much variation among different size of coconut holdings.

The results based on two years summerized that the coconut cultivation seems to be a profitable in Valsad district. So this study justify farmers investment in coconut cultivation.

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Genetic Architecture for Sex Expression and Qualitative and Quantitative Characters in Castor (*Ricinus communis* L.) Under Different Environments

Submitted to Gujarat Agricultural University

Name of Student

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Investigation were carried out on sex expression and maintenance studies of five castor females viz., VP1, Geeta, SKP 35, SKP 52 and SKP 93 under high and low temperature conditions and on heterosis and combining ability and nature and gene action analysis for qualitative and quantitative traits involving nine castor genotypes, 36 F_1 's and 36 F_2 's under irrigated and rainfed conditions at Main Castor Research Station, Gujarat Agricultural University, Sardar Krushinagar during *kharif* 1995-96.

The result indicated that to obtain maximum female plants, female lines should be maintained through environmental sensitive staminate (ESSF) pollinators and by selfing of late reverted plants. This will be helpful for increasing hybrid seeds with high genetic purity. The reversion in females upto 4th order (32.5°C temperature) was under limit. Therefore to get high genetic purity of hybrid seed, spikes upto 4th order should be harvested. The maintenance of S-type female is accomplished in male promoting environment (*summer*) whereas,

hybrid programme in female promoting environment (*winter*). The maximum heterosis was accomplished in cross TMV 5 x SKI 119 (44.59) under irrigated and heterobeltiosis in cross TMV 5 x SKI 119 (44.59) over both the environments. Parents SPS 43-3, SKI 22 and 48-1 under irrigated and VI 9, SKI 119 and 48-1 under rainfed conditions showed good GCA effect and *per se* performance for yield and its components. The crosses SKI 22 x TMV 5, 48-1 x SKI 119 and SKI 107 x SPS 43-3 under irrigated and SKI 22 x SPS 43-3, SKI F_2 22 x TMV 5 and SKI 22 x SKI 119 under rainfed conditions exhibited high heterosis and SCA effect. Crosses with high heterotic effect for yield and its components showed high inbreeding depression under both the conditions and thus heterosis was mainly due to non-additive gene action.

Estimate of KD/KR ratios along with D and H components revealed that additive as well as non-additive gene action was involved in the inheritance of most of the traits with predominant role of non-additive gene action under both the conditions. Under these conditions, biparental meeting and reciprocal recurrent selection offer promise. Alternate intermating and selfing showing transgressive segregation would be helpful in isolating superior genotypes. The graphical analysis revealed that both partial and overdominance were important for yield and its components. Estimates of heritability were high to moderate for most of the traits which were moderately influenced by environmental factors.

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**Impact of National Watershed Development Project
for Rainfed Areas on Farmers' Knowledge and
Adoption of Rainfed Agro Technology**

Submitted to Gujarat Agricultural University

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The study was undertaken during 1997 with 2 dependent variables (level of knowledge and extent of adoption) and 14 independent variables at Gujarat Agricultural University, Junagadh. A sample of 90 beneficiary farmers and 90 non beneficiary farmers representing eight villages of Junagadh district of Gujarat State were drawn by using multistage random sampling technique. The major findings were :

1. The BF's and NBF's differed significantly in their characteristics like, size of land holding, social participation, employment status, irrigation potentiality, cropping intensity, production, overall modernity, extension participation index, level of attitude, knowledge index and adoption index.
2. Majority of the BF's (60.11 %) and NBF's (74.45 %) belonged to medium level of knowledge category with 70.25 and 59.72 mean knowledge index, respectively. Even though they differed significantly in their level of knowledge of RAT.
3. Majority of the BF's (58.89%) and NBF's (71.11%) were medium adopters of RAT

with 67.43 and 52.86 mean adoption index, respectively. Eventhough they differed significantly in their extent of adoption. The practices like use of short duration crops and their varieties, timely sowing, optimum plant population, interculturing, use of organic manure, opening of furrow in summer season, weeding, supplementary irrigation, use of chemical fertilizer and plant protection measures were adopted by more than 74.00 per cent BF's. In case of the NBF's, the practices like: use of organic manure, opening of furrow in summer season, optimum plant population, timely sowing, use of short duration crops and their varieties, mid season correction, supplementary irrigation, weeding interculturing and use of chemical fertilizer were adopted by more than 55.00 per cent respondents.

4. There was a positive and significant association between BF's' level of knowledge about rainfed agro technology and their characteristics like : education, social participation, employment status, Irrigation potentiality, cropping intensity, production, extension participation index, training received, level of attitude and adoption index. They were jointly contributing significantly to 85.15 per cent of the variation in the level of knowledge of BF's.

5. There was a positive and significant association between NBFs' level of knowledge about RAT and their characteristics like : size of land holding, employment status, education, herd size, social participation, irrigation potentiality, production, extension participation index, training received and adoption index. They were jointly contributing significantly to 53.74 per cent of variation in the level of knowledge of NBFs.
6. There was a positive and significant association between BF's extent of adoption of RAT and their characteristics like : education, social participation, irrigation potentiality, cropping intensity, production, extension participation index, training received, level of attitude and adoption index. They were jointly contributing significantly to 76.21 per cent of variation in extent of adoption of BF's.
7. There was a positive and significant association between NBFs' extent of adoption of Rat and their characteristics like: education, social participation, production and knowledge index. They were jointly contributing significantly to 45.69 per cent of variation in the extent of adoption of NBFs.
8. Some of the important constraints faced by the BF's in adoption of RAT were : (i) lack of knowledge (71.11%), (ii) lack of technical guidance (66.67%), (iii) lack of training (63.33%), (iv) non availability of inputs at local level (58.89%), (v) high cost of inputs (52.22%) and (vi) lack of finance to purchase inputs (48.89%).
9. The important suggestions made by the BF's to overcome the constraints in adoption of RAT were (i) training should be given to the farmers in relation to rainfed agro technology (78.89%), (ii) easy and timely availability of agricultural inputs (74.44%), (iii) organization of need based demonstration (72.22%), (iv) easy and timely availability of credit facility (65.56%), (v) written material on rainfed agro technology should be published (63.33%) and (vi) extension system should be streamlined to disseminate latest rainfed / dryland technology (50.00%).

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