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Abstracts of Ph. D. Thesis

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Growth and Development of Soybean as Influenced by Intercropping with Pigeonpea and Phosphorus Level

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ABSTRACT

A field study of growth and development of soybean as influenced by intercropping with pigeonpea and phosphorus fertilization revealed that grain yield of soybean due to association of pigeonpea was reduced by 54.96 % in additive and 45.10 % in replacement system of intercropping. A remarkable reduction was noted in harvest index of soybean which was 23.75% in replacement and 19.60% in additive system in comparison to 29.24% in sole cropping. Soybean growth was poor due to association of pigeonpea in additive series. Application of phosphorus showed as positive effect on height of soybean, dry weight, root nodule, number of nodes per plant and other yield attributing characters upto the highest tested dose of 90 kg P_2O_5/ha. However, grain yield was maximum with the application of 60 kg P_2O_5/ha @ 4.67 q/ha of 54.11% over control. Optimum level of phosphorus was 61.65 kg P_2O_5/ha for pure soybean, 36.47 kg P_2O_5/ha, for inter cropped soybean in additive series and 65.53 kg P_2O_5/ha in replacement series of intercropping on per row basis.

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INTRODUCTION

The advantages of intercropping for productive utilization of available resources has been highlighted by Aiyer (1949) and Willey (1979). Intercropping of early maturing pigeonpea and soybean in additive and replacement series is gaining popularity in soybean growing tract of the country. According the Willey (1979), in additive series of intercropping, additional rows and plants of intercrop are adjusted in between two rows of main crop which is sown at wider row spacing. In intercropping of soybean with pigeonpea, most of the research worker have considered pigeonpea as main crop and soybean as intercrop (Ahlawat *et al.* 1982 and Tomar *et al.* 1987). In replacement series of intercopping particular row number of one crop is replaced by suitable number of row (s) by another crop. In these two crops, research worker have considered both component crop as main and intercrop. In replacement system of intercropping of soybean with pigeonpea, most of the research worker have replaced the row (s) of soybean by pigeonpea (Ahlawat *et al.* 1982 and Billore *et al.* 1993). Phosphorus is one of the most limiting plant nutrients which is essential for good growth and yield of soybean. The doses of phosphorus in intercropping for component crops is still to be decided for soybean in cental Uttar Pradesh.

MATERIALS AND METHODS

The present field investigation was made at Student's Instructional Farm, Chandra Sekhar Azad University of Agriculture and Technology, Kanpur in

Central Uttar Pradesh 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 two rows of pigeonpea, in replacement series) was tried under increasing doses of phosphorus (@ 0, 30, 60 and 90 kg P_2O_5/ ha) in a 4 replicated randomized block design. The sowing of kharif crops was done on June 25th during both the years with uniform application of 20 kg N+ 20 kg K_2O_5/ha. Phosphorus application was done through single super phosphate 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 soil was sandy loam in texture, low in organic carbon (0.47%) and nitrogen (227.3 kg/ha) medium in available P (16.2 kg P_2O_5/ha) and potash (120 kg/ ha) with slightly alkaline in reaction (pH 7.6).

RESULTS AND DISCUSSION

Effect of pigeonpea on soybean in intercropping

Soybean was grown in association of pigeonpea in additive 2:1 and in replacement series 4:2 and its growth and yield was compared with its pure stand which has been presented in Table 1. It is evident from the data that initial plant population of soybean in additive and replacement series was 100% and 65.33% in comparison to 100% in sole soybean. But at the time of harvesting, plant population of soybean was 72.14 % and 66.58 % in additive and replacement series in comparison to 100% in sole soybean.

The rate of mortality of plants was 32.61% in additive and 4.96% in replacement system while it was only 6.61% in pure soybean. It is thus clear that in additive series pigeonpea exerted greater adverse effect on soybean plants than replacement series in which the adverse effect of pigeonpea was observed only in adjoining rows (50 %) . This might be due to teletoxic association of pigeonpea with soybean. The various observations on growth parameters like number of nodes, pod bearing nodes and number of nodes per root clearly indicated that there was eticlated growth of shoot of soybean particularly in additive series in association with pigeonpea in comparison to pure soybean. The root excreted chemical compound of pigeonpea might be responsible for etiolated growth of soybean. Etiolated growth of shoot was also responsible for poor development on reproductive organs like, increase in height of first pod bearing node and reduction in pod beaning nodes, number of pods per bearing node, pod yield per plant, number of pods per plant and number of seed per pod (Cf Table 1). Consequently seed yield per plant in association of pigeonpea was reduced by 41.77% and 13.81% in additive and replacement series in comparison to pure soybean.

The reduction in grain and crop shoot biomass yield in association of pigeonpea particularly in additive system is explained on the basis of combined effect of reduction in final plant population and poor development of pods and grains. Grain yield of soybean in additive and replacement series was 45.05 % and 55.09 % in comparison to 100 % in sole soybean. The

TABLE 1

Growth and yield contributing characters of soybean as influenced by intercropping with pigeonpea and phosphorus level.

(2 year pooled)

Treatments	*Plant population 000 ha* Initial	Final	*Mortility %*	*Number of nodule per plant at 60 DAS*	*Branches per plant*	*Number of nodes per plant*	*Number of pod bearing nodes per plant*	*Number of pods per plant*	*Number seeds per plant*	*Pod yield per plant (g)*	*Seed yield per plant (g)*	*Crop shoot biomass (q) ha*	*Grain yield (q/ha)*	*HI %*
Cropping System														
Sole Soybean	387.18	361.29	6.61	12.19	4.02	16.65	8.47	58.69	69.95	12.16	5.65	60.02	17.65	29.24
	(100%)											(100%)	(100%)	
Soybean + Pigeonpea	387.27	260.64	32.61	8.35	2.98	15.94	7.55	41.69	44.75	7.76	3.29	38.14	7.95	19.60
(2:1) Additive	(100%)											(45.05%)	(45.04%)	
Soybean + Pigeonpea	252.95	240.56	4.96	12.35	3.36	16.20	7.43	53.12	62.76	10.48	4.87	40.56	9.69	23.75
(4:2) replacement	(65.33%)											(55.09%)	(54.97%)	
SE (d)	1.269	1.551	0.468	0.313	0.110	0.296	0.186	0.270	1.05	0.270	0.080	0.765	0.266	0.612
Cd at 5%	2.535	3.096	0.935	0.623	0.219	0.591	0.371	0.539	2.105	0.539	0.159	1.528	0.531	1.223
Doses of P_2O_5 kg/ha														
0	341.01	287.41	14.41	8.34	2.49	16.01	6.58	40.28	43.91	7.85	3.42	36.24	8.63	22.84
30	342.81	286.89	14.98	11.27	3.51	16.23	7.97	51.26	59.12	10.21	4.59	46.61	11.76	24.12
60	342.82	286.93	14.91	12.39	3.73	16.32	8.12	55.91	66.37	11.25	5.19	50.72	13.30	24.98
90	343.23	288.76	14.58	12.38	3.98	16.49	8.62	56.40	66.51	11.22	5.22	51.38	13.39	24.93
SE (d)	1.466	1.791	0.541	0.362	0.127	0.342	0.216	1.081	1.218	0.312	0.093	0.883	0.307	0.707
CD at 5%	NS	NS	NS	0.723	0.253	NS	0.429	2.158	2.431	0.623	0.185	1.764	0.614	1.412

( ) Figure's are % over sole corpping.

adverse effect of pigeonpea on growth and yield attributes and also on yield of soybean has also been reported by a number of research workers in additive series (Saxena and Yadav 1976 and Nimje 1995) and in replacement series (Nimje 1995 and Jadhao *et al.* 1992).

Effect of phosphorus on growth and development of soybean

Perusal of the results in Table - 1 make it clear that phosphorus had little effect on initial and final plant stand of soybean which is because of the fact that in the field conditions, phosphorus has no effect either on germination or on mortality of plants. The majority of yield contributing characters were found significant upto 60 kg P_2O_5/ha. The grain yield of soybean was found to be increased with the application of phosphorus upto 60 kg P_2O_5/ha and quadratic regression equation indicated that for maximum yield of soybean required 76.22 kg P_2O_5/ha. Grain yield per plant was also increased in a linear manner upto 60 kg P_2O_5/ha which was governed by positive effect of P on number of grains per plant and their size. Number of grains per plant was increased because of increase in number of pods per plant and seed per pod. While number of pods per plant was increased due to increase in the number of pod bearing nodes per plant. Similar findings was also reported by Nimje (1995).

Phosphorus requirement of soybean in pure and in association of pigeonpea. Data presented in Table-2 reveals that the response of soybean to the application of phosphorus was different in pure and in intercropping sequences. Optimum level of phosphorus in pure soybean was worked out as 61.65 kg P_2O_5/ha while it was 36.47 kg P_2O_5/ha in additive series and 65.53 kg P_2O_5/ha in replacement series on row basis.

TABLE 2

Regression equation, X-maximum and X-optima, yield and response per unit of P and per rupee spent on P in soybean in pure and with pigeonpea.

(For pooled data)

Cropping Systems	*Regression equation*	*X-maxima kg P_2O_5/ha*	*X-optima kg P_2O_5/ha*	*Yield at xmaxima q/ha*	*Response kg Grain/kg P_2O_5/ha*	*Response Rs./Rs. invested on P_2O_5*
C1-Sole Soybean	$Y=12.70+6.01x-1.16x^2$	77.69	61.65	20.48 (100%)	40.81	32.90
C3-Soybean + Pigeonpea (2:1)	$Y=6.01+2.76x-0.63x^2$	66.13	36.47	7.31 (35.67%)	21.66	16.38
C-4 Soybean + Pigeonpea (4:2)	$Y=6.97+3.15x-0.57x^2$	82.48	65.53	11.30 (55.17%)	20.25	16.38
Main effect of phosphorus	$Y=8.64+3.86x-0.76x^2$	76.22	51.79	13.54	26.66	21.60

Where x = is the interval between two phosphorus doses (*i.e.* 30 kg P_2O_5/ha).
Y = grain yield q/ha.

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Effect of Methods and Scheduling of Irrigation and Mulching on Yield of Cotton

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ABSTRACT

A field experiment was conducted on deep black soil of Main Cotton Research Station, Gujarat Agricultural University, Surat (Gujarat) during *kharif* season of 1992-93 and 1993-94 to study the effect of methods and scheduling of irrigation and mulching on growth, yield and quality of G. Cot. Hy-6 under South Gujarat condition. Eighteen treatment combinations of two irrigation methods (I_1 : All furrow irrigation and I_2 : alternate furrow irrigation) ; three irrigation scheduling (R_1 : 0.3 IW / CPE ratio, I_2 : 0.5 IW/CPE ratio and R_3 : 0.7 IW/ CPE ratio) at the depth of 70 mm and three mulching (M_0 : No mulch, M_1 : Soil mulch and M_2 : Paddy straw mulch @ 5 t/ha) were tested in split plot design with three replications. Irrigation methods did not show significant effect on yield of cotton. However 50 per cent saving in irrigation water was obtained with alternate furrow irrigation. Irrigating cotton at 0.7 IW/CPE ratio resulted in significantly higher yield and net returns. This crop required 5 or 6 irrigation each of 70 mm depth. The first irrigation should be one month of the cessation of monsoon. Soil mulch resulted in higher incremental cost benefit over no mulch. Consumptive use of water was higher with more frequent irrigations and no mulch treatments. However, WUE has reverse trend for this treatment.

(Received on, 18th Nov. 1998)

INTRODUCTION

Irrigation is one of the most important inputs for crop production as water is a pre-requisite for an efficient utilization of all farming inputs. Cotton crop is sensitive to water scarcity and to excess water. At the same time water being a costly input, its saving is very much essential in crop production. Exploration of the possibility of curtailment in irrigation requirement through regulating the evaporation from the soil surface by irrigating the crop as per climatic requirement and use of mulch becomes important. Therefore, method of irrigation, irrigation scheduling and mulching assumes special importance in cotton cultivation.

Keeping this idea in view, an attempt was made to study the effect of irrigation methods, irrigation scheduling and mulching on growth and yield of cotton.

MATERIALS AND METHODS

The experiment was conducted at the Main Cotton Research Station (20°-12' N latitude, 72°-52' E longitude) of Gujarat Agricultural University, Surat (Gujarat) during 1992-93 and 1993-94 with cotton hybrid G. Cot.-6. The soil of the experimental field was deep, moderately drained which contain 56 to 64% clay, 18 to 21 % silt, 16 to 22% sand and bulk density is 1.30, which is classified as clayey. Which represents the typical black

cotton soils of South Gujarat. Chemically low in nitrogen (234 kg/ha) and phosphorus (23.53 kg/ha) and high for potassium (486 kg/ha) with a pH of 7.7. The moisture content at field capacity was 33% while at permanent wilting point it was 18 %. The experiment were laid out in split plot design with two irrigation methods (I_1 : Irrigation in all furrow and I_2: irrigation in alternate furrow alternatively). Three irrigation scheduling (R_1 : 0.3 IW/CPE ratio R_2 : 0.5 : 0.5 IW/CPE ratio and R_3 : 0.7 IW/CPE ratio IW = 70 mm) as main plot treatments and three mulches (M_0 : No mulch, M_1 : Soil mulch / soil stirring and M_2 : Paddy straw mulch @ 5 t/ha) treatment as a sub plot treatment replicated thrice in 7.2 m x 4.8 m plots. The crop was dibbled on the onset of monsoon (25 and 18 June during 1992 and 1993, respectively) at the spacing of 120 x 45 cm. All the plots received a common dose of 320 kg N/ha phosphorus and potash fertilizer was not given. The nitrogen fertilizer was applied in four equal splits at 25-30 days interval starting from 20 days after sowing in the form of urea. The crop was adequately protected from diseases and insect pests. Total rainfall received during rainy season of the year 1992-93 and 1993-94 was 1142 mm and 1408 mm, respectively. However, during experimental period effective rain was not recorded during both the year of study. The irrigation treatment started one month after cessation of rainfall. At that time crop completed four to five month stage get a height of 82 cm in 1992-93 and 124 cm in 1993-94. Measured quantity of irrigation water given in furrow through throat parshall flume as per CPE recorded near the experimental plot. Soil mulch was done by stirring the soil after each irrigation on 4th day of irrigation. Paddy straw mulch (5 t/ha) was applied as per the treatment on the third day from the commencement of irrigation with the manual labour. It was spread uniformly on the soil surface in between the two rows and the two plants of cotton.

RESULTS AND DISCUSSION

Height of the plant, seed cotton yield and stalk yield recorded at last picking showed that it did not differed markedly between two methods of irrigation during both the years of study (Table - 1). The tallest plants with highest yield of seed cotton and stalk was recorded with frequent irrigation i.e. at 0.7 IW/CPE ratio (R_3) during both the years and in pooled result, except plant height during 1993-94 (Table-1). Among mulching treatments application of paddy straw mulch recorded significantly tallest plants and yield during course of study except for plant height during 1993-94 (Table-1). Higher growth and yield was due to more moisture available with more frequent irrigation and in mulching with paddy straw. Similar result was also reported by Singh *et al.* (1990); Verma *et al.* (1991) and Singh and Surajbhan (1993). Among quality characters lint yield and oil yield also have similar trend as shown in growth the yield attributes. Highest lint and oil yield was reported with higher rate of irrigation application at 0.7 IW/CPE ratio (R_3) and with mulch treatments (Table-1). This was also due to more moisture availability which increase uptake and so the yield output. However, treatments R_2 and R_3, R_1 and R_2, M_0 and M_1 as well as M_1 and M_2 remain at par for growth, yield and quality characters. Net return from irrigation

TABLE 1

Effect of irrigation methods, scheduling and mulch on cotton.

Treatments	Plant height (cm)			Seed cotton yield (kg/ha)			Stalk yield (kg/ha)		
	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Irrigation methods									
I_1 : Irrigation in all furrow	110.26	142.58	126.41	2459	2709	2584	3191	4264	3728
I_2 : Irrigation in alternate furrow alternatively	109.67	142.67	126.17	2411	2699	2555	3163	4087	3625
S.Em. ±	1.43	2.61	1.50	88	79	59	75	113	68
C.D.at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Irrigation scheduling									
R_1 : 0.3 IW/CPE ratio	105.50	138.78	122.14	2173	2467	2320	2583	3348	2966
R_2 : 0.5 IW/CPE ratio	111.28	142.33	126.81	2407	2747	2577	3238	4314	3776
R_3 : 0.7 IW/CPE ratio	113.11	146.72	129.92	2725	2898	2812	3710	4863	4287
S.Em. ±	1.75	3.20	2.58	107	96	102	92	138	117
C.D. at 5%	5.53	N.S.	7.61	339	303	301	289	435	346
Mulching									
M_0 : No mulch	106.17	138.72	122.44	2209	2493	2351	2663	3606	3134
M_1 : Soil mulch	110.83	143.83	127.33	2454	2752	2603	3308	4297	3802
M_2 : Paddy straw mulch @ 5 t/ha	112.89	145.28	129.08	2642	2868	2755	3561	4622	4091
S.Em. ±	1.43	3.79	2.03	76	97	62	104	206	115
C.D. at 5%	4.18	N.S.	5.93	222	283	175	303	600	328
Interaction	–	–	–	–	–	–	–	–	–

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Irrigation methods									
I_1 : Irrigation in all furrow	856	917	887	303	337	320	25.456	0.052	1:1.74
I_2 : Irrigation in alternate furrow alternatively	819	913	866	298	326	312	25.404	-	1:1.79
S.Em. ±	31	28	21	13	11	9	-	-	-
C.D.at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	-	-	-
Irrigation scheduling									
R_1 : 0.3 IW/CPE ratio	725	824	774	269	300	284	21.884	-	1:1.55
R_2 : 0.5 IW/CPE ratio	831	935	883	297	337	316	25.483	3.559	1:1.76
R_3 : 0.7 IW/CPE ratio	957	985	971	336	359	347	28.935	7.051	1:1.98
S.Em. ±	38	34	36	16	14	15	-	-	-
C.D. at 5%	119	107	106	49	43	43	-	-	-
Mulching									
M_0 : No mulch	740	832	786	275	305	290	22.752	-	1:1.66
M_1 : Soil mulch	841	926	884	304	340	322	26.033	3.280	1:1.81
M_2 : Paddy straw mulch @ 5 t/ha	932	986	959	323	350	336	27.514	4.762	1:1.81
S.Em. ±	33	38	25	9	12	8	-	-	-
C.D. at 5%	96	110	71	27	36	22	-	-	-
Interaction	–	–	–	–	–	–	–	–	–

TABLE 2

CU & WUE as influenced by various treatments.

Treatments	*Consumptive use*		*Water use efficiency kg seed cotton/ha.mm*	
	1992-93	*1993-94*	*1992-93*	*1993-94*
Irrigation methods				
I_1 : Irrigation in all furrow	317	247	8.07	12.27
I_2 : Irrigation in alternate furrow alternatively	293	233	8.69	12.81
Irrigation scheduling				
R_1 : 0.3 IW/CPE ratio	208	139	10.53	17.91
R_2 : 0.5 IW/CPE ratio	331	263	7.32	10.50
R_3 : 0.7 IW/CPE ratio	376	317	7.31	9.21
Mulching				
M_0 : No mulch	323	255	7.13	10.62
M_1 : Soil mulch	309	245	8.26	12.36
M_2 : Paddy straw mulch @ 5 t/ha	284	220	9.76	14.64

TABLE 3

Number of irrigation, interval between successive irrigation turns and average interval between two irrigation as per IW/CPE ratio.

	Number of irrigation	*Interval between*					*Average interval*
		Commomn-1	*1-2*	*2-3*	*3-4*	*4-5*	
				1992-93			
R_1 (0.3)	3	41	56	-	-	-	49
R_2(0.5)	5	23	30	34	28	-	29
R_3(0.7)	6	16	18	24	24	22	21
				1993-94			
R_1(0.3)	2	69	-	-	-	-	69
R_2(0.5)	4	36	44	26	-	-	36
R_3(0.7)	5	23	30	30	20	-	26

methods shows that all furrow method of irrigation gave marginally higher return i.e. Rs. 52 per hectare. However, alternate furrow method save 50 per cent irrigation water.

Among irrigation scheduling treatments highest net return (Rs. 28935) was realised from frequent irrigation (i.e. 0.7 IW/CPE ratio, R_3) which also gave higher return per rupee invested (Rs. 1.98). While, R_1 treatment gave Rs. 1.55 per rupee invested. The incremental cost benefit ratio over R_1 shows that R_3 treatment have higher (Rs. 12.26) value than R_2 (Rs. 9.35).

Among mulching treatments higher net return may reported from (Rs. 27514) paddy straw mulch treatment. However, CBR value were similar for soil mulch and straw mulch treatment and were higher than no mulch treatments. The ICBR over no mulch shows that soil mulch gave higher return than paddy straw mulch treatments (Table-1). It was due to higher cost of paddy straw. Similar result was also reported by Nikolar (1992); Singh and Surajbhan (1993) and Anonymous (1993).

CONSUMPTIVE USE OF WATER & WUE

Higher CU (317 and 247) was reported with all furrow method of irrigation (I_1) than irrigation in alternate furrow (I_2) (293 and 233). While WUE showed reverse trend (Table-2). Among IW/CPE ratio treatments, increase in CU was reported with increase in IW/CPE ratio from 0.3 to 0.7 during both the years of study while WUE reported reverse trend and recorded higher with lower IW/CPE ratio i.e. 10.53 and 17.91 kg seed cotton/ha-mm during 1992-93 and 1993-94, respectively. While that for higher frequency treatment R_3 were 7.31 and 9.21 kg seed cotton/ha-mm. Among mulching treatments higher CU was reported with no mulch treatment, while lower CU was with paddy straw mulch treatment (Table-2). While WUE was reported higher 9.76 and 14.64 kg seed cotton/ha-mm with paddy straw mulch treatment.

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Performance of Castor *(Ricinus communis)* Genotypes Under Various Sowing Times and Row Spacings in Summer Season

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ABSTRACT

A field experiment was conducted during the summer season of 1995 and 1996 at Junagadh to find out optimum time of sowing and row spacing for castor *(Ricinus communis* L.) genotypes. Sowing on 15 January favoured most of the yield attributes (capsules/main spike, seed weight/ main spike, spikes/ plant, capsules/ plant, test weight and seed weight/ plant) and resultantly seed yield. The level of spacing did not affect growth and yield attributes, however, there was a significant increase in branches/ plant, spikes / plant, capsules / plant, seed weight/ plant and seed yield with wider row spacing (90 cm). The variety GCH 4 recorded the highest seed yield with improved growth and yield attributes.

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INTRODUCTION

Castor (*Ricinus communis* L.) is generally grown in rainy (kharif) season. There is also a greater scope of growing castor in summer season (Saran and Giri, 1987). The crop matures within 100 to 135 days in summer as compared to 210 to 240 days in *kharif* season, therefore, it is possible to take other crop in kharif season. Moreover, summer crop is less infested by insect-pests as compared to kharif crop, hence total monetary returns could substantially increased. Looking to the predominancy of kharif groundnut in the south Saurashtra region of Gujarat, the present experiment was undertaken to evaluate the performance of castor genotypes under various sowing times and row spacings in summer season.

MATERIALS AND METHODS

The field experiment was conducted during the summer season of 1995 and 1996 at the Instructional Farm, Department of Agronomy, Gujarat Agricultural University, Junagadh on clayey soil (vertisol). It had pH 7.9, E.C. 0.3 dS/m, organic carbon 0.66-0.75 %, available nitrogen 251.5-260.7 kg/ ha, phosphorus 20.9-27.5 kg/ha and potassium 216.4-237.7 kg/ha. The experiment was laid out in split plot design with 4 replications, having 3 times of sowing (15 January, 30 January and 15 February) in main plots and 2 row spacings (60 and 90 cm) and 3 genotypes (GAUC 1, GC 2 and GCH 4) in sub-plots. The crop was sown at 60 cm x 60 cm and 90 cm x 60 cm with seed rate of 15 and 10 kg/ha, respectively and fertilized with 75 kg N + 50 kg P_2O_5/ha. A whole dose of P and half dose of N in the form of diammonium phosphate and urea were applied at the time of sowing and remaining half dose of N as urea was top-gressed in two equal splits at 45 and 65 days of sowing.

TABLE 1

Effect of time of sowing and row spacing on growth and yield attributes of castor genotypes (pooled mean).

Treatments	*Plant height (cm)*	*Branches/ plant*	*Length of main spike (cm)*	*Capsules/ main spike*	*Seed weight/ main spike (g)*	*Spikes/ plant*	*Capsules/ plant*	*Seed weight/ plant (g)*	*100 seed weight (g)*
Time of sowing									
15 January	136.9	3.6	43.5	78	54.9	3.8	158	108.3	29.6
30 January	140.2	3.8	46.3	73	49.6	3.9	132	86.2	29.1
15 February	136.7	3.9	46.0	66	44.8	3.6	117	70.8	27.8
CD (P=0.05)	NS	0.1	1.7	6	3.0	0.3	9	5.2	0.7
Row sowing (cm)									
60	137.2	3.5	45.4	73	50.3	3.6	130	85.1	28.7
90	138.7	4.0	45.1	72	49.2	4.0	141	91.8	29.0
CD (P=0.05)	NS	0.2	NS	NS	NS	0.2	5	2.5	NS
Genotype									
GAUC 1	139.7	2.8	47.4	85	52.0	2.8	136	82.2	26.4
GC 2	144.9	3.5	39.5	44	33.9	4.0	112	71.3	28.4
GCH 4	129.3	5.0	48.9	84	63.7	4.5	158	111.8	31.8
CD (P=0.05)	4.9	0.2	2.4	3	1.9	0.2	6.	3.0	1.3

TABLE 2

Yield and oil content of castor genotypes as influenced by time sowing and row spacing.

Treatments	*Seed yield (q/ha)*			*Stalk yield (q/ha)*			*Oil content*		
	1995	*1996*	*Pooled*	*1995*	*1996*	*Pooled*	*1995*	*1996*	*Pooled*
Time of sowing									
15 January	16.87	16.24	16.56	21.00	17.24	19.12	48.44	48.45	48.45
30 January	15.46	15.92	15.69	23.14	19.21	21.17	48.38	48.32	48.35
15 February	10.83	11.64	11.23	18.51	18.94	18.73	48.37	48.33	48.35
CE (P=0.05)	1.06	2.36	1.15	1.92	NS	1.59	NS	NS	NS
Row sowing (cm)									
60	14.10	14.31	14.20	21.32	19.53	20.43	48.39	48.29	48.39
90	14.68	14.88	14.78	20.44	17.40	18.92	48.40	48.35	48.38
CD (P=0.05)	NS	NS	0.54	NS	1.55	0.92	NS	NS	NS
Genotype									
GAUC 1	13.62	14.20	13.91	21.31	17.20	19.25	47.92	47.96	47.94
GC 2	11.97	13.54	12.75	20.44	19.23	19.83	48.29	48.33	48.31
GCH 4	17.57	16.62	16.81	20.91	18.96	19.93	48.98	48.81	48.89
CD (P=0.05)	0.78	1.11	0.67	NS	NS	NS	NS	NS	NS

RESULTS AND DISCUSSION

Dates of sowing had a significant effect on all the growth and yield attributes except plant height. Sowing on 15 January recorded significantly the highest number of capsules / main spike, seed weight / main spike, capsules / plant, seed weight / plant and test weight, though 15 January and 30 January sowings were at par regarding capsules / main spike, spikes / plant and test weight (Table -1). Significantly the highest number of branches / plant was observed under 15 February sowing date. The climatic condition prevailed in early sowing might have provided sufficient period for flowering and development of seed leading to higher production of photosynthates before the critical heat period. Seed yield also followed the same trend as observed with yield attributes. Significantly the highest seed yield was recorded with 15 January sowing but it was at par with 30 January sowing during 1996 and pooled results. There was a sharp decline in seed yield in the sowing thereafter (Table-2).

Sowing on 30 January recorded significantly the highest stalk yield during 1995 and pooled results, however, times of sowing did not affect the stalk yield in 1996 and oil content in both the years as well as in pooled results. The results are in close confirmity with the findings of Saran and Giri (1987).

Row spacings

Spacing did not affect significantly the plant height, length of main spike, capsules / main spike, seed weight / main spike and test weight, however, number of branches / plant, spikes / plant, capsules / plant and seed weight / plant were significantly higher under 90 cm than under 60 cm spacing (Table-1). Though spacing did not influence the seed yield during both the years, significantly higher seed yield of 14.78 q/ha was recorded under wider row spacing than narrow spacing in pooled results (Table-2). While, narrow spacing produced significantly higher stalk yield than wider spacing in 1996 and pooled results. Oil content of seed was not influenced by spacing. This indicates that wider spacing favoured individual plant performance and better for the summer crop than narrow spacing. Thadoda (1993) also suggested 90 cm x 60 cm spacing for *kharif* castor.

Genotypes

Genotypes GC 2 recorded significantly the tallest plants, while genotypes GAUC 1 and GCH 4 registered significantly higher length of main spike and capsules / main spike over GC 2. Significantly the highest number of branches / plant, seed weight / main spike, spikes / plant, capsules / plant, seed weight / plant and test weight were observed in variety GCH 4 (Table-1). The differences in growth and yield attributes were due to genetic characters of genotypes. Castor hybrid 'GCH 4' also recorded significantly the highest seed yield during both the years and pooled results (Table-2). Genotypes did not differentiate stalk yield and oil content in both the years and pooled results. Better performance of variety GCH 4 was also noticed at Palem, Andhra Pradesh (Anon.; 1995).

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Studies on Heat Tolerance in Wheat Genotypes

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ABSTRACT

In a field experiment, 10 wheat genotypes were sown timely (Nov. 19) and Late (Dec. 20) to study some of the physiological parameters related to terminal heat stress tolerance. Genotypes and sowing dates had significant influence on memberane thermostability, specific leaf weight, flag leaf chlorophyll content, canopy temperature depression and grain as well as biological yield. Memberane thermostability and specific leaf weight both recorded at anthesis showed negative and positive correlation respectively with both grain or biomass yields. Canopy temperature depression and flag leaf chlorophyll did not show significant association with grain or biological yield.

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INTRODUCTION

In the present era of intensive agriculture, the increased cropping intensity has pushed more and more area under late sown wheat, which ultimately results in the exposure of plants to high temperature at grain development stage. So the crop is forced to mature without getting its sink demand fulfilled, leading to subnormal grain size. This results in heavy yield losses because of heat stress during grain filling period.

Wheat genotypes show variation in their heat stress tolerance, which may be attributed to the difference in various physiological traits. Therefore, the present investigation was aimed to studying some of the physiological parameters, which may have bearing on terminal heat stress tolerance of wheat genotypes.

MATERIALS AND METHODS

A field experiment was conducted with 10 wheat genotypes (HD 2501, K 8962, K 9329, NIAW 34, PBW 226, PBW 373, UP 2338, UP 2425, Raj 3765 and Sonalika) during the *rabi* season of 1997-98 in split plot design with three replications. The treatments comprised of two dates of sowing (Nov. 19 & Dec. 20) as main plot and varieties as sub plot treatment.

Memberane thermostability in terms of relative injury (RI%) was recorded by the method described by Saadalla *et al.*, (1990). Flag leaf chlorophyll content was extracted in dimethyl sulphoxide (DMSO) by the method given by Hiscox and Israelstam (1979). Canopy temperature depression was recorded using infrared thermometer (Telatemp AG-42) during grain growth period. Specific flag leaf weight was determined by dividing flag leaf dry weight

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by its area recorded with the help of automatic area meter.

The field was prepared after pre-sowing irrigation. The crop was manually sown in rows opened 23 cm apart with 300 seeds per square metre. The crop was adequately fertilized with 120 kg nitrogen and 60 kg P_2O_5 per ha through urea and DAP. Half dose of nitrogen and full dose of phosphorus were applied at the time of sowing and remaining half dose of nitrogen was top dressed at crown root initiation stage i.e. 25 days after sowing. The crop was harvested at maturity and the grain as well as biological yield was reported on the basis of net plot (3.68 m^2) harvested. The coefficient of correlation (r) between yield and different physiological parameters was computed on the basis of mean values for varieties.

RESULTS AND DISCUSSION

Significant increase in the relative injury (RI%) was noticed with delay in sowing after Nov. 19 (Table 1). The highest and lowest memberane injury was recorded in variety K 9329 and NIAW 34, respectively at anthesis in Nov. 19 sown crop, while variety Sonalika and PBW 373 showed the highest and lowest relative injury at anthesis under late sown conditions. Under late sown crop, variety Sonalika at 15 days after anthesis also showed the highest relative injury. The reason for highest relative injury in case of Sonalika than other varieties may be the heavy rust incidence which might have damaged cell memberane leading to solute leakage from its cell than that of all other varieties. Saadalla *et al.* (1990) found considerable genetic variation in relative injury. Relative injury increased during a fortnight after anthesis. Porter *et al.* (1994) also made similar observations. Membrane injury at the time of anthesis showed significant and negative correlation with grain as well as biological yield, indicating that the genotypes in which cell memberane can tolerate high temperature stress and show less injury, yielded more than those

TABLE 1

Effect of sowing dates, genotypes and their interaction on memberane thermostability (Relative injury %) and specific leaf weight (mg cm^{-2}) at anthesis.

Sr. No.	Genotypes	Memberane thermostability (RI %)						Specific leaf weight		
		0 DAA			15 DAA					
		Nov.19	Dec.20	Mean	Nov.19	Dec.20	Mean	Nov.19	Dec.20	Mean
1.	HD 2501	5.87	7.18	6.53	20.57	29.79	25.18	3.59	4.83	4.21
2.	K 8962	6.00	9.21	7.61	21.06	38.70	29.88	4.04	5.12	4.58
3.	K 9329	9.07	5.10	7.08	26.66	29.85	28.26	4.29	4.99	4.64
4.	NIAW 34	2.00	4.31	3.16	15.76	35.58	25.67	6.42	5.08	5.75
5.	PBW 226	6.48	9.28	7.88	25.81	38.17	31.99	3.72	6.42	5.07
6.	PBW 373	2.37	3.07	2.72	16.07	20.50	18.29	6.67	5.80	6.23
7.	UP 2338	2.42	4.52	3.47	15.57	30.80	33.18	3.93	5.99	4.96
8.	UP 2425	5.61	4.22	4.92	20.83	26.10	23.47	3.89	5.02	4.46
9.	Raj 3765	3.36	3.47	3.67	18.50	27.72	23.11	4.24	4.91	4.58
10.	Sonalika	4.12	10.44	7.28	22.04	47.15	34.60	3.97	5.04	4.51
	Mean	4.73	6.13	5.43	20.29	32.44	26.36	4.48	5.32	4.90

Table 1 (contd.)

	SEM ±	CD(5%)	SEM ±	CD(5%)	SEM ±	CD(5%)
Dates	0.01	0.07	0.02	0.14	0.02	0.14
Genotypes	0.05	0.12	0.11	0.30	0.05	0.16
For comparing two genotypes at same sowing date	0.07	0.19	0.15	0.43	0.08	0.22
For comparing two dates for same or different genotypes	0.06	0.19	0.14	0.42	0.08	0.24

DAA - Days after anthesis

which were susceptible to heat stress at anthesis. Coefficient of correlation between yield and memberane injury at 15 days after anthesis was also negative but it was not up to the level of significance.

Significantly higher specific leaf weight was recorded in Dec. 20 sown crop as compared to Nov. 19 sown crop(Table-1). Although delay in sowing resulted in the reduction in both the area and dry weight of flag leaf but due to more reduction in flag leaf area as compared to flag leaf dry weight, Dec. 20 sown crop showed significantly higher specific leaf weight than Nov. 19 sown crop. PBW 373 and PBW 226 produced the highest specific leaf weight under normal and late sown conditions respectively, while variety HD 2501 showed the lowest specific leaf weight under both the showings.

Highly significant positive correlation was found between specific leaf weight and grain as well as biomass yield (Table-2). Considerable differences in the specific leaf weight of different cultivars have been reported by Zhu. *et al.*, (1982).

TABLE 2

Effect of sowing dates, genotypes and their interaction on flag leaf chlorophyll content (mg g^{-1} fresh weight) at anthesis and 15 days after anthesis and canopy temperature depression (°C) during grain growth period.

Sr. No.	*Genotypes*	*Chlorophyll content*						*Canopy temperature depression*		
		0 DAA			*15 DAA*					
		Nov.19	*Dec.20*	*Mean*	*Nov.19*	*Dec.20*	*Mean*	*Nov.19*	*Dec.20*	*Mean*
1.	HD 2501	0.83	1.86	1.34	2.76	1.81	2.29	1.97	3.17	2.56
2.	K 8962	1.23	2.05	1.64	1.69	1.62	1.66	0.97	1.23	1.10
3.	K 9329	1.67	2.00	1.83	2.38	1.48	1.93	1.93	3.40	2.67
4.	NIAW 34	1.20	1.81	1.51	2.28	1.73	2.00	1.93	4.37	3.15
5.	PBW 226	1.39	2.06	1.72	2.03	1.95	1.99	2.37	4.20	3.28
6.	PBW 373	1.28	1.55	1.41	3.12	1.58	2.35	2.67	3.43	3.05
7.	UP 2338	1.27	1.71	1.49	2.15	1.88	2.02	2.07	3.53	2.80
8.	UP 2425	1.00	1.95	1.48	2.00	2.03	2.01	2.47	3.60	3.03
9.	Raj 3765	1.10	2.00	1.55	3.16	1.89	2.52	1.67	2.27	1.97
10.	Sonalika	1.10	1.98	1.54	2.07	1.11	1.59	1.10	3.40	2.25
	Mean	1.21	1.90	1.55	2.36	1.71	2.04	1.91	3.26	2.59

Table - 2 (contd.)

	SEM ±	CD(5%)	SEM ±	CD(5%)	SEM ±	CD(5%)
Dates	0.01	0.08	0.01	0.07	0.03	0.15
Genotypes	0.02	0.05	0.02	0.05	0.09	0.26
For comparing two genotypes at same sowing dates	0.02	0.06	0.02	0.07	0.13	0.36
For comparing two dates for same or different genotypes	0.03	0.10	0.02	0.09	0.12	0.37

DAA - Days after anthesis

At the time of anthesis, the chlorophyll content was significantly higher in Dec. 20 sown crop than Nov. 19 sown crop but 15 days after anthesis the pattern was just opposite (Table-2). It appears that temperature played an important role in the synthesis of chlorophyll. At the time of anthesis temperature was more favourable for chlorophyll synthesis in Dec. 20 sown crop and was low in case of Nov. 19 sown crop. But rising temperature during a fortnight after anthesis became more favourable in case of Nov. 19 sown crop than in Dec. 20 sown crop. At the time of anthesis, the other possible reason may be its higher specific leaf weight. Variety K 9329 and PBW 226 produced the highest chlorophyll content under normal and late sown conditions, respectively, while variety HD 2501 and PBW 373 produced the lowest chlorophyll content in their flag leaf under normal and late sown crop, respectively. Hari Kumar (1989) also found variation in the chlorophyll content of different wheat varieties. The lower chlorophyll content of variety K 8962 and Sonalika can be attributed to the heavy incidence of brown rust. Flag leaf chlorophyll content did not show significant correlation with grain or biological yield indicating that the leaf chlorophyll was not a limiting factor. According to Kasanga and Monsi (1954) most higher plants contain atleast the level of chlorophyll required for carbon dioxide assimilation and excess chlorophyll is not related to production.

Significantly higher canopy temperature depression (CTD) was found under late sown conditions as compared to normal sown conditions (Table-2). Under normal sown conditions (Nov. 19) variety PBW 373 and under late sown conditions, variety NIAW 34 showed the highest canopy temperature depression. The lowest canopy temperature depression was recorded in variety K 8962 under both the dates of sowing. The canopy temperature depression did not show any relation with grain or straw yield. Canopy temperature depression varies with change in the number of external variables, like, soil moisture, wind velocity and its turbulence and cloud cover in field conditions. Frequent rainfall during grain growth period when CTD was recorded on a bright day, might be the reason for non-significant correlations between CTD and grain for biological yield. Amani *et al.*, (1996) reported a significant positive correlation between canopy temperature depression (CTD) and yield.

The grain yield was significantly affected by sowing dates. The highest mean grain yield was obtained in Nov. 19 sown crop. Delay in sowing (Dec. 20) resulted in significant reduction in mean grain yield (Table-3). On an average, variety PBW 373 significantly out yielded all other varieties. It was followed by NIAW 34, Raj 3765 which statistically did not differ in their grain yield. The lowest grain producing variety K 8962 was followed by HD 2501 and UP 2425.

In Nov. 19 sowing variety NIAW 34 and in Dec. 20 sowing PBW 373 yielded significantly higher than all other varieties. In Dec. 20 sowing variety K 8962 and in Nov. 19 sowing UP 2425 produced significantly lower grain yield than all other varieties. Higher grain yield from timely than late sown crop has also been reported by Naik *et al.*, (1991) and Singh (1988).

TABLE 3

Effect of sowing dates, genotypes and their interaction on grain yield and biological yield (t ha^{-1}).

Sr. No.	*Genotypes*	*Grain yield*			*Biological yield*		
		Nov.19	*Dec.20*	*Mean*	*Nov.19*	*Dec.20*	*Mean*
1.	HD 2501	3.71	3.12	3.42	11.62	9.78	10.70
2.	K 8962	3.75	2.91	3.33	11.67	9.51	10.59
3.	K 9329	3.69	3.73	3.71	11.65	9.05	10.35
4.	NIAW 34	4.71	3.68	4.20	13.51	9.35	11.43
5.	PBW 226	4.51	3.71	4.11	11.44	9.53	10.49
6.	PBW 373	4.59	4.28	4.43	13.11	11.92	12.51
7.	UP 2338	4.28	3.49	3.88	11.53	9.86	10.70
8.	UP 2425	3.57	3.72	3.65	10.76	9.93	10.35
9.	Raj 3765	4.53	3.78	4.16	11.97	9.47	10.72
10.	Sonalika	4.32	3.19	3.76	11.96	9.29	10.63
	Mean	4.17	3.56	3.86	11.92	9.77	10.85
			SEM ±	CD(5%)		SEM ±	CD (5%)
Dates			0.01	0.07		0.04	0.24
Genotypes			0.02	0.06		0.06	0.17
For comparing two genotypes at same sowing date			0.02	0.08		0.08	0.24
For comparing two dates for same or different genotypes			0.02	0.10		0.09	0.31

DAA - Days after anthesis

TABLE 4

Correlation coefficients between yield and different physiological parameters.

Sr. No.	Parameters	'r' value	
		Grain yield	Biological yield
1.	Memberane thermostability (RI%)		
	0 DAA	-0.644*	-0.649*
	15 DAA	-0.374	-0.606
2.	Canopy temperature depression	0.552	0.279
3.	Specific leaf weight	0.805**	0.877**
4.	Chlorophyll content		
	0 DAA	-0.073	-0.468
	15 DAA	0.489	0.397

RI % : Relative injury per cent.

There was significantly lower biological yield in Dec. 20 sowing than in Nov. 19 sowing (Table-3). The late sown crop was forced to mature earlier without fulfilling its requirements during vagetative and reproductive period due to rise in temperature in the month of February resulting lower grain as well as straw yield than timely sown crop. Tewari (1990) and Rao (1986) also reported that late sowing resulting in reduction in biological yield.

The highest biological yield was recorded in NIAW 34 followed by PBW 373 and lowest by of 2425 under normal sown conditions (Nov. 19). Varieties PBW 373 and K 9329, respectively produced the highest and lowest biological yield than all other varieties under late sown conditions.

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Influence of Varietal Option and Time of Planting on Grain Yield and Quality of Scented Rice

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ABSTRACT

A field experiment was conducted on screening of three aromatic rice varieties viz., Pusa Basmati-1, Kasturi and RNR 18833 with 3 dates of planting July 15th, July 30th and August 14th during *kharif*, 1998 at Rajendranagar, Hyderabad. Among three scented rice varieties, RNR 18833 produced significantly higher grain yield of 3354 kg ha^{-1}. With regard to the quality traits, RNR 18833 and Pusa Basmati-1 proved significantly superior to Kasturi in L/B ratio, head rice recovery, aroma and taste. These value addition traits were significantly superior by delayed planting of the crop in mid August than in July planting though mid July planting was found to be the optimum time of planting averaged over the three varieties to reap better harvest in Southern Telangana Region of Andhra Pradesh.

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INTRODUCTION

Aromatic rice enjoys a special place in the domestic as well as the international trade. The profitability in terms of yield and quality varies with option of genotypes and several management practices. Date of planting is one of the agronomic strategies to exploit the genotypic potential of a variety and its photoperiod sensitivity so as to harness maximum production with improved quality of grain for high premiums. Varietal option suitable to the specific ecological situations is a vital factor for enhancing yield and to obtain quality grain. Very little information is available on the performance of newly identified scented rice varieties under different times of transplanting for Southern Telangana Region of Andhra Pradesh. This prompted to evaluate the relative performance of newly developed scented rice varieties Kasturi and RNR 18833 with the traditionally grown variety Pusa Basmati-1 and to evaluate the most optimum time of planting that increases yield and improves the grain quality for export preference.

MATERIALS AND METHODS

A field experiment was conducted at the Students Farm of the College of Agriculture, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad during *kharif*, 1998. This soil was an alfisol with medium gradation of available nutrients viz., 261.0 kg N, 23.04 kg P_2O_5 and 409.2 kg K_2O ha^{-1}. The pH of the soil was 8.0 and ECE was 0.34 dSm^{-1}. The experiment was laid out in a Randomised Block Design, replicated thrice. The treatments were a factorial combination of three scented rice varieties viz., Pusa Basmati-1, Kasturi and RNR

18833 each tested for their response to planting on 15th July, 30th July and 14th August. The length and breadth of rice grain were measured with dial micrometer. Milling of rice, recovery per cent was recorded from a sample of 500 g from each plot which were milled with satake rice husker and polished to 8-10 per cent. The qualitative seed characteristics viz., aroma, taste and appearance was individually scored over 1-4 scale by 12 judges and the mean values were worked out (Julino *et al.*, 1965).

RESULTS AND DISCUSSION

Among the three varieties tested, RNR 18833 out yielded the other two varieties producing 3354 kg ha^{-1} grain (Table-1). Kasturi resulted in least grain yield of 2940 kg ha^{-1}. Thus, RNR 18833 provided 4.3 per cent and 12.3 per cent additional grain over Pusa Basmati-1 and Kasturi respectively. The variety Pusa Basmati-1 had the finest grain with significant superior L/B ratio but significantly low head rice recovery per cent compared to RNR 18833 (Table-2) whereas Kasturi had significantly inferior values over other. The traits like water absorption (ml) during soaking as well as during cooking, time taken for cooking and aroma were higher with the cultivar RNR 18833 followed by Pusa Basmati-1 and the cultivar Kasturi. However, traits like the grain milling per cent, weight of cooked rice in grams and appearance of grain were similar in all the three varieties.

TABLE 1

Grain yield (kg ha^{-1}) of scented rice as influenced by varieties and dates of planting.

	Grain yield (kg ha^{-1})	
Varieties (V)		
Pusa Basmati - 1 (V_1)		3216
Kasturi (V_2)		2940
RNR 18833 (V_3)		3354
	SE ±	36
	CD (0.05%)	76
Dates of Planting (D)		
Mid of July (D_1)		3433
End of July (D_2)		3194
Mid of August (D_3)		2883
	SE ±	36
	CD (0.05%)	76

Delaying in planting time from mid of July to mid of August progressively reduced the grain yield. The reduction was 6.96 per cent when it was delayed for 15 days (mid July to the end of July) and to the tune of 16 per cent when delayed by one month (mid July to mid August). Singh and Pillai (1995) also confirmed that the scented variety Kasturi was sensitive to the time of planting. It produced significantly less yield which was 6.4 and 13.0 q ha^{-1} low when planted on 25th July and 4th August than

TABLE 2

Physical properties and quality traits of scented rice grain as influenced by varieties and date of planting.

	Length / breadth	Milling (%)	Head rice recovery (%)	Water absorption (ml) during		Time taken for cooking (minutes)	Weight of cooked rice (g)	Aroma	Taste	Appea-rance
				Soaking	Cooking					
Varieties										
Pusa Basmati-1	4.00	63.8	53.8	30.5	176.3	30.6	308.6	3.90	3.90	4.0
Kasturi	3.80	66.7	53.0	27.2	166.7	29.0	305.6	3.70	3.60	3.7
RNR 18833	3.90	65.8	54.5	32.3	178.0	32.3	313.7	4.00	3.90	3.6
SE±	0.03	1.8	0.3	0.7	1.9	0.9	4.1	0.05	0.02	0.3
CD (0.05)	0.08	NS	0.6	1.5	3.9	1.9	NS	0.10	0.05	NS
Dates of Planting										
Mid of July	3.80	63.9	52.6	31.0	175.7	30.6	311.0	3.80	3.70	3.3
End of July	3.90	65.4	53.7	30.1	173.3	31.6	310.0	3.80	3.80	3.9
Mid of August	3.90	67.1	54.7	28.9	171.9	29.6	307.0	4.00	3.90	4.0
SE±	0.03	1.8	0.3	0.7	1.9	0.9	4.1	0.05	0.02	0.3
CD (0.05)	0.08	NS	0.6	1.5	NS	NS	NS	0.10	0.05	NS

on 15th July. For obtaining higher yields early planting of scented rice was also revealed by many workers (Dhiman *et al.*, 1995., Amarjit Bali and Uppal, 1995; Gohian and Saikia, 1996; Hari Om *et al.*, 1997 and Gangwar and Sharma, 1997). The planting date had a significant impact on the quality of the grain. The L/B ratio as well as head rice recovery per cent increased significantly by planting the crop on 30th July than 15th. Planting of scented rice in mid August further increased the head rice recovery while the water needed for soaking reduced significantly compared to early planting in mid July. The dates of planting had no significant influence on the time taken for cooking, weight of cooked rice or appearance. But both the aroma as well as the taste improved significantly by delaying the planting time to the mid August.

With the foregoing investigation, it can be stated that RNR 18833 variety sown in mid July can be suitably recommended to the farmers of Southern Telangana Region of Andhra Pradesh to reap better harvest whereas the optimum planting time for value addition of grain for international trade is mid August.

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Gene Effects for Yield and Shootfly Resistance in Sorghum*

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ABSTRACT

Generation means analysis involving six generations of each of six crosses was used to elucidate the inheritance of grain yield and shootfly resistance. The genetic analysis for seven characters in sorghum indicated manifestation of complex genetic interaction for most of the characters. Both additive as well as non-additive gene effects were recorded for days to flowering, plant height, dry fodder yield per plant, grain yield per plant, grain weight, number of shootfly eggs per plant and dead heart (%). Grain yield was found to be predominantly under the control of dominance effects. These results indicated the use of biparental approach/intermating for improvement in grain yield and shootfly resistance.

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INTRODUCTION

The nature of gene action governing the expression of various traits is helpful for planning effective breeding programme. Several genetic models are available for the estimation of relative magnitude of different components of genetic variation viz., additive, dominance and epistasis. Among the various models used for the generation mean analysis the model suggested by Hayman (1958) is simple one and provides information about all the six parameters. The present investigation has been carried out to obtain genetic information for yield components and resistance to shootfly, using generation mean analysis in six crosses of sorghum.

MATERIALS AND METHODS

The experimental material consisted of eight homozygous lines viz., ICSV 700, ICSV 705, IS 2312, GJ 39, GJ 40, Malwan, CSV 15 and GSSV 148, the first three parents being resistant to shootfly and the remaining parents susceptible. The cross combinations were derived in such a way that to obtain resistance x resistance, resistance x susceptible and susceptible x susceptible viz., ICSV 700 x ICSV 705, ICSV 705 x IS 2312, ICSV 700 X GJ 39, ICSV 700 x GJ 40, GJ 39 x Malwan and CSV 15 x GSSV 148. Six generations viz., P_1, P_2, F_1, F_2, BC_1 and BC_2 of each cross were evaluated in a compact family block design with three replications during the *kharif* season 1997. Each parental and F_1 generation was represented by single row of 4 m long, two rows for back cross generation and four rows for F_2 generation. The distance was maintained at 45 x 15 cm. Five plants each in P_1, P_2 and F_1, ten plants each in BC_1 and BC_2 and 20 plants each in F_2 generation were scored for seven characters. The data were first

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TABLE 1

Estimation of gene effects for seven characters in sorghum crosses.

Cross	Genetic parameter					
	m	*(d)*	*(h)*	*(i)*	*(j)*	*(l)*
Days to 50 per cent flowering						
ICSV 700 x ICSV 705	73.00	-1.33**	20.50**	-17.33**	-2.17**	20.99**
ICSV 705 x IS 2312	-	-	-	-	-	-
ICSV 700 x GJ 39	67.33**	3.00	-0.02	-15.33**	-2.50	24.33*
ICSV 700 x GJ 40	72.00	7.00	-24.66**	-26.00	4.00	38.66**
GJ 39 x Malwan	-	-	-	-	-	-
CSV 15 x GSSV 148	-	-	-	-	-	-
Plant height						
ICSV 700 x ICSV 705	205.00**	51.00**	78.17**	7.33	-17.17**	-69.61**
ICSV 705 x IS 2312	167.00**	-86.00**	195.83**	135.33**	-14.83**	-123.6
ICSV 700 x GJ 39	206.00**	9.67	-60.83**	-42.00**	0.49	112.33**
ICSV 700 x GJ 40	187.00**	40.00**	151.33**	128.60**	2.67	-218.67**
GJ 39 x Malwan	183.60**	-25.33**	226.16**	238.7**	20.16**	-239.00**
CSV 15 x GSSV 148	-	-	-	-	-	-
Dry fodder yield per plant (g)						
ICSV 700 x ICSV 705	73.00**	-32.00**	72.00**	52.00**	-37.00**	-116.00**
ICSV 705 x IS 2312	105.00**	-97.00**	18.00**	-46.00**	-79.00**	72.00**
ICSV 700 x GJ 39	111.10**	23.00**	-64.00**	-91.33**	29.5**	77.00**
ICSV 700 x GJ 40	113.6**	-15.00**	116.50**	108.66**	4.17**	-319.66**
GJ 39 x Malwan	86.00**	13.33**	110.00**	92.00**	20.33**	-80.00**
CSV 15 x GSSV 148	102.00**	-26.0**	-44.50**	-68.00**	-14.831**	137.00**
Grain yield per plant (g)						
ICSV 700 x ICSV 705	23.66**	-3.83**	33.33**	19.66**	-7.67**	-13.33**
ICSV 705 x IS 2312	31.66**	4.66**	15.66**	-9.99	2.17	14.00
ICSV 700 x GJ 39	27.17**	-11.17**	26.67**	17.00**	-7.33**	0.67
ICSV 700 x GJ 40	36.00**	4.77**	7.50	-3.66	10.00**	19.00**
GJ 39 x Malwan	64.46**	22.16**	-59.25**	-92.99**	9.75**	113.83**
CSV 15 x GSV 148	29.83**	3.50**	40.24**	38.99**	-2.15*	-55.83**
1000 - grain weight						
ICSV 700 x ICSV 705	20.29**	-2.55**	-9.38**	-9.38**	-6.63**	22.36**
ICSV 705 x IS 2312	18.89**	-1.39**	-6.02**	-9.40**	4.19**	39.27**
ICSV 700 x GJ 39	18.63**	0.16	23.67**	23.64**	-1.37**	-27.03**
ICSV 700 x GJ 40	19.62**	0.69**	-14.72**	-11.58**	-2.32**	27.03**
GJ 39 x Malwan	16.15**	-8.67**	20.60**	15.24	-7.42**	9.19
CSV 15 x GSSV 148	20.29**	7.19**	20.59**	7.33**	-5.87**	0.66
No. of shootfly eggs per plant						
ICSV 700 x ICSV 705	-	-	-	-	-	-
ICSV 705 x IS 2312	0.94**	-0.28**	-0.31	-0.39	-0.23**	0.33
ICSV 700 x GJ 39	1.30**	-0.33**	-0.51**	0.75**	-0.15**	0.37
ICSV 700 x GJ 40	1.06**	-0.10**	-0.61**	-0.19	-0.04**	0.8**
GJ 39 x Malwan	0.95**	-0.17**	0.19	0.19*	-0.14**	-0.11
CSV 15 x GSSV 148	0.87**	0.13	-0.34*	-0.41**	-0.15**	0.54**
Dead heart (%)						
ICSV 700 x ICSV 705	21.98**	-5.98*	-39.43**	-42.03**	-6.11*	35.93**
ICSV 705 x IS 2312	16.57**	12.29**	8.84	6.76	12.51**	-21.38
ICSV 700 x GJ 39	23.39**	-4.08	36.73**	11.83	2.73	3.51
ICSV 700 x GJ 40	25.96**	-4.93*	-55.60**	-62.03**	5.47	83.03**
GJ 39 x Malwan						
CSV 15 x GSSV 148						

subjected to scaling tests of Hayman and Mather (1955) to detect epistasis and then the six parameter model suggested by Hayman (1958).

RESULTS AND DISCUSSION

The analysis of variance indicated significant differences in all the crosses except days to flowering in ICSV 705 x IS 2312, GJ 39 x Malwan and CSV 15 x GSSV 148 and number of shootfly eggs per plant in ICSV 700 x ICSV 705, which were not considered for gene action studies. The estimates of scaling test and gene effects for different traits (Table-1) revealed the presence of epistatic interactions for the inheritance of these characters. Similar results have been reported by Geeta and Rana (1987), Hussain Sahib *et al.* (1988) and Desai and Shukla (1998).

From the analysis of six parameter model it can be inferred that, both fixable and non-fixable gene effects were significant for most of the characters in all the six crosses. However, the magnitude of non-additive component was more predominant in most of the crosses for all the characters. In sorghum, varying magnitude of additive and non-additive gene effects have been reported for various characters by Indi and Goud (1981), Dabholkar *et al.* (1989), Chandak and Nandanwankar (1994) and Desai and Shukla(1998). Epistasis was also observed by Nimbalkar *et al.* (1988) and Kachave and Nandanwankar (1990) in sorghum crosses.

Involvement of additive as well as non-additive gene effects for grain yield and its components for different crosses in the present study suggested that it would be desirable to explore the possibility of commercial exploitation of heterosis or alternatively it would be desirable to follow biparental method of breeding involving selection of superior recombinants and their *interse* crossing for evolving desirable genotypes of sorghum possessing good yield and resistance against shootfly.

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Effect of Irrigation, Date of Sowing and Nitrogen on the Incidence of Mustard Aphid, *Lipaphis erysimi* Kalt.

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ABSTRACT

Investigation were carried out on the effect of irrigation, date of sowing and nitrogen on population of mustard aphid during *rabi* 1995-96 and 1996-97 at College Farm, Gujarat Agricultural University, Junagadh.

Pooled results revealed that the frequent irrigation (15 days interval) increase the incidence (24 aphids/ 10 cm tender shoot during 13th WAS) of mustard aphid. The early sown crop (up to 15 October) escaped from infestation of aphid, but infestation was highest from pod formation stage to harvest (15.80 to 102.73 aphids / 10 cm tender shoot) in crop sown on 15th November. In case of fertilizer, the crop receiving heavy dose of nitrogen (75 kg/ha) suffered more as 26.12 aphids / 10 cm tender shoot were recorded during 13th WAS. Interaction effects indicated that the crop escaped from the incidence of aphid in early sown crop (up to 15th October) when irrigated at an interval of 20 days (4 irrigations). Similar interaction effects was recorded in early sown crop fertilized with 25 kg N/ha.

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INTRODUCTION

Mustard is an important winter grown oilseed crop in India. In area and production of repeseed and mustard, India ranks first in the world. It occupies 6.3 million hectares of land with the production of 5.4 million tonnes (Anonymous, 1996). But, an average productivity of this crop at national level is very low (907 kg/ha) due to non adoption of improved production technology and large area being rainfed on marginal land of low fertilizer. In addition, the insect pests and diseases cause heavy losses to these crop especially mustard.

The mustard aphid, *Lipaphis erysimi* (Kalt.) is a key pest of mustard. Although, the aphid remains present throughout the year in the fields but its population becomes very high during December to March. As a results of sucking the sap, the plants lose their vigour, remain stunted and fail to produce yield. Emphasis has been laid primarily on the chemical control of insect pests. But much work has not been done on the effect of cultural practices and there is a need to undertake the study in a detail in the state.

MATERIALS AND METHODS

The field experiment was conducted in a split plot design during *rabi* seasons of 1995-96 and 1996-97 at the College Farm, College of Agriculture, Gujarat Agricultural University, Junagadh. Row to row distance was kept 45 cm and plant to plant distance was maintained 15 cm by thinning at 15 days after sowing. In each plot, the plant population was maintained by gap filling and thinning.

The treatments consisted of all combinations of two levels of irrigation, four levels of date of sowing and three levels of nitrogen which were tried in a split plot design. Each treatment was replicated three times with a main plot size of 5.00 to 32.40 m while the size of sub plot and sub sub plot was 5.0 x 8.10 m and 5.00 x 2.25 m, respectively. The details of individual treatment were as below :

a. Main treatment-irrigation

I_1 = Five irrigations at an interval of 15 days after two common irrigations.

I_2 = Four irrigations at an interval of 20 days after two common irrigation. (First irrigation was given at the time of sowing and second irrigation at 7 days after sowing as common irrigation).

b. Sub treatment - Date of sowing

D_1 = 1st October
D_2 = 15th October
D_3 = 1st Novermber
D_4 = 15th November

c. Sub sub treatment - Nitrogen

N_1 = 25 kg N/ha
N_2 = 50 kg N/ha
N_3 = 75 kg N/ha

The population of aphid was recorded from ten randomly selected plants in each plot from ten cm length of tender shoot of the plant. The observations were recorded at weekly intervals during initiation of the incidence of aphid till the maturity of the crop.

RESULTS AND DISCUSSION

Irrigation

The pooled results (Table-1) indicated that the incidence of aphid appeared from 9th WAS and continued throughout the season. The population of this pest was significantly higher being 2.26, 8.92, 13.64, 20.02 and 24.00 aphids / 10 cm tender shoot during 9, 10, 11, 12 and 13th WAS in crop irrigated with five irrigations as compared to four irrigations. Peak activity of mustard aphid was observed during 13th WAS in both the treatments. It can be seen from the results that the more number of irrigations induced the incidence of mustard aphid. Similar results were also obtained by Ram *et al.* (1989).

Date of sowing

The data of two years experimental results (Table-1) indicated that the crop was escaped from aphid infestation when it was sown on October-1. Further, the lower infestation (0.00 to 0.65 aphid / 10 cm tender shoot) was also observed throughout the season when the crop was sown on October 15. In third date of sowing i.e. November 1, 0.35, 4.34, 13.34, 42.27, 53.96 and 57.27 aphids / 10 cm tender shoot was recorded during 9, 10, 11, 12, 13 and 14th WAS, respectively. Among all four date of sowing, November 15 sown crop was heavily infested with 15.82, 65.17, 79.78, 91.28, 102.73 and 87.11 aphids / 10 cm tender shoot during 9, 10, 11, 12, 13 and 14th WAS, respectively. Bhagat and Singh (1989), Varma *et al.* (1993), Singh *et al.* (1995) and Upadhyay (1996) had reported that early sown crop (September or early in October) either escaped from aphid infestation or have low incidence than late sown crop.

Nitrogen

The pooled results showed that significantly lowest population i.e. 1.63, 6.00, 10.06, 16.23, 19.75 and 17.99 aphids / 10 cm tender shoot during 9, 10, 11, 12, 13

TABLE 1

Effect of irrigation, date of sowing and nitrogen on the incidence of mustard aphid, *L. erysimi* (pooled of 1995-96 and 1996-97).

Treatment	*Aphid population/10 cm tender shoot at different week after sowing*					
	9	*10*	*11*	*12*	*13*	*14*
Irrigation						
5 irrigations (I_1)	1.66*	3.07*	3.76*	4.53*	4.95*	4.67*
	(2.26)	(8.92)	(13.64)	(20.02)	(24.00)	(21.31)
4 irrigations (I_2)	1.52	2.79	3.40	4.31	4.75	4.52
	(1.81)	(7.28)	(11.06)	(18.08)	(22.06)	(19.93)
S. Em ±	0.04	0.07	0.05	0.07	0.03	0.05
C.D. at 5%	0.13	0.20	0.17	0.20	0.10	NS
C. V. %	21.91	36.48	12.55	12.69	4.50	9.41
Date of Sowing						
October 1 (D_1)	0.71	0.71	0.71	0.71	0.71	0.71
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
October 15 (D_2)	0.71	0.71	0.93	0.85	1.16	0.71
	(0.00)	(0.00)	(0.36)	(0.22)	(0.85)	(0.00)
November 1 (D_3)	0.92	2.20	3.72	6.54	7.38	7.60
	(0.35)	(4.34)	(13.34)	(42.27)	(53.96)	(57.27)
November 15 (D_4)	4.04	8.11	8.96	9.58	10.16	9.36
	(15.82)	(65.27)	(79.78)	(91.28)	(102.73)	(87.11)
S.Em ±	0.14	0.38	0.09	0.36	0.20	0.71
C.D. at 5%	0.64	1.74	0.26	1.60	0.89	3.17
C.V. %	20.90	20.08	14.60	10.49	10.01	9.65
Nitrogen						
25 kg N/ha (N_1)	1.46	2.55	3.25	4.09	4.50	4.30
	(1.63)	(6.00)	(10.06)	(16.23)	(19.75)	(17.99)
50 kg N/ha (N_2)	1.64	2.97	3.59	4.46	4.89	4.62
	(2.19)	(8.32)	(12.39)	(19.39)	(23.41)	(20.84)
75 kg N/ha (N_3)	1.67	3.27	3.89	4.71	5.16	4.86
	(2.36)	(10.19)	(14.63)	(21.68)	(26.12)	(23.12)
S.Em ±	0.06	0.10	0.08	0.07	0.08	0.07
C.D. at 5%	0.17	0.29	0.23	0.22	0.24	0.20
C.V. %	25.51	24.28	15.66	12.29	12.20	10.79
Interaction						
C. D. at 5 % ID	0.23	0.41	NS	NS	NS	NS
IN	NS	NS	NS	NS	NS	NS
DN	0.33	0.58	0.46	0.44	0.48	0.40
IDN	NS	NS	NS	NS	NS	NS

* $\sqrt{x + 0.5}$ transformation.
Figures in parentheses are retransformed values.

TABLE 2

Population of *L. erysimi* influenced by interaction of irrigation and date of sowing in mustard crop pooled of (1995-96 and 1996-97).

Treatments	I_1	I_2
After 9th week of sowing		
D_1	0.71* (0.00)	0.71* (0.00)
D_2	0.71 (0.00)	0.71 (0.00)
D_3	0.96 (0.42)	0.88 (0.27)
D_4	4.27 (17.73)	3.80 (13.94)
S. Em. ±	0.80	
C. D. at 5 %	0.23	
After 10th week of sowing		
D_1	0.71 (0.00)	0.71 (0.00)
D_2	0.71 (0.00)	0.71 (0.00)
D_3	2.30 (4.79)	2.10 (3.91)
D_4	8.57 (72.94)	7.65 (58.02)
S. Em. ±	0.14	
C. D. at 5 %	0.41	

*$\sqrt{x + 0.5}$ transformation.
Figures in parentheses are retransformed values.

TABLE 3

Population of *L. erysimi* influenced by interaction of date of sowing and nitrogen level in mustard crop (pooled of 1995-96 and 1996-97).

Treatments	N_1	N_2	N_3
After 9th week of sowing			
D_1	0.71* (0.00)	0.71* (0.00)	0.71* (0.00)
D_2	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
D_3	0.80 (0.14)	1.04 (0.58)	0.93 (0.36)
D_4	3.64 (12.75)	4.12 (16.47)	4.35 (18.42)
S. Em. ±	0.12		
C. D. at 5 %	0.33		
After 10th week of sowing			
D_1	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
D_2	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)

1	2	3	4
D_3	1.61 (2.09)	2.15 (4.12)	2.85 (7.62)
D_4	7.18 (51.05)	8.34 (69.05)	8.81 (77.12)
S. Em. ±	0.21		
C. D. at 5 %	0.58		
After 11th week of sowing			
D_1	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
D_2	0.78 (0.11)	0.96 (0.42)	1.05 (0.60)
D_3	3.38 (10.92)	3.69 (13.12)	4.08 (16.15)
D_4	8.13 (65.60)	9.01 (80.68)	9.73 (94.17)
S. Em. ±	0.16		
C. D. at 5 %	0.46		
After 12th week of sowing			
D_1	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
D_2	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
D_3	5.95 (34.90)	6.71 (44.52)	6.98 (48.72)
D_4	8.99 (80.32)	9.61 (91.85)	10.14 (102.32)
S. Em. ±	0.15		
C. D. at 5 %	0.44		
After 13th week of sowing			
D_1	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
D_2	098 (0.46)	1.16 (0.84)	1.34 (1.29)
D_3	6.68 (44.12)	7.56 (56.65)	7.90 (61.91)
D_4	9.62 (92.04)	10.15 (102.52)	10.71 (114.20)
S. Em. ±	0.17		
C. D. at 5 %	0.51		
After 14th week of sowing			
D_1	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
D_2	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
D_3	7.19 (51.20)	7.60 (57.26)	8.02 (63.82)
D_4	8.59 (73.29)	9.47 (89.18)	10.01 (99.70)
S. Em. ±	0.14		
C. D. at 5 %	0.40		

* $\sqrt{x + 0.5}$ transformation.
Figures in parentheses are retransformed values.

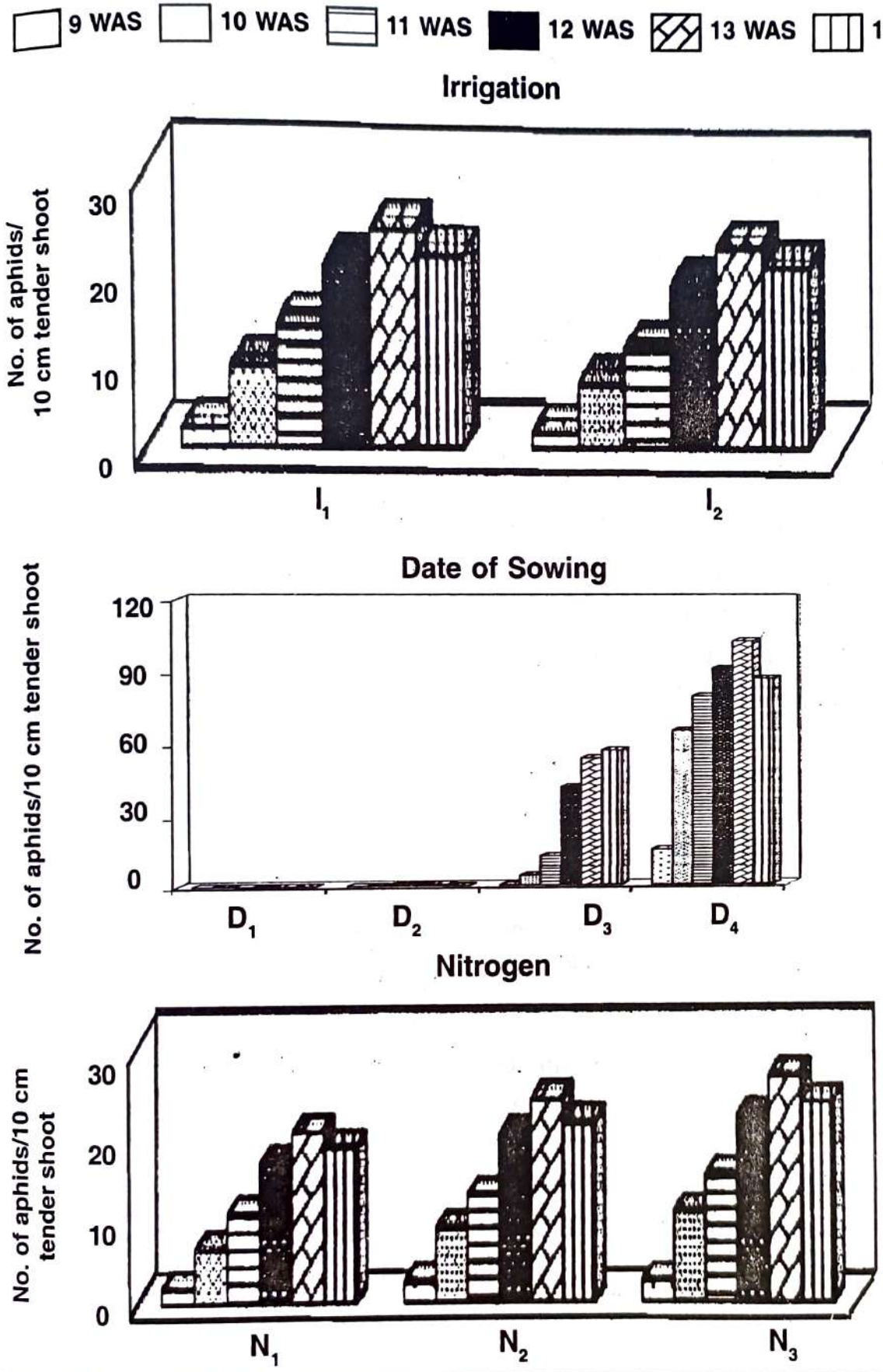

Fig. 4 : Effect of various cultural practices on the incidence of mustard aphid, *L. erysimi.*

and 14 th WAS, respectively was noted in treatment consisting lowest dose of nitrogen fertilizer (25 kg/ha) while, treatment consisting highest dose of nitrogen showed significantly highest population i.e. 2.36, 10.19, 14.63, 21.68, 26.12 and 23.12 aphids/ 10 cm tender shoot during 9, 10, 11, 12, 13 and 14th WAS, respectively. The population did not differ significantly among two doses of nitrogenous fertilizer i.e. 50 kg/ha and 75 kg/ha during 9th WAS. It can be seen from the results that the higher doses of nitrogenous fertilizer increased the incidence of aphid in mustard because of succulent growth of the crop. Similar trend was also observed by Singh *et al.* (1995a) and Upadhyay (1996).

Interaction effect (I X D)

The results (Table-2) showed that among various treatment combinations, incidence of aphid did not appear in treatment combination of I1D1, I1D2, I2D1 and I2D2 during 9 and 10th WAS. Significantly highest population was recorded in treatment combination of I1D4 (17.73 and 72.94 aphids / 10 cm tender shoot during 9 and 10th WAS, respectively.

Interaction effect (D x N)

Interaction effect between date of sowing and nitrogenous fertilizer levels (Table-3) was found significant for the build up of aphid population from commencement of the pest (9th WAS) up to harvest of mustard crop. Mustard crop was completely free from aphid infestation in treatment combinations of D1N2, D1N3, D2N1, D2N2 and D2N3 during 9th, 10th and 14th WAS, D1N1, D1N2 and D1N3 during 11 and 13th WAS and D1N1, D1N2, D1N3 and D2N1 during 12th WAS. Treatment combination of D4N3 recorded significantly highest population being 18.42, 77.12, 94.17, 102.32, 114.20 and 99.70 aphids / 10 cm tender shoot during 9, 10, 11, 12, 13 and 14th WAS, respectively and followed by D4N2 (16.47 aphids / 10 cm tender shoot) and D4N1 (12.75 to 92.04 aphids / 10 cm tender shoot) during these periods.

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Effect of Moisture Stress on Qualitative Characters in Cluster Bean Genotypes*

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ABSTRACT

Four Cluster bean genotypes viz., Pusa Naubahar, Pusa Sadabahar, Super 501 and Navchetana were evaluated for their response to qualitative characters under induced soil moisture stress at three different stages of crop growth viz., vegetative (30 DAS), flowering (45 DAS) and pod development stage (70 DAS). Results revealed that stress at pod development stage reduced the pod protein content (3.61%) whereas crude fibre content (2.73%) was increased in all the cultivars. Among the cultivars Super 501 recorded higher pod protein (3.93%) and lower crude fibre content (2.24%) under stress.

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INTRODUCTION

Cluster bean *(Cyamopsis tetragonoloba* L.*)* commonly known as 'guar' is one of the most important drought resistant *kharif* legume capable of growing under poor fertility and scanty rainfall conditions. Due to its multiple importance as fodder, vegetable and industrial seed gum it has become popular and research work has gained momentum from last few years. But still very little is known about the most important parameters like quality, particularly under drought. Hence this work was undertaken to study the changes in quality characters like protein content and crude fibre content of the pods in relation to moisture stress under different stages of crop growth.

MATERIALS AND METHODS

A field trial was conducted at the Horticultural garden, S. V. Agricultural College, Tirupati to study the effect of moisture stress at different stages of crop growth in certain Cluster bean cultivars during the summer season 1998. The trial was carried out in a Randomised complete block design with four stress treatments viz., stress at vegetative stage (30 DAS), stress at flowering stage (45 DAS), stress at pod development stage (70 DAS) and stress free control. There were four cultivars viz., Pusa Naubahar, Pusa Sadabahar, Super 501 and Navchetana and three replications. Water stress was imposed in respective treatments by withholding irrigations till the CPE readings reached evaporation of 70 mm and then irrigations were resumed till harvest. The protein content in pods (%) was calculated by multiplying N% of pods with a constant 6.25. The per cent N in pods was estimated following the micro kjeldahl's method. Crude fibre content in pods (%) was estimated as per the procedure described by Ranganna (1979).

RESULTS AND DISCUSSION

Protein content in pod (%) : The study shows that moisture stress at different stages as well as cultivars exhibited a

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significant variation in pod protein content (%) (Table-1). Among the crop growth stages the stress at pod development stage recorded significantly the lowest protein content in pods (3.61%) followed by flowering and vegetative stages, while, the stress free control recorded higher pod protein content (3.90%). Failure of amino acid metabolism

TABLE 1

Effect of moisture stress at different phenological stages of crop growth in cluster bean cultivars on protein content in pod (%).

Cultivars *Stress treatments*	*Pusa Naubahar*	*Pusa Sadabahar*	*Super 501*	*Navchetana*	*Mean*
Control	3.86	3.90	4.13	3.73	3.90
Stress at vegetative stage (30 DAS)	3.86	3.83	3.96	3.66	3.81
Stress at flowering stage (45 DAS)	3.76	3.82	3.93	3.72	3.80
Stress at pod development stage (70 DAS)	3.56	3.63	3.70	3.56	3.61
Mean	3.75	3.79	3.93	3.66	–
		F-test	S.Em.±	CD 5%	
Varieties	:	S	0.03	0.10	
Stages	:	S	0.03	0.10	
Interaction	:	NS	0.07	–	

causing breakdown of protein content in pods under stress at pod development stage might be the reason for the decline in pod protein content. Similar reports were made by Lenka and Gautam (1971) in pea and Anuradha (1994) in soybean.

Among the cultivars Super 501 was found to be superior which recorded significantly the highest pod protein content (3.93%) followed by Pusa Sadabahar (3.79%) and Pusa Naubahar (3.75%) while the cultivar Navchetana recorded the lowest pod protein content (3.66%). The superiority of the cultivar Super 501 attributed to its ability to withstand moisture stress and still yield higher pod protein content.

Crude fibre content in pod (%) : Moisture stress at different stages of crop growth as well as cultivars and their interaction was significant regarding crude

TABLE 2

Effect of moisture stress at different phenological stages of crop growth in cluster bean cultivars on crude fibre content (%).

Cultivars *Stress treatments*	*Pusa Naubahar*	*Pusa Sadabahar*	*Super 501*	*Navchetana*	*Mean*
Control	2.30	2.13	2.03	2.05	2.12
Stress at vegetative stage (30 DAS)	2.36	2.20	2.10	2.15	2.20
Stress at flowering stage (45 DAS)	2.43	2.36	2.16	2.38	2.33
Stress at pod development stage (70 DAS)	2.63	2.76	2.70	2.83	2.73
Mean	2.43	2.36	2.24	2.35	–

		F-test	S.Em.±	CD 5%
Varieties	:	S	0.02	0.06
Stages	:	S	0.02	0.06
Interaction	:	S	0.04	0.12

fibre content in pods (Table-2). Moisture stress during pod development stage recorded significantly the highest crude fibre content (2.73%) and it was declined progressively with stress in the earlier stages of crop growth. Stress at vegetative stage had little effect on crude fibre content (2.20%) and it was on par with control (2.12%), indicating moisture stress at pod development stage is detrimental to the quality of the pods as it increased the crude fibre content. Among the cultivars Super 501 recorded significantly lower crude fibre content (2.24%) under moisture stress conditions, indicating its genetic ability to withstand moisture stress and results a superior quality produce. These results are in accordance with findings of Maurer *et al.* (1968) in snapbeans. The cultivar Pusa Naubahar recorded significantly higher crude fibre content (2.43%) followed by Pusa Sadabahar (2.36%) and Navchetana (2.35%). A significant interaction was recorded between stress at different stages and cultivars regarding crude fibre content in pod. Cultivar Navchetana recorded significantly higher crude fibre content (2.83%) during stress at pod development stage, while it was the least with Super 501 (2.03%) under non stress conditions.

It can be concluded that stress at pod development stage was found to be more detrimental to the quality of pods and the cultivar Super 501 was considered to be the best to produce quality crop even under stress at pod development stage.

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Development of Aonla Shredding cum Stone Extracting Machine

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ABSTRACT

A continuous flow, power operated machine for production of aonla shreds as well as extraction of stone has been designed and developed. The machine consists of a hopper, a tapered roller, a drum chamber with concave sieve, a discharge chute and a power transmission system. The machine was tested at roller speed ranging from 200 to 400 revolutions per minute (RPM). At 330 RPM speed of roller, maximum aonla shreds (97-98 %) were recovered with minimal breakage of stone (6-7%). The machine could process 60-70 kg aonla per hour, which is 10 times more than the manual processing. The cost of processing of aonla using the developed machine is just Rs. 159 per tonne as compared to Rs. 833 per tonne for manual extraction.

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INTRODUCTION

Aonla (*Emblica officinalis*, Gaerin) is an important arid fruit crop. Its commercial cultivation can be seen mainly in Gujarat and Uttar Pradesh in India. The area under its cultivation is increasing now a days as the crop is becoming popular among farmers. Annual production of aonla in Gujarat is about 2000 tonnes and per tree production is about 400-500 kg at private farms. Average production of aonla per wild tree in forest is about 150 kg (Anon. 1991).

Aonla is a rich source of vitamin C. About 600 - 900 mg of vitamin C is found in 100 g of aonla pulp (Kikani *et al.* 1993). Due to this, aonla has a high demand in pharmaceutical and other allied industries i.e. Soap, Shampoo, Hairdye, Ink etc. Besides this, Chyavanprash, Squash, Jam, Candy, Triphala, Pickles, Mukhavas (Salted Dried Flakes) etc. are prepared from aonla. For all above preparation, stone is required to be removed, while for Mukhavas, Pickles, Triphala, and Candy, shreds are needed.

Traditionally, aonla shreds & stones are removed manually using knife. Manual process is time and labour consuming, tedious, unhygienic and uneconomical. It also causes injuries to the skin and hand while processing of aonla by labourers. Besides this, manual capacity of aonla processing is about 6 kg/h only. Non availability of adequate skilled labourers for this job in time is another problem. Dependence on human labour for aonla processing results in delay of separating seed from stone and increased cost of production.

The present study was undertaken with the objective to design & develop a suitable machine for aonla shredding and simultaneously stone removal from mature aonla fruits and to evaluate its performance.

MATERIALS AND METHODS

A continuous flow type power operated machine was designed to handle about 100 kg mature aonla fruits per hour. The

machine consists of a hopper, a tapered roller, a drum chamber with concave sieve, a discharge chute, a power transmission system and framework. The complete machine except the framework is fabricated using food grade stainless steel (AISI 304) material. The overall dimensions of the machine are 1370 x 330 x 650 mm (Fig. 1).

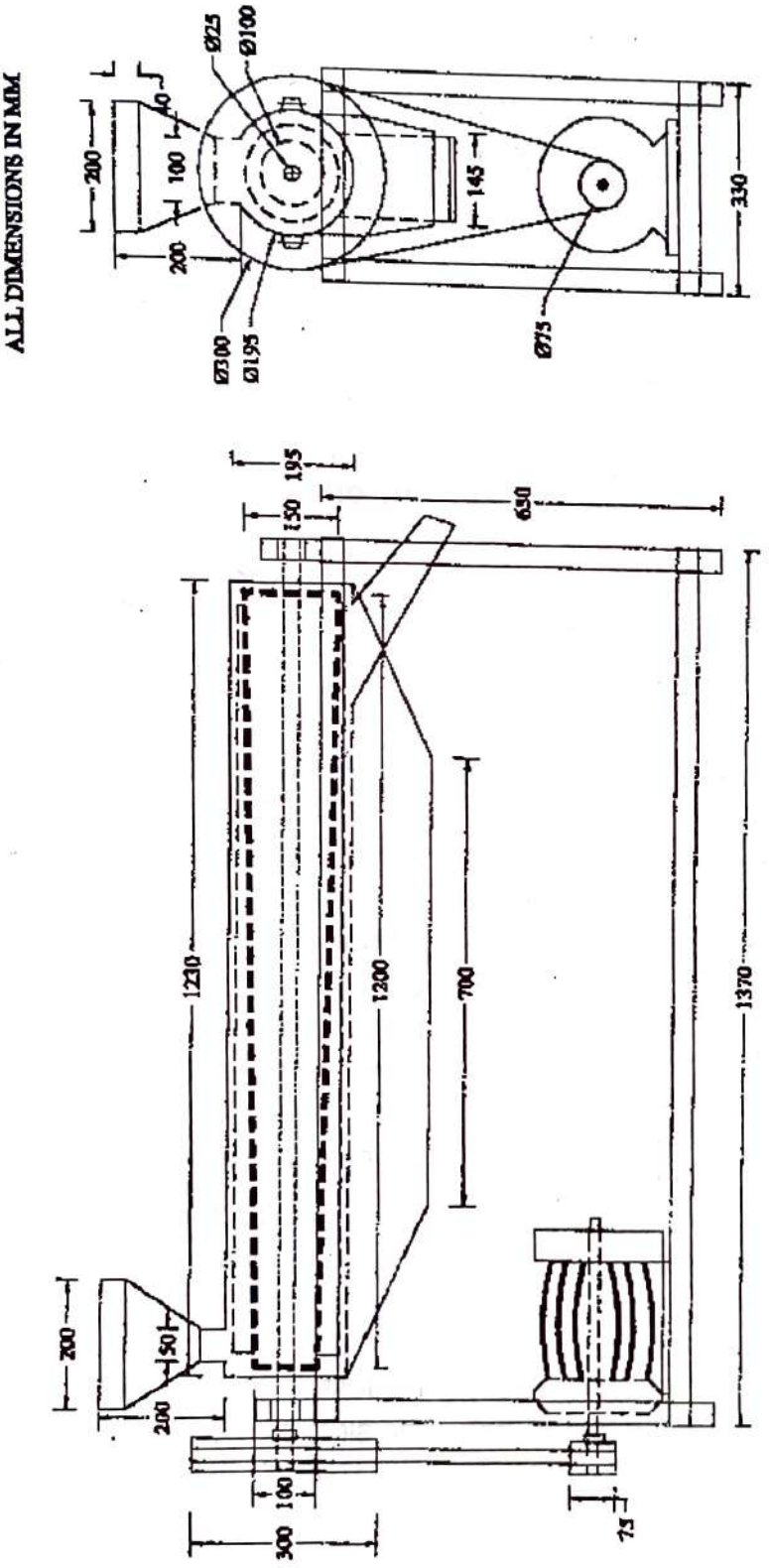

Fig. 1 : Drawing of Aonla shredding cum stone extracting machine.

The machine works on the principle of gradual scraping of the pulp from all around the fruit till the inner stone is free from pulp. Due consideration was also given to the fact that uniformly coarse size shreds are produced which will find direct use and the seeds inside the stone are undamaged to achieve maximum germination. The aonla fed to the machine is made to pass through the gradually reducing clearance between the roller and the stationary concave sieve, where it is continuously scraped and shredded while simultaneously conveying forward.

The hopper for feeding of aonla to the machine is fabricted from 1 mm thick S. S. sheet. The top and bottom cross sectional dimensions being 200 x 200 mm and 100 x 50 mm respectively. A free board of 40 mm height at the top and another 40 mm extension at bottom has been provided. The total height of the hopper is kept to be 200 mm.

The machine has a rotating taper roller fitted inside the drum chamber. The diameter of the roller at feed end is 100 mm and that at the discharge end is 150 mm. The length of the roller is 1200 mm inclusive of the end plates. The roller has been made from stainless steel round bars of 8 mm diameter and 1200 mm length. In all, thirty two such round bars are used. The bars have been welded with the end plates on both the sides in such a way that there is a forward angle of 8 degree from the feed end side. The forward twist has been provided to convey the material towards the discharge end. Two scrapers made up of 5 mm thick canvass belt have been fitted with bar no. 1 and bar no. 17, to scrap the material against the perforation of concave. The roller is mounted on a stainless steel shaft of 25 mm diameter and the shaft is fitted to the frame with the help of bearings.

The cylindrical drum chamber is made up of two equal halves namely, top cover and concave sieve. The top semi circular half (top cover) has a length of 1230 mm and radius of 97.5 mm and is made from 1 mm thick S. S. sheet and opening of 100 x 50 mm has been provided in the top cover near the feed end. There is a projection of 40 mm height at the opening; so as to push fit the feed hopper. The lower semi circular half is the concave sieve, having 1230 mm length and 97.5 mm radius, also made from 1 mm thick S. S. sheet.

The slit shape perforations of 25 x 4 mm size and 25 mm apart have been cut through out the concave in zigzag fashion. An opening of 110 x 65 mm has been provided at the discharge end of the concave for the discharge of the aonla stone and an inclined scoop has been welded there to guide the stones to a collecting pan kept below.

A trapezoidal shape discharge chute of 1230 x 195 mm top dimensions and 700 x 145 mm bottom dimensions is fitted below the concave. The sides of chute have smooth downward slope for easy flow of aonla shreds into the collecting pan, kept below the chute. The power is transmitted to the taper roller from a 3 phase, 1 HP, 1400 RPM electric motor through a set of pulleys and V-belt.

The structural frame of 1370 x 330 mm size is fabricated from M. S. angles. Four legs of 650 mm length have also been welded to support the complete machine. Pedestals and bearings have been fixed in the slots provided on each end of the frame, for mounting the central shaft. The schedule of quantities and rates of different items required for fabrication of the machine is given in Table-1.

RESULTS AND DISCUSSION

Mature aonla fruits of 'Gujarat Aonla1' variety was used for evaluating the performance of the machine. The fruits fed to the drum chamber through hopper and pass into the space between taper roller and concave sieve. The machine was tested for different operating speeds (200-400 RPM) of the roller. The fruits got scraped continuously while the rotating roller against the projected perforations of the concave and the aonla shreds were obtained which pass down through openings in the sieve. The shreds were collected in a pan kept under the machine through the discharge chute. The aonla stones were conveyed forward in the machine while being scraped and were finally discharge separately at the other end in a container.

The performance of the machine was evaluated in terms of percentage of complete shredless stones recovered in single pass and the stone breakage (if any) by using following expressions :

$$\text{Shreds loss, (\%)} = \frac{\text{Wt. of shreds lost with stones}}{\text{Wt. of shreds recovered + Wt. of shreds lost with stones}} \times 100$$

$$\text{Breakage, (\%)} = \frac{\text{Wt. of broken stones}}{\text{Wt. of whole stones + Wt. of broken stones}} \times 100$$

TABLE 1

Quantities and rates of material required for fabrication of aonla shredding cum stone extracting machine.

Sr. No.	*Item*	*Specifications*	*Quantity (kg)*	*Rate (Rs./kg)*	*Cost (Rs.)*
1.	M. S. angle	35 x 35 x 5 mm	24.0	15	360
2.	S. S. angle	25 x 25 x 3 mm	2.5	110	275
3.	S. S. flat	25 x 5 mm	6.6	110	726
4.	S. S. sheet	1829 x 1219 x 1 mm	20.0	95	1900
5.	S. S. flange	150 x 6 mm x 1 no.	4.5	110	495
		125 x 6 mm x 1 no.			
		102 x 6 mm x 1 no.			
6.	S. S. round bar	8 mm Ø	14.0	110	1540
7.	S. S. round bar	25 mm Ø	6.0	110	660
8.	S. S. bush	40 mm Od x 25 mm ID x 25 mm length x 2 nos.	0.5	110	55
9.	C. I. pulley	Single B groove, 300 mm	1 No.	180	180
10.	C. I. pulley	Single B groove, 75 mm	1 No.	45	45
11.	V-belt	B-62	1 No.	150	150
12.	Ball bearing	No. 6305	2 Nos.	90	180
13.	Pedestal for bearing	No. 6305	2 Nos.	125	250
Total Material cost					**6816**
14.	Fabrication charges	30 % of material cost			2045
15.	Electric motor	3 phase, 1 HP, 1400 rpm	1 No.	1500	1500
Total cost of machine				**Rs.**	**10361**
				Say Rs.	**10500**

The extraction capacity of the machine was computed. Three replications were taken.

The performance data of the machine as a function of roller speed are presented in Table-2. The manchine extracted the stones clear of shreds completely in single pass for all the four speeds tested. The results indicate that as the speed of the roller is increased from 231 to 396 RPM, the total shreds loss reduced from 10.10 to 1.94%. But the corresponding breakage percentage of the stone increased from 4.38 to 10.74 %.

TABLE 2

Performance of mechanical aonla shreds cum stone extracting machine.

Batch size + 5 kg aonla, Gujarat Aonla-1 variety

Sr. No.	*Speed of roller (RPM)*	*Capacity (kg/hour)*	*Shreds loss (%)*	*Breakage (%)*
1.	231	53.2	10.10	4.38
2.	264	61.3	6.11	5.99
3.	330	64.7	2.59	6.15
4.	396	69.4	1.94	10.74

Above data are average of three replications.

The breakage of the stones increased abruptly to 10.74 % at 396 RPM speed of the roller. This shows that at high speed more stones were crushed. Therefore, the speed of 330 RPM, which resulted in comparatively lower shreds loss (2-3%) as well as less breakage of stone (6-7%), was considered to be the best.

However, the breakage of the stone caused in the machine did not harm the seeds, which are inside the stone. Some of the shreds loss obtained in the stone outlet could be recovered (1-2%) and hence the net shreds loss was less than 1%.

The economics of mechanical extraction of stone from aonla vis-a-vis the manual technique have been computed. The cost of the machine was calculated (Table-1). The details of various expenditures in terms of fixed cost, variable cost, etc. and the cost of extracting stone for both the mechanical method as well as manual method are given in Table-3.

The cost of the machine has been found to be about Rs. 10500, inclusive of the cost of electric motor. In manual extraction technique one labourer can extract only about 48 kg of aonla in 8 hour shift. Thus, the cost of stone extraction and shredding works out to be Rs. 833 per tonne. When the machine is used for the above work, it can process about 480 kg of aonla in 8 hour shift. Assuming 10 years useful life and 20 % salvage value, 12 % interest on investment, 10 % repair & maintenance cost, the total fixed cost comes out to be Rs. 3150. Similarly considering the actual consumption of electric power at the rate of 6 kWh per hour and the actual labour charges, the total variable cost works out to be Rs. 64 per day.

Considering the above values of fixed cost and variable cost, the cost of stone extraction and shredding aonla using the machine was found to be Rs. 159 per tonne. The above reveals that there will be net saving of Rs. 674 for processing of one tonne of aonla by the developed machine as compare to the traditional method.

TABLE 3

Cost of aonla shredding cum stone extraction.

Sr. No.	Particulars	Specifications	Rate (Rs.)	Total Cost (Rs.)
I.	**Manual Extraction**			
	Labour charges	1 No., Rs. 40 per 8 man hour	40.00	
	Capacity of stone extraction	Av. 48 kg per 8 man hour		
	Cost of extraction per kg aonla		0.833	
	Cost of extraction per tonne aonla			**833.00**
II.	**Mechanical Extraction**			
	Initial cost of the machine		10500.00	
A.	**Fixed cost**			
	Depreciation of the machine	10 years useful life, 20 % salvage value	840.00	
	Interest on investment	@ 12% on initial cost of m/c	1260.00	
	Repair and maintenance	@ 10 % of initial cost of m/c	1050.00	
	Total fixed cost		3150.00	
	Fixed charges per day			**12.60**
B.	**Variable cost**			
	Electricity charges	@ 6 k Wh per 8 hours and Rs. 4 per kWh	24.00	
	Labour charges	1 No. Rs. 40 per 8 man-hour	40.00	
	Total variable cost/day			**64.00**
	Total cost of extraction per day (8 hours)	**(A+B)**		**76.60**
	Capacity of aonla stone extraction per day	480 kg / 8 hours.		
	Cost of extraction per kg aonla		0.159	
	Cost of extraction per tonne aonla			**159.00**
Pay back period			**32 days**	
Break even quantity			**15.5 tonne handling of aonla**	

The pay back period for the investment on the machine, comes to be about one month only. Therefore, the break-even quanity for the recovery of expenditure for mechanical extraction works to be about 15.5 tonnes of aonla.

There are various other benefits of using this machine, which can not be overlooked. The benefits include higher capacity of processing, better hygiene, superior quality product and elimination of possible health hazard. Thus, it can be concluded that for aonla shredding and stone extraction, the machine developed and described above is technically competent and economically viable. The comparative features of the machine vis-a-vis the manual extraction is briefly given in Table-4.

Conclusions

The Aonla Shredding cum Stone Extracting Machine gave good quality aonla shreds and simultaneously remove stones

TABLE 4

Comparative features of mechanical and manual aonla shredding cum stone extraction.

Sr. No.	Particulars	Mechanical extraction	Manual extraction
1.	Cost of the machine	Rs. 10500	Nil
2.	Stone extraction rate	60-70 kg per hour	6 kg per man hour
3.	Shreds recovery (%)	97-98	90-92
4.	Whole stone recovery (%)	93-94	100
5.	Cost of stone extraction	Rs. 159 / tonne	Rs. 833 / tonne
6.	Break even quantity	15.5 tonne	Nil

from mature aonla. The machine could process 60-70 kg aonla per hour, which is 10 times more than the manual processing. The cost of processing of aonla using the developed machine is just Rs. 159 per tonne as compared to Rs. 833 per tonne for manual extraction. It could safeguard the hazardous effects of the labourer's hands and skin.

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Techno-Economic Consequences Implicit Through Adoption of Drip Irrigation System

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ABSTRACT

The present study was conducted in six talukas of Junagadh district to analyze the constraints faced by mango orchard growers in adoption of drip irrigation system. The data collected from the 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 the most important economic constraints faced by mango orchard growers in adoption of drip irrigation. It is also reflected that the adoption of drip irrigation system had resulted in many changes. The system had contributed for a significant increase in area under fruit crops. Cropping intensity and cropping pattern had been changed in the farmers' fields with the inclusion of several fruit and commercial crops. Farm machinery / farm implements and household possession had also been increased and many farmers had diverted their cropped area to orchards. The savings and investment, standard of living and self-sufficiency of majority of respondents had been increased as a result of adoption of drip irrigation system.

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INTRODUCTION

Land and water are the two basic inputs for progress in agriculture and economic development of any country. Gujarat State has a relatively lower share in the overall availability of water in India.

Saurashtra region is considered as a dry farming area, where the availability of water for irrigation in wells is extremely scarce and irregular. Therefore, the farmers of this region have been attracted towards the modern method of irrigation and they have introduced drip irrigation system with the hope of making the judicious and scientific use of irrigation water at hand on farm lands and thereby overcoming the various problems such as labour, money and water management. Any technology that is adopted needs to be assessed periodically to suggest the effective changes for subsequent functioning and this truly holds good with drip irrigation system as quite a few years have already been passed and probably this is the high time to examine the consequences of this system. Therefore, a study on techno economic consequences implicit through adoption of drip irrigation system was undertaken.

MATERIALS AND METHODS

In this study the resultant changes occurred among the mango orchard growers as a result of adoption of drip irrigation system in the form of techno-economic changes have been taken into account as consequences of drip irrigation

system. It is operationally defined as the resultant changes due to adoption of drip irrigation system in terms of techno-economic aspects that prospered among the mango orchard growers. The techno economic change was measured in terms of ten aspects namely changes in land use, cropping intensity, cropping pattern, farm machinery / farm implements and household possession, savings and investment, food habits, clothing pattern, housing condition and change in self-sufficiency. Change taken place in a particular aspect during two points of time viz., before and after approach was followed for getting information about the aspects selected for the study. The scoring procedure followed for these aspects was as under :

Change in land use

Actual area increased in hectares under fruit crops be taken as change in land use. One score was assigned to each in case of increased land.

Change in cropping intensity

Actual increase in cropping intensity was taken as cropping intensity after deducting the cropping intensity from prior to adoption of DIS. Scoring was done based $\bar{\chi} \pm$ S. D.

Change in cropping intensity	Score
No change	0
Upto 15 per cent change	1
16 to 102 per cent change	2
Above 102 per cent change	3

Change in cropping pattern

Actual area increased in hectares under different field crops was taken as change in cropping after deducting the area from the area prior to adoption of DIS. One score was assigned to each 0.50 ha of increased area.

Change in farm machinery/farm implements

Farm machinery/farm implements and equipment purchased by the mango orchard growers after adoption of DIS was taken as change in farm machinery/farm implements and equipment. Scoring was done on the basis of cost as given in Table-2.

Change in household items

Additional household items purchased by the mango orchard growers after adoption of DIS was taken as the change in household items. Scoring procedure was followed on the basis of household items as given in Table-2.

Change in savings and investment

Eight statements regarding change in savings and investment were included in the study. The score of 1 and 0 was assigned for 'yes' and 'no' answer, respectively. The score of such statement was added to obtain final score indicating change in savings and investment.

Change in food habits

The statements regarding change in food habits were prepared. The respondents were asked to give their reply to each statement in the from of 'yes' or 'no'. The score of 1 and 0 was assigned for yes and no answer to each statement, respectively. Thus, the summated score was obtained as total score for change in food habits in quantitative items.

Change in clothing pattern

Four statements pertaining to change in clothing pattern were prepared. The respondents were asked to reply each statement as yes or no. The score of 1 and 0 was assigned to yes and no answer to

each statement, respectively. In order to obtain total score for change in clothing pattern, the score of each statement was added up.

Change in housing condition

The statements about change in housing condition were prepared. The respondents were asked to give their response. The answer to each statement was yes or no and score was assigned 1 and 0 respectively. The score of each statement was summed up to obtain final score indicating change in housing condition.

Change in self-sufficiency

Change in self-sufficiency was measured with the help of six statements and the responses of the mango orchard growers were obtained against each statement in terms of yes or no. The scoring procedure was 1 and 0 for yes and no response, respectively. An individual respondents scores on change in self-sufficiency were computed summing the scores obtained by him on six statements.

RESULTS AND DISCUSSION

TABLE 1

Distribution of Mango orchard growers according to their level of Techno-economic consequences.

N = 175

Sr. No.	*Level of techno-economic consequences*	*Score range*	*Frequency*	*Per cent*
1.	Low	Upto 38	23	13.14
2.	Medium	39 to 72	128	73.14
3.	High	Above 72	24	13.72

Mean = 54.989
SD = 17.267

The data presented in table - 1 indicate that majority of (73.14 per cent) of the mango orchard growers were found to have medium level of techno-economic consequences, whereas merely similar number (13.72 per cent and 13.14 per cent) of respondents were found to have high and low level of techno economic consequences, respectively.

Thus, it can be concluded that majority (73.14 per cent) of the mango orchard growers were found to have medium level of techno-economic consequences. The probable reason may be due to the fact that nearly two fifth of the adopters had covered only quarter to half of the mango orchards under drip method of irrigation rather than covering their entire orchards.

Further an effort had been made to know the techno economic consequences before and after adoption of drip irrigation system in few aspects.

Drip irrigation system has played a significant role in the context of techno-economic developments on mango orchard growers. Results of the farm level performance with mango orchards before and after adoption of the system are summarized in Table-2.

The data presented in table-2 reveal the fact that there was significant increase in the average area taken up under fruit crops plantation by reducing of growing field crops significantly. The probable reason may be that the farmers might have visualized about the success of the drip irrigation system in orchard crops than in other field crops.

So far as change in cropping intensity is concerned, the drip irrigation system had contributed for a significant increase in the average intensity of cropping system. The possible reason may be that there might have tremendous saving of water, which might be resulted in increase of total cropped area. It is also possible that the farmers might have diverted their areas to the orchard crops. Since in orchards, the plants as well as the rows are widely spaced, the farmers might have grown the crops in between the rows of the fruit crops, which might have resulted in increase of total cropped area. It was also observed that there was significant change in cropping pattern. This change may be due to the diversion of field crops area to fruit crops and farmers might have used their cultivable wasteland or agricultural land for plantation of fruit crops. It is also possible that more area could be brought under irrigation by introducing drip irrigation system, especially for fruit and commercial crops.

TABLE 2

Aspect wise Techno-economic consequences implicit through Adoption of Drip Irrigation system.

Sr. No.	*Particulars*	*Prior to adoption*	*After adoption of DIS*	*Mean difference*	*'t' value*
1.	Change in land use				
i)	Area under fruit crops (Mean area in ha)	1.910	3.093	1.183	**9.516
ii)	Area under field crops (Mean area in ha)	2.109	1.117	0.992	**9.066
2.	Change in cropping intensity (Mean intensity in per cent)	123.040	181.651	58.611	**17.727
3.	Change in farm machinery and farm implements (Mean score)	19.640	29.942	10.302	14.730
4.	Change in cropping pattern				
i)	Fruit crops (Mean area in ha)	1.910	3.093	1.183	**9.516
ii)	Field crops (Mean area in ha)	0.519	1.780	1.261	**13.698
5.	Change in household possession (Mean score)	18.020	29.642	11.622	**22.776

** Significant at 0.01 level of profitability.

The data further reveal that the average increase in farm machinery / farm implements and household posession score of mango orchard growers was significant after adoption of drip irrigation system. The probable reason may be that the adoption of drip irrigation system might be of a great advantage to the farmers in achieving agricultural production and thereby approving their economic conditions, which might have resulted a raising the farm machinery / implements and household possession of the mango orchard growers.

It can be inferred that the drip irrigation system had contributed for a significant increase in area under fruit crops. Cropping intensity and cropping pattern had been

changed with the inclusion of several fruit and commercial crops. Farm machinery / farm implements and hosehold possession had also been increased and many farmers had diverted their cropped area to orchards.

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Short Communications

Effect of Sowing Dates and Varying Levels of Nitrogen and Phosphorus on Coriander (*Coriandrum sativum* L.)

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A field trial was conducted at the Instructional Farm of the Gujarat Agricultural University, Junagadh during *rabi* season of 1994-95 on coriander Var. Gujarat Coriander-2 with twenty seven treatment combinations of three dates of sowing (15 and 30 October and 15 November) and three levels each of nitrogen (20, 40 and 60 kg/ha) and phosphorus (0, 20 and 40 kg/ha). The dates of sowing were taken in main plots and combinations of levels of nitrogen and phosphorus were taken in sub plots. The layout was a split plot design with three replications. The crop was sown and fertilized as per treatments with inter row spacing of 30 cm and seed rate of 20 kg/ ha. The soil of the experimental field was medium black clayey. It was low in available nitrogen (218.2 kg/ha) and medium in available phosphorus (32.5 kg/ha) and potash (214.2 kg/ha) with pH 7.7 and EC 0.35 dS/m.

Sowing coriander on 30 October recorded significantly the highest seed (905 kg/ha) and stick (1070 kg/ha) yields. Fifteen days earlier sowing on 15 October reduced the seed yield by 14 % and the stick yield by 26 %. Corresponding reductions due to 15 days delayed sowing on 15 November were 12 and 22 %. Greater plant height, more number of branches and umbels per plant and more test weight of seeds of 30 October sown crop contributed to greater seed and stick yield as compared with those of 15 October and 15 November sowing. The results confirmed the earlier findings of Mathakia (1993) who reported maximum yield of coriander with 25 October sowing under Junagadh condition. The maximum seed oil content (18.19%) and the net monetary return (Rs. 4,743/ha) were also obtained by sowing the crop on 30 October.

Response to increasing level of nitrogen was observed upto 40 kg N/ha, only. Thereafter the yield declined with additional application of nitrogen. Application of 40 kg N/ha recorded 19.6 and 4.0 % more seed yield than those of 20 and 60 kg N/ha. The corresponding increases in

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TABLE 1

Effect of sowing dates and levels on N and P on growth, yield, oil content and monetary return.

Treatment	Plant height (cm)	Number of Branches/ plant	Number of Umbels/ plant	1000 seed weight (g)	Yield (kg.ha) Seed	Yield (kg.ha) Stick	Oil content (%)	Net monetary ruturn (Rs./ha)
Date of sowing								
15 Oct.	37.22	3.72	6.55	21.46	778	942	17.95	3,441
30 Oct.	40.27	4.09	6.83	22.34	905	1070	18.19	4,743
15 Nov.	36.23	3.39	6.39	20.97	669	839	18.09	2,326
S.Em ±	0.58	0.11	0.07	0.20	21	31	0.17	-
C.D. at 5%	2.28	0.43	0.27	0.80	83	123	NS	-
C.V.%	8.06	15.10	5.38	4.92	14	17	4.80	-
Nitrogen (kg/ha)								
20	36.30	3.58	6.33	20.58	703	820	18.01	2,814
40	39.31	3.93	6.82	22.24	841	1046	18.17	4,086
60	38.21	3.69	6.63	21.93	809	984	18.06	3.607
S.Em ±	0.39	0.10	0.06	0.17	16	21	0.14	-
C.D. at 5%	1.55	0.28	0.16	0.50	45	61	NS	-
C.V. %	5.44	13.80	4.65	4.19	11	12	3.99	-
Phosphorus (kg/ha)								
0	36.30	3.40	6.42	20.60	715	821	17.98	3,197
20	37.95	3.69	6.59	21.55	793	975	18.07	3,599
40	39.51	4.11	6.76	22.61	844	1055	18.18	3,701
S.Em. ±	0.39	0.10	0.06	0.17	16	21	0.14	-
C.D. at 5%	1.55	0.28	0.16	0.50	45	61	NS	-
C.V. %	5.44	13.80	4.65	4.19	11	12	3.99	-

Interaction : None of the interactions was found significant.

stick yield being 27.5 and 6.3 %. The higher yield under application of 40 kg N/ha might be due to its favourable influence on growth and yield attributes as compared with 20 and 60 kg N/ha. The highest oil content (18.17 %) and net monetary return (Rs. 4,086/ha) were also realized with application of 40 kg N/ha. The results corroborate those of Jani (1988) and Sankat (1993).

Positive response was found to application of phosphorus upto 40 kg P_2O_5/ha. Seed (844 kg/ha) and stick (1055 kg/ha) yields produced with the application of 40 kg P_2O_5/ha were 6.4 and 8.2 % more than those of 20 kg P_2O_5/ha and 18.0 and 28.5 % more than those of the control plot. The highest oil content (18.18%) and net moneatry return (Rs. 3,701/ha) were also obtained with application of 40 kg P_2O_5/ha. Higher yield with the highest level of phosphorus (30 kg/ha) was also reported by Sankat (1993) under Junagadh conditions.

It can be summarized from the above findings that for higher production and profit from coriander Var. Gujarat Coriander 2, the crop should be sown on 30th October with 40 kg/ha each of nitrogen and phosphorus.

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Response of Multicut Forage Sorghum [*Sorghum bicolor* (L.)] to Biofertilizers and Levels of Nitrogen

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The multicult variety of forage sorghum GFSH-1 in Gujarat State, is becoming popular due to its suitability in intensive agriculture. Information on nutritional requirement of this variety in respect to nitrogen is lacking. Enriching the rhizosphere with biofertilizers economise chemical fertilizer requirement by reducing the cost of production (Subba Rao *et al.*, 1980). With a view an experiment was conducted to findout the response of N and biofertilizer on growth & yield of forage sorghum. The treatment comprises three biofertilizers (uninoculated, Azotobacter and Azospirillum inoculation) combined with four levels of nitrogen (0, 40, 80 and 120 kg/ha) which were tried in a factorial randomized block design with four replications at the Instructional Farm, Gujarat Agricultural University, Junagadh during *kharif* season of 1995-96. The soil was clayey in texture, slightly alkaline in reaction (pH 8.10), normal in salt content (EC 0.33 dS/m), low in available nitrogen (232.5 kg/ha), medium in available phosphorus (35.4 kg/ha) and rich in available potassium (312.5 kg/ha). Half dose of nitrogen, alongwith 40 kg phosphorus/ha was applied before sowing and remaining half dose of N was applied at 30 days after sowing as per treatment. The seed was inoculated as per treatments with Azotobacter and Azospirillum culture @ 50 g/kg seed. The sowing was done on 12th July, 1995 with a row spacing of 30 cm and seed rate of 30 kg/ha. The second cut crop was fertilized only with nitrogen as per treatments (Half dose of nitrogen applied in the first cut crop). Yield components, yield, nutrient uptake and quality parameters were recorded during the course of experimentation.

During first cut (Table-1 & 2), inoculation either with Azotobacter or Azospirillum produced significantly higher green (481 and 495 q/ha, resp.) as well as dry (221 and 231 q/ha, resp.) forage yield over uninoculated crop. Respective increases in green forage yield were 6.42 and 9.51 per cent and dry forage yield were 6.76 and 11.59 per cent higher over the yield of uninoculated crop. This improvement in yield might be due to significant effect of inoculation on the plant height. The results corroborate with those of Raj Reddy *et al.*, (1977) in respect to Azotobacter and Veerabandran and Rajendran, (1993) in respect to Azospirillum inoculation. In the second cut, there was no significant effect of inoculation on yield components and yield. Inoculation either with Azotobacter or Azospirillum was found very economical,

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TABLE 1

Effect of different treatments on forage yield of sorghum, nitrogen uptake, quality parameters and economics.

Treatments	*Green forage yield (q/ha)*		*Dry forage yield (q/ha)*		*Nitrogen uptake (kg/ha)*		*Crude protein (%)*		*Crude fibre (%)*		*Net retrurn (Rs/ha)*	*Net ICBR*
	FC	*SC*	*FC*	*SC*	*FC*	*SC*	*FC*	*SC*	*FC*	*SC*		
Biofertilizers												
Uninoculated	452	208	207	116	235	120	6.79	6.36	32.75	31.63	11691	-
Azotobacter	481	215	221	116	297	121	8.31	6.39	32.71	31.66	12691	1:25.01
Azospirillum	495	213	231	117	306	122	8.36	6.38	32.63	31.50	13084	1:34.83
S. Em. ±	10	5	5	2	7	1	0.17	0.04	0.15	0.16	-	-
C. D. at 5%	28	NS	13	NS	20	NS	0.48	NS	NS	NS	-	-
Nitrogen (kg/ha)												
0	346	128	187	91	188	80	6.41	5..47	33.66	32.75	6076	-
40	423	171	203	102	226	94	6.85	5.81	33.25	32.25	9049	1:4.69
80	529	231	226	131	300	139	8.34	6.65	32.36	31.23	13665	1:7.45
120	607	318	261	141	403	172	9.67	7.59	31.51	30.16	18222	1:8.66
S.Em. +	11	5	5	3	8	2	0.19	0.05	0.17	018	-	-
C. D. at 5%	32	16	15	8	23	5	0.56	0.13	0.50	0.53	-	-
C.V. %	8.12	8.91	8.21	8.18	9.76	4.89	8.60	2.44	1.83	2.01	-	-
Interaction (B x N)												
S.Em. ±	19	9	9	5	14	3	0.34	0.08	0.30	0.32	-	-
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-

FC = First Cut SC = Second Cut NS = Non-Significant

TABLE 2

Effect of different treatments on yield components of forage sorghum.

Treatments	Plant height (cm)		No. of internodes /plant		Length of Internodes (cm)		Stem thickness (cm)		Leaf area index	
	FC	SC	FC	SC	FC	SC	FC	SC	FC	SC
Biofertilizers										
Un inoculated	240	119	8.80	6.56	29.88	15.55	1.01	0.70	15.26	7.18
Azotobacter	253	120	9.27	6.62	29.32	15.61	1.03	0.72	18.10	7.31
Azospirillum	255	120	9.08	6.61	29.38	15.72	1.04	0.71	17.24	7.26
S. Em. ±	3	2	0.16	0.10	00.22	00.22	0.02	0.02	00.8	0.12
C. D. at 5%	10	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen (kg/ha)										
0	203	101	7.56	5.55	28.61	12.83	0.87	0.55	12.90	4.54
40	243	109	9.18	6.36	28.98	16.16	0.98	0.67	15.02	6.32
80	268	130	9.31	6.86	30.00	16.50	1.07	0.74	18.24	8.20
120	282	139	10.51	7.61	30.53	17.01	1.19	0.88	21.30	9.93
S.Em ±	4	3	0.19	0.12	0.25	0.25	0.03	0.02	0.92	0.14
C. D. at 5%	11	8	0.54	0.34	0.73	0.72	0.08	0.06	2.65	0.39
C.V. %	5.55	8.20	7.22	6.14	2.97	5.56	9.04	10.03	18.90	6.47
Interaction (B x N)										
S.Em. ±	6.91	4.92	0.33	0.20	0.44	0.44	0.05	0.04	1.60	0.24
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

FC = First Cut SC = Second Cut NS = Non-Significant

which was reflected in net return of Rs. 12691 and Rs. 13084 per hectare and net ICBR of 1:25.01 and 1:34.83, respectively.

Application of nitrogen produced significant effect on the yield as well as yield components and quality parameters including nutrient uptake (Table 1 & 2) of forage. Increased response was found up to the highest level of nitrogen application (120 kg/ha). Every increment in nitrogen produced significantly higher forage yield over the preceding level of nitrogen. Thus significantly higher green (607 and 261 q/ha) and dry (318 and 141 q/ha) forage yields were produced when the forage crop was fertilized with 120 and 60 kg N/ha during first and second cut, respectively over the control. The probable reason for such a positive response to nitrogen application might be due to the poor inherent nitrogen status of the soil and response behaviour of the forage sorghum to nitrogen, which tended to put more vegetative growth and efficient photosynthesis as reflected in significant improvement in yield components viz., phant height, number of internodes/plant, length of internodes, stem thickness and leaf area index and nitrogen uptake with increasing nitrogen (0 to 120 kg/ha). Thus, finally produced more forage yield. This result is in agreement with those of Patel *et al.* (1994).

From this study, it can be concluded that for getting potential and economic production from multicut forage sorghum (GRSH-1), the seeds of the crop should be inoculated either with Azospirillum or Azotobacter culture before sowing. Moreover, the first and second cut crop hould be fertilized with 120 and 60 kg N/ha respectively.

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Effect of Phosphorus on the Growth and Yield of Hybrid Maize (*Zea mays* L.)

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Phosphorus is the backbone of any fertilizer management. The phosphorus status of our soils have revealed in the low category. There is a need to apply phosphorus for achieving higher yield in about 98 % of the soils of our country (Ghosh and Hassan, 1979). Response to P application in soils, having high available P status (Tandon 1987). Therefore their is a need to workout optimum requirement of phosphorus to exploit higher yield potential of hybrid maize.

A field experiment was conducted to study the response of phosphorus level on growth and grain yield of maize at Main Maize Research Station, Gujarat Agricultural University, Godhra during three kharif seasons of 1995, 1996 and 1997 under rainfed conditions. The experiment was laid out in randomized block design with 6 replications. The soil was sandy loam, containing 251, 48 and 417 kg/ha, total N_1 available P_2O_5 and available K_2O respectively. The treatments consisted of 4 phosphorus levels (0, 20, 40 and 60 kg P_2O_5/ha). A uniform dose of nitrogen 100 kg/ha was applied in all the treatments. Seeds were uniformly sown in furrows and later on thinned to obtain the required plant density. All package of practices required for the crops were followed.

The growth characters like plant height (cm) and dry matter production were significantly affected by application of 0 to 60 kg P_2O_5 /ha. Maximum plant height 161 cm was recorded with 60 kg P_2O_5 /ha. Likewise the highest dry matter production (3680 kg/ha) was obtained with 60 kg P_2O_5/ ha. These findings are in accordence to the results observed by Subbian *et al.* (1991). The yield attributes like number of Cobs/ha and test weight (1000 grain weight in g) were also known to be significantly affected by graded levels of phosphorus. Maximum number of cobs per ha. (69167) was noted with 60 kg P_2O_5 /ha, which was however at par with 40 kg/P_2O_5/ha. The highest test weight (195.g) was also recorded with 60 kg. P_2O_5 /ha. which remained statistically at par with 40 kg/P_2O_5/ha.

The grain yield was significantly influenced by different doses of phosphorus, highest being in 60 kg P_2O_5 /ha treatment followed by 40 kg P_2O_5/ ha treatment. The yield of both the treatments was statistically at par and significantly superior than remaining doses of phosphorus (Table-1). This increase in grain yield with the increase in phosphorus levels may be attributed probably to the development of extensive root system, which enabled the plants to absorb more nutrient from the soil depth

TABLE 1

Effect of different phosphorus levels on growth parameter and yield of hybrid maize (pooled data).

Treatments	*Plant height (cm)*	*No.of cobs /ha ('000)*	*1000 grain weight (g)*	*Length of cobs (cm)*	*Grain yield (kg/ha)*	*Yield of stover (kg/ha)*
Phosphorus levels (kg/ha)						
PO	152	60.0	156	16.6	1354	1896
P20	153	63.3	170	17.1	1824	2736
P40	159	66.7	188	17.6	2248	3484
P60	161	69.20	195	18.0	2453	3680
S.Em. +	1.74	0.77	2.20	0.79	111	122
C.D. at 5%	6.03	2.23	7.63	NS	385	423
C.V.%	5.22	4.14	5.72	16.30	7.40	8.19

Sing. Int. Y x T.

TABLE 2

Economics as influenced by different treatments.

Treatments	*Grain yield (kg/ha)*	*Yield of stover (kg/ha)*	*Gross realization (Rs./ha.)*	*Cost of production (Rs/ha.)*	*Net realization (Rs/ha.)*	*CBR*
P0	1354	1996	8666	5000	3666	1:1.73
P20	1824	2736	11856	5391	6465	1:2.20
P40	2248	3484	14724	5782	8942	1:2.55
P60	2453	3680	15945	6173	9772	1:2.58

and might have growth of the plant enhanced photosynthetic activities. The positive effect of phosphorus levels on grain yield and yield attributes have also been reported by Kumpawat and Rathore (1995) and Singh *et al.* (1995).

It was also found that higher net/profit of Rs. 9772/ha was obtained with 60 kg P_2O_5/ha with a CBR at 1:2.58 followed by Rs. 8942/ha with CBR of 1:2.55 in 40 kg P_2O_5/ha. Therefore to harvest higher yield (2453 kg/ha) of hybrid maize under rainfed condition of middle Gujarat Agro-climatic Zone-II (AES-II) a dose of 60 kg P_2O_5 in conjunction with 100 kg N/ha K_2O was observed to be economical.

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Lipid and Fatty Acid Changes During Seed Development of Safflower (*Carthamus tinctorius* L.) Var. Bhima

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A field experiment was conducted during *rabi* season of 1995-96 at the College Agronomy Farm, Gujarat Agricultural University, Anand, to find out effect of different maturity stages S_1, S_2 and S_3 (15, 30 and 45 DAF), on lipid content and fatty acid profile of safflower seed. Lipid content on both fresh and dry weight basis increased from S_1 to S_3 stages of seed maturity. Among different fatty acids, palmitic acid was significantly decreased, while oleic acid and linoleic acids were significantly increased with advancement of maturity. At 45 DAF linoleic acid was found to be maximum (68.6%).

Recommended dose of fertilizers (50:25:0, N:P:K kg ha^{-1}) was given prior to sowing. Cultural practices were done as per the package of practices recommended for safflower cultivation. In the later stage of crop growth, sucking pest (aphids) was controlled through spraying of Malathion 30 EC @ 0.3 ml L^{-1} water. To control alternaria leaf spot, Mancozeb 0.25 % was sprayed @ 0.5 g L^{-1} water.

Developing seeds were harvested at different days after flowering (DAF) viz., (15 DAF S_1), (30 DAF S_2) and (45 DAF S_3).

Observations on fresh and dry weight of seeds were recorded and moisture content was worked out. Dry seeds were analyzed for total lipid (Baxi, 1989) and fatty acid composition of total lipid was determined by Gas Liquid Chromatography (GLC) after methylation with sodium methoxide and boron trifluoride (BF3) (Morrison & Smith, 1964). The laboratory analytical data of replicated samples were subjected to statistical analysis of variance (Snedecor *et al.*, 1967).

The data obtained for the moisture, total lipid (fresh and dry weight basis) and changes in fatty acid on per cent weight basis as well as g per total lipid basis at different maturity stages are presented in Table-1.

Total Lipid

The accumulation of lipids in safflower seed in general was accompanied by decrease in moisture content due to methods. But the increase in lipid content from S_1 to S_2 stage, was much faster than the fall in seed moisture content between these stage of seed maturity. This is because of the fact that lipid is not the only material being stored during seed development. These changes of total lipid

TABLE 1

Lipid and fatty acid profile during seed development of safflower.

Seed development stages	*Moisture content (%)*	*Total lipid (%)*		*Fatty acid composition**					
				Per cent weight basis			*g/total lipid basis*		
		Fresh	*Dry*	*Palmitic acid*	*Oleic acid*	*Linoleic acid*	*Palmitic acid*	*Oleic acid*	*Linoleic acid*
S_1 (15 DAF)	64.31	3.63	10.14	31.84	14.63	53.49	3.18	1.45	5.30
S_2 (30 DAF)	28.03	17.03	23.66	20.91	16.14	62.95	4.93	3.82	14.82
S_3 (45 DAF)	5.48	32.04	33.90	11.44	19.76	68.80	3.87	6.69	23.31
S. Em.	0.181	0.054	0.086	0.111	0.111	0.132	0.034	0.026	0.070
C.D. (0.05)	0.511	0.153	0.243	0.317	0.317	0.377	0.099	0.076	0.199

* Average of two replications.

content are in agreement with those reported by Ichihara and Noda (1980) for safflower.

Fatty Acid Profile

Palmitic acid content was significantly affected due to stages of maturity. Among maturity stages, S_1 recorded significantly the highest palmitic acid content, which decreased significantly as the maturity advanced. Such decrease in palmitic acid was also reported by Ichihara and Noda (1980) in safflower during seed development. Similar decrease in palmitic acid was also reported in sunflower (Hazel *et al.*, 1978; Lotti *et al.*, 1987 and Rana *et al.*, 1990), mustard (Mukherjee and Kiewitt, 1984; Zukelova *et al.*, 1985), soyabean (Rubel *et al.*, 1972) and groundnut (Sander, 1980 and William *et al.*, 1984).

The percentage of oleic acid ($C_{18:1}$) was less (14.63%) at S_1 maturity stage, which significantly increased at each successive stages of maturity i.e. from S_1 to S_2 and S_2 to S_3 stage (Table-1). The increase in oleic acid percentage was accompanied by the decrease in palmitic acid during seed development. The increase in oleic acid coincided with the increase in synthesis of TG as seed progressed towards maturity. This type of change in oleic acid percentage has also been reported in safflower by Ichihara and Noda (1980). Similar increase in oleic acid was also reported in sunflower (Rana *et al.*, 1990), mustard (Awasthi and Pathak, 1993) and groundnut (Niranjan Kumar *et al.*, 1988).

The percentage of linoleic acid ($C_{18:2}$) (Table-1) was less at S_1 maturity stage but continuously increased in subsequent stages of maturity. The increase in linoleic acid content with maturity may be due to increase in the activity of oleooyl desaturase and decrease in palmitic acid content during seed development. Ichihara and Noda (1980) reported that $C_{18:2}$ and $C_{18:1}$ were complementary to each other in proportion.

Oleic acid and linoleic acid on g per total lipid basis continuously increased with the advancement of seed maturity, whereas palmitic acid increased upto S_2 maturity stage and thereafter it decreased at S_3 stage. The increase in amount of fatty acids is only due to accumulation of more lipid with progressive maturity but the proportional fall in palmitic percentage could not be accompanied by the percentage rise in lipid content after 30 DAF to seed maturity (45 DAF).

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Varietal Reaction of Tomato to Early Blight Caused by *Alternaria solani* (Ell. & Mart.) Jones & Grout

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Tomato is cultivated throughout the year in Maharashtra as the crop is highty remunerative. Early blight caused by *Alternaria solani* is the most sévere disease of this crop and it always results in quantitative and qualitative lossses (Datar & Mayee 1981). Disease resistance is an important aspect in the management strategy and therefore, promising lines of tomato were screened against the natural incidence of the disease.

TABLE 1

Reaction of tomato varieties against early blight.

Sr. No.	*Name of variety*	*Per cent disease intensity*				*Reaction Type*
		40 DAT	55 DAT	70 DAT	85 DAT	
1.	LE-415	13.93	30.14	48.25	71.48	S
2.	BT-102-12	15.74	32.53	52.36	77.12	S
3.	BT-8	12.19	22.65	39.84	60.24	S
4.	BWR-5	17.38	30.83	51.42	74.32	S
5.	BRH-1	9.28	17.65	27.78	33.19	MS
6.	BRH-2	11.34	19.53	31.29	45.41	MS
7.	BT-21	8.66	16.92	24.43	35.82	MS
8.	EL-333	7.59	14.32	24.63	34.91	MS
9.	EL-342	10.82	18.24	28.56	39.33	MS
10.	Sun-7610	8.37	15.23	24.49	35.80	MS
11.	Sun-7611	9.72	17.80	25.32	36.69	MS
12.	DPL-T-4	5.37	10.52	15.63	23.72	MR
13.	DPL-T-14	5.24	11.31	17.87	24.44	MR
*14.	Megha	-	-	-	-	-
*15.	Pusa ruby	-	-	-	-	-
*16.	BT-1	-	-	-	-	-
Location severity index (LSI)		10.43	19.82	31.68	45.57	-

Where,

S = Susceptible
MS = Moderately Susceptible
MR = Moderately Resistant
DAT = Days After Transplanting
* = Susceptible to Bacterial wilt.

In all, sixteen tomato varieties were sown in the last week of November-1997 by adopting regular nursery practices. One month old seedlings were transplanted at the spacing 60 x 60 cm in RBD with three replications. Ten randomly selected plants were tagged for recording observations. Per cent disease intensity was recorded four times at 40, 55, 70 and 85 days after transplanting (DAT). Per cent disease intensity (PDI) was recorded by adopting 0-4 scale. (Ramakrishnan *et al.* 1971) and on this basis varieties were differentiated into different categories.

It is evident from the table -1 that, there is differential varietal reaction of tomato varieties to early blight. The location severity index (LSI) ranged between 10.43 to 45.57 per cent. There was gradual increase in the disease intensity with increase in the crop age. All varieties recorded highest disease intensity at 85 DAT.

Out of sixteen entries DPL-T-4 and DPL-T-14 recorded minimum intensity of early blight (PDI 23.27 and 24.44 respectively) and these varieties are rated as moderately resistant varieties. These lines also showed high degree of tolerance to bacterial wilt. Varieties viz., BRH-1 & 2, BT - 21, EL - 333 & 342 and Sun - 7610, 7611, were rated as moderately susceptible as PDI ranged between 26-50 per cent. LE-415, BT-102-12, BT-18 and BWR-5 recorded susceptible reaction. However reaction of Megha, Pusa ruby and BT-I could not be recorded as these varieties succumbed to bacterial wilt within 30 to 45 days after transplanting.

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Study of Detection Methods and Location of *Alternaria carthami* Chowdhury in Safflower Seed

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Physically vaible and healthy seed is the primary segment of economically higher production technology of crop. Variety of oil, proteins, carbohydrates are present in safflower seed which make the seed liable to attack by range of seed liable to attack by range of seed borne pathogens. In safflower, *Alternaria carthami* Chowdhury is seed-borne in nature causing leaf spot diseaase Chowdhury (1944). Classen *et al.* (1949) reported more than 50 per cent loss due to this disease from USA. Irwin (1976) reported that *Alternaria carthami* caused pre-emergence mortality, seedling death and reduced seed quality. Considering the importance of seed borne nature of the pathogen, studies were undertaken to find out suitable method for its detection and location of the pathogen.

Standard blotter method and agar plate method (ISTA, 1976), freezing blotter method (Limonard, 1968) were employed to detect the association *A. carthami* from the pre-tested seed samples having maximum natural infection. Blotter method was modified by using water with four different pH level (5, 6, 7 and 8). In order to locate site of infection by *A. carthami* in different parts of seed, component plating method was used (Maden *et al.*, 1975).

Among the four methods tested, blotter method without pre-treatment (Table-1) resulted in maximum per cent (38%) association of *A. carthami* followed by modified blotter method (25%) at pH7. The minimum (8%) per cent association was found in freezing method. The data (Table -2) exhibited that the association of *A. carthami* was comparatively high (75%) in seed coat than the colyledon (25%) while, plumule and radicle were completely free from infection.

Similar results have been observed by Bhale *et al.* (1999) in detection of *A. alternata* from chilli seeds and Agrawal *et al.* (1972) for detection of *A. longissima* from green gram seed, Irwin (1976) and Chowdhury (1944) confirm our findings regarding location of *A. carthami* in safflower seeds.

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TABLE 1

Comparison of various methods in detection of *A. carthami* associated with safflower seeds.

Sr. No.	*Methods*	*Average association of A. carthami (%)*
1.	Standard blotter method	
	a. Untreated seeds	38.0
	b. Pretreated seed	13.5
2.	Deep freezing	08.0
3.	Agar plate (PDA)	17.5
4.	Modified blotter pH	
	5	11.0
	6	21.0
	7	25.0
	8	13.0

TABLE 2

Association of *A. carthami* with different parts of safflower seeds.

Seed parts	*Per cent association*
Seed coat	75
Colyledon	25
Embryo	0
Plumule	0
Radicle	0

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Effect of Cultural Practices on Oil and Carbohydrate Content of Green and Red Chilli (*Capsicum annum* L.) Var. Jwala

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A field experiment was conducted during October, 1995 to May, 1996 at the College Agronomy Farm, Gujarat Agricultural University, Anand to find out the effect of mulch, nitrogen and irrigation levels on oil and carbohydrate content of chilli at green and red mature stage. The carbohydrate and oil content of chilli fruits were analyzed as they are important quality parameters and also play an important role in the yield.

'Jwala' variety of chilli was grown in four replications under split plot design taking irrigation as a main plot treatment [drip irrigation at 10% (I_1), 60% (I_2), 80% (I_3) replenishment of PE and surface irrigation at 0.7 IW/CPE ratio (I_4)] and combinations of mulch [No mulch (M_0) and black polythene sheet (M_1)] and irrigation levels [75 (F_1), 100 (F_2) and 125 (F_3) kg N ha^{-1}].

Fruit samples of similar age of green mature stage (S_1) and red mature stage (S_2) were collected separately and analyzed for oil and total carbohydrate content. Oil and total carbohydrate content was determined by methods described by Dubois *et al.* (1956) and Sadasivam and Manickam (1992) respectively and results were reported on dry wt. basis. The laboratory analytical data of replicated samples were subjected to statistical analysis of variance (Snedecor *et al.*, 1967).

The data obtained for oil and total carbohydrates at green and red mature stage are presented in Table-1.

Oil Content

The oil content was significantly higher in fruits from $I_4M_1F_3$ combination (5.05%) being at par with $I_3M_0F_1$ (5.01%) than rest of the treatment combinations at green mature stage. The fruits from combination $I_4M_0F_2$ recorded the lowest oil content at green mature stage but was at par with $I_2M_0F_2$, $I_3M_1F_1$ and $I_4M_0F_1$. At red mature stage, among different treatment combinations $I_3M_0F_2$ (12.58%) being at par with $I_2M_1F_2$ (12.53%) than rest of the treatment combination $I_3M_0F_3$ than rest of the combinations.

Oil content was reduced significantly with increase in amount of water applied through different irrigation schedules. This may be due to the dilution effect resulted from increased carbohydrate content. The differences in fat content of fruits were not significant due to mulch treatment. No definite trend was observed with varied levels of nitrogen. Oil content of fruits was

TABLE 1

Oil and carbohydrate contents as influenced by I x M x F interaction in green and red mature chilli.

Treatment			Green stage (S_1)		Red stage (S_2)	
Irrigation	Mulch	Fertilizer	Oil (%)	Total carbohydrate (%)	Oil (%)	Total carbohydrate (%)
I_1	M_0	F_1	3.91	17.57	10.95	21.00
		F_2	4.79	20.04	11.86	20.49
		F_3	4.41	21.04	11.78	23.28
	M_1	F_1	4.03	18.93	11.91	21.59
		F_2	3.53	19.77	11.64	22.63
		F_3	4.54	21.92	11.44	23.21
I_2	M_0	F_1	4.52	20.91	11.62	24.30
		F_2	3.52	18.59	11.62	20.50
		F_3	3.72	20.19	11.54	24.19
	M_1	F_1	4.51	19.77	11.25	23.08
		F_2	3.67	18.20	12.53	21.15
		F_3	3.45	21.47	11.92	23.93
I_3	M_0	F_1	5.01	20.89	11.13	23.29
		F_2	4.27	19.67	12.58	21.77
		F_3	3.72	20.51	10.60	22.53
	M_1	F_1	3.33	19.67	10.80	22.14
		F_2	3.46	21.42	11.72	23.77
		F_3	3.57	20.28	11.56	22.29
I_4	M_0	F_1	3.36	19.54	11.46	23.70
		F_2	3.31	19.72	11.01	22.64
		F_3	3.66	21.18	11.16	24.10
	M_1	F_1	3.71	19.41	11.64	23.84
		F_2	3.49	20.11	11.72	22.30
		F_3	5.05	21.04	10.93	23.09
S. Em.			0.05	0.11	0.05	0.11
C. D. at 5%			0.13	0.30	0.13	0.30
C. V. %			1.02	0.90	1.02	0.90

increased significantly with increase in ripening. This is because of accelerated rate of lipid metabolism in the fruit at later stage of ripening (Jinap *et al.*, 1993).

Total Carbohydrate

At green mature stage fruits obtained from treatment combination $I_1M_1F_3$ (21.92%) significantly higher total carbohydrate content than rest of the treatment combinations. The content was the lowest in fruits from $I_1M_0F_1$ combination at green mature stage. At red mature stage, fruits from treatment combination $I_2M_0F_1$ (24.03%)being at par with $I_2M_0F_2$ (24.19%) and $I_4M_0F_3$ (24.10%) contained significantly higher total carbohydrate content than rest of the treatment combinations. The content, at red mature stage was significantly lower in fruits from $I_1M_0F_2$ combination than rest of the treatment combination except $I_2M_0F_2$.

Total carbohydrate content of chilli fruits was significantly increased as the amount of available water to plants increased either through irrigation on mulching with black polythene. Total carbohydrate content was the highest at higher dose of nitrogenous fertilizer (F_3). As nitrogen application increases foliage and photosynthetic activity hence, higher rates of nitrogenous fertilizer along with water might have increased total carbohydrate content. Higher marketable yield of tomato fruits was obtained, when nitrogen was applied at higher rates (Singh, and Singh, 1992). This is because of the fact that total carbohydrate content accounts for major portion of yield. Total carbohydrate content on per cent dry weight basis was increased significantly with increase in ripening of fruits. This is because of increased metabolism of carbohydrate at later stage of fruit ripening (Almazan, 1991; Hubbard and Pharr, 1992 and MacRae *et al.*, 1992).

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Nutritional Evaluation of Rape Seed Cake

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Rape seed cake is a byproduct of oil milling industry available after extraction of oil from rape seeds. It is traditionally fed to ruminants in northen region of the country (Ranjhan, 1981 and Banerjee, 1986). However, its feeding is not popular in Gujarat State. Data for nutritive value of rape seed cake are not available for this region. Hence an effort was made to determine its nutritive value in adult ruminants.

The nutritive value of rape seed cake was determined by difference method on six bullocks of good nutritional status. These bullocks were fed rape seed cake initially 0.25 kg daily in increasing order for adaptation. Initially bullocks did not consume the cake because of its peculiar taste even when offered only 1.0 kg/day. Therefore cake was mixed with wheat bran in 2:1 proportion alongwith salt and fed to bullocks. After adaptation each bullock was offered the uniform mixture of 2.0 kg rape seed cake, 1.0 kg wheat bran and 30 g salt daily during preliminary period of 21 days. Mature pasture grass was fed as basal roughage. A digestion cum balance trial following conventional method was conducted on six bullocks with seven days collection period. The digestibilities of mature pasture grass and wheat bran were also determined. The samples of feeds and fodders were analysed for proximate nutrient content (AOAC, 1980).

Bullocks maintained their body weight. Average dry matter intake by each bullock was 4.48±0.18 kg/day and 1.84±0.08 kg/100 kg body weight, which is sufficient for maintenance of adult non producing large ruminants.

Dry matter intake from rape seed cake only was 1.31± 0.10 kg/day/animal (Table 1). It indicates that rape seed cake was found palatable to adapted animals when fed after mixing with some palatable feeds like wheat bran.

The data for proximate composition of feeds and fodders fed to animals are

TABLE 1

Average body weight and dry matter intake by bullocks.

Av. body weight of bullocks (kg)	246.67 ± 18.37
Breed of animals	Cross bred bullocks
Av. dry matter intake	
kg/day/animal	4.48 ± 0.18
kg/100 kg body weight	1.84 ± 0.08
g/ kg $W^{0.75}$	72.51 ± 1.99
Av. dry matter intake from rape seed cake only (kg/day/animal)	1.31 ± 0.10
Av. dry matter intake from wheat bran only (kg/day/animal)	0.65 ± 0.05

TABLE 2

Chemical composition (per cent on DM basis) of feed and fodders, digestibility coefficients and balances of nutrients of bullocks fed rape seed cake.

Constituents / *Feeds*	*Crude Protein*	*Ether Ext.*	*Crude fibre*	*NFE*	*Ash*	*Silica*	*P*	*Ca*
Rape seed cake	38.47	1.47	5.85	46.16	8.05	2.23	1.23	1.47
Wheat bran	18.33	4.04	5.36	67.94	4.33	0.76	1.21	0.48
Mature pasture grass	2.22	1.68	42.25	46.00	7.85	6.34	0.05	0.65

Digestibility coefficients and digestible nutrients of rape seed cake only.

Crude protein	*Ether extract*	*Crude fibre*	*NFE*	*OM*	*DCP*	*TDN*
81.97 ±3.14	62.31 ±10.13	26.13 ±11.55	68.51 ±3.34	80.36 ±3.44	31.53	66.74

Average balances of nitrogen, phosphorus and calcium (g/day/animal).

Nutrients / *Particulars*	*Nitrogen*	*Phosphorus*	*Calcium*
Total intake	106.68±7.53 (100)	26.70±1.51 (100)	38.25±1.91 (100)
Voided in feces	32.58±1.37 (30.54)	17.16±0.74 (64.27)	23.91±1.05 (62.51)
Voided in urine	51.84±4.94 (48.59)	0.16±0.03 (0.60)	1.82±0.17 (4.76)
Total voided	84.42±5.49 (79.13)	17.32±0.75 (64.87)	25.73±1.12 (67.27)
Balance	+22.26±3.71 (20.87)	+9.38±0.94 (35.13)	+12.52±1.33 (32.73)

( ) Figure indicates percentage of intake.

presented in Table 2. Rape seed cake had 38.47 per cent crude protein on dry matter basis. The digestibility coefficients of rape seed cake only for crude protein, ether extract, nitrogen free extract and organic matter were 81.97, 62.31, 68.51 and 80.36, respectively, however crude fibre digestibility was very low.

The balances of whole ration for Nitrogen (N), Phosphorus (P) and Calcium (Ca) were + 22.26 ± 3.71, + 9.38 ± 0.98 and + 12.52 ± 1.33 g/day/animal, respectively. Positive balances of N, P and Ca indicated that bullocks utilized the nutrients of rape seed cake efficiently. Rape seed cake provided 31.53 per cent DCP and 66.74 per cent TDN on dry matter basis. Sen and Ray (1971) reported slightly lower DCP (27.83%) and higher TDN (78.10%) values for rape seed cake. Higher value of TDN reported for rape seed cake may be because of expeller type of cake as against deoiled rape seed cake used under present investigation.

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Abstracts of Ph. D. Thesis

Management of Pulse Beetle, *Callosobruchus maculatus* (Fabricius) in Stored Pigeonpea

Submitted to Gujarat Agricultural University

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Investigation on management of pulse beetle, *Callosobruchus maculatus* (Fabricius) in stored pigeopea were carried out in and out of the laboratory conditions at the College of Agriculture, Junagadh during 1996 to 1997.

The bruchid built up its population drastically by 656 folds at 90 days (2624.22 beetles/500 g seeds), and by 1327 folds at 180 days (5308.84 beetles/500 g seeds) which resulted in 97.73 per cent grain damage, 34.03 per cent weight loss and complete germination loss in pigeonpea variety BDN-2.

Regarding damage by one generation of the bruchid in ten pigeonpea varieties, maximum grains were damaged in ICPL 87 (125.26/50 g) and minimum in Bhadbhoot (84.97/50 g), whereas per cent grain damage was highest in GT 1 (21.92), followed by GAUT 88-13 (21.34) and lowest (15.03) in GAUT 85-18, followed by BDN 2 (15.53). Weight loss was maximum in ICPL 87 (5.80%) and minimum 2.87 per cent in Bhadbhoot and GAUT 88-6.

On the basis of overall rank values of resistance parmeters, varieties GAUT 88-6 and BDN 2 were found as resistant, Bhadbhoot and GT 100 as moderately resistant and ICPL 87 as highly susceptible.

In solar heat treatment, adult stage of *C. maculatus* was found more susceptible to solar heat. Its exposure alongwith pigeonpea seeds to solar heat for more than 4 hours (35.2º to 36.1º C) gave complete control. While exposure of the egg stage for 2 to 8 hours (35.2º to 37.31º C) gave 76.96 to 97.10 per cent protection. Grains with larvae or pupae exposed even for eight hours gave only partial control. Solar heat did not affect the germination of seeds.

Among eight oils tested, neem and cocount oils @ 10 ml/kg seed provided the complete control of grains against bruchids for six months, followed by karanj, mustard and castor oil @ 10 ml/kg seed without any adverse effect on germination.

Out of eight botanical materials, only custard apple seed powder at all the doses (1, 2 and 3%) had provided the complete protection and tobacco leaf powder at 3 per cent proved better to protect the pigeonpea seeds. The botanical materials had not affected the germination of pigeonpea seeds.

Among eight insecticide tested, chlorpyriphos at 5.0 mg a.i./kg seed was found most effective for six months, followed by malathion at 10.0 mg a.i. / kg seed against *C. maculatus*.

Covering of ash or sand at 1:1 (5 cm layer) and 1:0.50) (2.5 cm layer) ratio (v/v) or mixing-covering at same ratio of ash and sand or only mixing of ash at 1:1 ratio (v/v) gave the complete protection of pigeonpea seeds for six months.

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Studies on Heterosis, Combining Ability and Phenotypic Stability in Asiatic Cotton

(*Gossypium herbaceum* L.)

Submitted to Gujarat Agricultural University

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In the present investigation, information on the magnitude of heterosis, combining ability and stability parameters was obtained for 18 plant characters including seed cotton yield and its components following diallel mating design involving ten elite varieties/strains of desi cotton *G. herbaceum* L., tested at Surat, Bharuch and Hansot during *kharif* 1996-97.

The analysis of variance for parents and F_1s revealed highly significant differences due to parents and F_1s indicating considerable genetic variation among these genotypes.

Highly significant positive heterobeltiosis and standard heterosis for seed cotton yield and its component characters in the crosses, involving elite lines as the parents, suggested that there is a good scope of exploiting heterosis commercially and also possibility of isolating desirable segregats. Significant heterobeltiosis and standard heterosis and high *per se* performance with regards to seed cotton yield and its components was recorded by four crosses, viz., Digvijay x G. Cot. 17, GShv-856/91 X 4011, G Cot-17 X GShv-856/91 and Digvijay x Sujay.

Combining ability analysis indicated that both additive and non-additive gene effects were important in the inheritance of all the traits. However, high magnitudes of GCA over SCA variances indicated preponderance of additive gene effect for almost all the traits except number of bolls per plant and number of seeds per boll were non-additive type of gene effects played an important role.

Two parents G. Cot-17 and GShv 856/91 were consistently good general combiners for seed cotton yield and other yield contributing traits.

The analysis of variance for stability parameters showed highly significant variation among the genotypes and three environments for all characters. Mean squares due to G x E interaction were highly significant for all the characters except 2.5 per cent span length. The analysis further revealed that the component of G x E (linear) had important contribution for all the characters except 2.5 per cent span length, seed index and fibre fineness indicating significant differences among the genotypes for their regression on environmental indices. However, pooled deviation (non-linear components) variances were also significant for all the characters except 2.5 per cent span length suggesting importance of both linear and non-linear components. Parent G. Cot-17 showed high performance and bi value equal to unity together with low S^2 di for seed cotton yield. Crosses as a group yielded slightly higher mean values than the parents. Three crosses viz., Digvijay x 4011, GShv - 856/91 x GShv-389/92 and GShv-866/91 x 4011 were identified as stable for seed cotton yield.

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