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Genetic study of attributes impacting development of source and sink in wheat under high temperature condition

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ABSTRACT

High temperatures affects development of both source and sink attributes and conspicuous yield impacts in wheat. The genetics of fourteen attributes impacting source, sink and quality was ascertained using fourteen parents and their ninety-one cross combinations that were evaluated under high temperature condition created by late sowing during rabi 2005-06 at Sardarkrushinagar (Gujarat). There was considerable genetic variation among the parents and hybrids for all the traits. The higher yielding genotypes exhibited better source development with concomitant development of sink and deployment of source to sink. On the basis of mean performance, GW 344 x KYZ 9636 followed by KYZ 9712 x GW 323 and KYZ 9712 x GW 337 were the best cross combinations for grain yield per plant as also for sink development (number of spikelets per spike) and harvest index that is indicative of strong carbohydrate carriage chain. There were significant differences among the parents and crosses for combining ability. Lesser ratio of σ gca/σsca indicated greater role of non-additive genetic component in the inheritance of all the traits impacting source and sink development under high temperature. Among the good general combiners, GW 323 exhibited good general combining ability for source and sink impacting attributes. Among the different good specific combinations, KYZ 9712 x GW 323 involved both the parents with high gca and may be exploited to select better transgressive segregants. Considering mean performance, general and specific combining ability, the parents GW 323, ABV 2002-120 and KYZ 9712 and cross combinations like GW 344 x KYZ 9636, GW 344 x GW 337, KO 123 x Inqualab 91 and KYZ 9712 x KYZ 9636 may be exploited for development of better source, sink and quality attributes under high temperature conditions. Further crosses like GW 344 x GW 337 and KO 123 x Inqualab 91 can be exploited for the amelioration of source development that is so precarious and affected most under high temperature growing conditions in wheat. Similarly KYZ 9712 x KYZ 9636 can be exploited for improvement of sink.

Key words : Combining ability, source, sink, wheat

Wheat is a crop of temperate climate. Growing wheat most parts of India, in general, and Gujarat in articular is hemmed in short and mild winter with gh temperatures rigors on either end of the crop eason that affects both source and sink evelopment putting a production ceiling irrespective timely, late or early sowing conditions. There hardly eeds any emphasis on the impact of imminent rise global temperatures on wheat production that has ready begun to take food off the world's table and the forecast is still frightening with 51% decline in India's wheat-growing land, potentially leaving hundreds of millions hungry. The best hope lies in breeding heat-resistant varieties by engineering characters related to source and sink development. Lately broad leaved, long ear types and stay green habits called "buitre" have been used to expand the sink to avail the maximum advantage of developed source but have not succeeded mainly due to poor mobilization of source to the sink. Therefore, for precise success of the breeding efforts, information on genetics of component characters conditioning source and sink need to be ascertained under high temperature condition.

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MATERIALS AND METHODS

Fourteen selfed homozygous parents representing gamut of genetic oddities were selected from the available genetic resources at the Main Wheat Research Station, S. D. Agricultural University, Vijapur, Gujarat on the basis of components of source [leaf characteristics like width, length, stay green habit and number etc.] and sink development [ear size, number of spikelets, grain size and plumpness etc.]. The selected lines were crossed as in diallel fashion, excluding reciprocals. Ninety-one F_1 crosses were developed during rabi 2004-05. Self-seeds of parental lines were also obtained simultaneously. The complete set of 105 entries comprising 14 parents and 91 F_1's were planted for evaluation in Randomized Block Design (RBD) with three replications in high temperature environment created by late sowing on 29th November during rabi 2005-06. Each entry was accommodated in a single row plot of 1 meter length with inter and intra row spacing of 30 cm and 5 cm, respectively. The observations were recorded on 1000-grain weight, grain yield per plant, leaf area at spike initiation, leaf area at maturity, flag leaf area, chlorophyll content, spikelets per spike, spikelet length, harvest index, leaf area index, leaf area ratio, protein content, sedimentation value and hectoliter weight. The data were subjected to analysis of variance as per Panse and Sukhatme (1978). The combining ability analysis was done as per the method of Griffing's, (1956) Model I (Fixed model), Method II.

RESULTS AND DISCUSSION

The analysis of variance for experimental design revealed considerable genetic variation among the parents and hybrids for all the traits under study (Table 1). Mean values of various traits that affected source and sink evinced that the performance of crosses was better than the parental lines. ABV 2002-120 was the best yielding genotype (15.66g) followed by GW 323 (13.57g) and Raj 4038 (13.24g). The perusal of the characters that affected source and sink indicated that these higher yielding genotypes exhibited better source development as indicated by higher chlorophyll content, leaf area at maturity, leaf area index, leaf area ratio and flag leaf area with concomitant development of sink (spikelets/spike) and deployment of source to sink (100-grain weight and harvest index). On the basis of mean performance, GW 344 x KYZ 9636 (18.78g) followed by KYZ 9712 x GW 323 (16.36g) and KYZ 9712 x GW 337 (15.02g) were the best cross combinations for grain yield per plant.

Table 1 ANOVA of various characters impacting source, sink and quality attributes in wheat under high temperature condition

Source	d.f.	Characters													
		Chlorophyll content	Leaf area at spike initiation (cm^2)	Leaf area at maturity (cm^2)	Leaf area index	Leaf area ratio	Flag leaf area (cm^2)	No. Spikelet per spike	Spike length (cm)	1000-grain weight (g)	Harvest index (%)	Protein content (%)	Sedimentation value	Hectoliter weight (kg/hl)	Grain yield/ plant (g)
Replication	2	12.09	18.81	64.44	0.19	0.005	104.69	0.847	0.25	0.43	0.11	0.36	1.97	27.89	2.25
Genotype	104	331.4**	35998.6**	112452.9**	235.6**	4.99**	206.64**	12.89**	7.71**	136.82**	144.22**	7.37**	55.19**	122.24**	22.0**
Parents	13	2951.31**	314861.4**	1164312.4**	1707.5**	51.75**	1068.21**	432.22**	127.08**	671.59**	1514.1**	148.45**	1130.84**	924.8**	259.9**
Hybrids	90	30303.8**	3354655.9**	10521551.0**	215.87**	467.7**	20366.0**	908.76**	644.4**	13389.6**	13386.1**	599.37**	4472.08**	11295.1**	1998.41**
Parents vs hybrids	1	1213.87**	74342.08**	9173.90**	1217.44**	0.4124**	57.32**	0.420	30.62**	162.1**	1.16**	18.90**	136.9**	493.2**	30.45**
Error	208	7013.69	85671.72	152708.3	919.92	6.79	3623.0	379.5	38.18	390.79	6904.67	49.78	1177.71	3763.0	378.21

** Significant at p = 0.05 and 0.01 level of significance, respectively

These crosses were better for sink development (number of spikelets per spike) and harvest index that is indicative of strong carbohydrate carriage chain.

The analysis of variance for combining ability indicated that the mean squares due to general combining ability and specific combining ability effects were significant for all the traits under study (Table 2). This indicated that there were significant differences among the parents for combining ability. Similarly different crosses also differed in combing ability. The ratio of σ^2 gca/σ^2 sca was less then one for all the characters, which indicated greater role of non-additive genetic component in the inheritance of all the traits impacting source and sink development under high temperature conditions at the terminal end of wheat crop. These results are in consonance with the findings of Manon and Sharma (1995), Mishra *et al.*, (1996), Katiyar (1998) and Sharma *et al.*,(2003) who have also reported predominance of dominance genes in late planting conditions.

Combining ability effects have been successfully employed for identifying superior parents and their utilization in further breeding programme. The estimates of gca effects in the present study showed no consistent pattern for all the characters. Consequently it was arduous to pick one good general combiner for all the characters. The gca effects of the parents revealed that seven parental lines *viz.*, ABV 2002-120 (1.48), KYZ 9712 (1.10), GW 337 (0.86), GW 323 (0.63), Inqualab 91 (0.52), KO 123 (0.45) and Raj 4038 (0.36) exhibited the positive and significant general combining ability effects for grain yield per plants. Thus, these lines were identified as good general combiners for grain yield per plant (Table 3). Among these, GW 323 exhibited good general combining ability for source developing attributes (leaf area at spike initiation, leaf area at maturity, leaf area index, leaf area ratio and flag leaf area); sink attributes (no. of spikelets per spike and spike length) and good carriage to the sink (1000-grain weight and harvest index). Similarly, GW 337 was good general combiner for source development attributes (leaf area at spike initiation, leaf area at maturity, chlorophyll content, leaf area ratio and flag leaf area), good carriage to the sink (1000-grain weight) and quality attributes (sedimentation value and hectoliter weight); KYZ 9712 for source development attributes (leaf area at spike initiation, leaf area at maturity, leaf area index, leaf area ratio and flag leaf area) and sink attributes (number of spikelet per spike and spike length); ABV 2002-120 for leaf area at maturity, chlorophyll content and leaf area ratio, spike length, 1000-seed weight,

Table 2 ANOVA for gca and sca for different characters impacting source, sink and quality attributes in wheat under high temperature condition

Source	d.f.	Characters													
		Chlorophyll content	Leaf area at spike initiation (cm2)	Leaf area at maturity (cm^2)	Leaf area index	Leaf area ratio	Flag leaf area (cm^2)	No. Spikelet per spike	Spike length (cm)	1000-grain weight (g)	Harvest index (%)	Protein content (%)	Sedimentation value	Hectoliter weight (kg/hl)	Grain yield/plant (g)
gca	13	134.20**	14674.2**	79802.4**	194.05**	3.54**	135.22**	16.87**	0.72*	80.01**	91.96**	2.99**	17.13**	59.79**	12.24**
sca	90	107.00**	11617.404**	31435.4**	62.06**	1.39**	59.40**	2.5**	21.26**	40.69**	41.80**	2.35**	18.57**	38.02**	6.63**
Error	208	11.24	137.28	244.63	1.47	0.01	5.80	0.55	0.06	0.62	11.06	0.07	1.88	6.03	0.60
σ gca		1.7	191.04	3022.75	0.195	0.134	4.738	0.898	0.65	2.45	3.13	0.038	0.09	1.36	0.35
σ sca		95.76	11480.16	31393.77	60.59	1.38	53.6	1.95	1.20	40.07	30.74	2.31	16.69	31.99	6.03
σgca/ σsca		0.017	0.016	0.096	0.003	0.097	0.088	0.46	0.54	0.06	0.1	0.016	0.005	0.042	0.06

** Significant at p = 0.05 and 0.01 level of significance, respectively

harvest index and sedimentation value; Raj 4038 for chlorophyll content, leaf area at spike initiation, leaf area at maturity, protein content and sedimentation value; KO 123 for leaf area at spike initiation, leaf area at maturity and leaf area ratio besides hectoliter weight; and Inqualab 91 for leaf area at maturity, leaf area index, and leaf area ratio in addition to spike length and protein content.

The estimates of gca effects were compared with the per se performance of parents, it was observed that parents with high gca effects also evinced excellent per se performance. Thus, the choice of parents on the basis of *per se* performance and gca effects may be very effective for enhancing grain yield under high temperature growing condition at grain filling and development stage wheat.

The estimates of specific combining ability revealed that 25 hybrids exhibited significant positive sca effects for grain yield per plant. Cross GW 344 x KZY 9636 (10.72) followed by KYZ 9712 x GW 323 (5.09) and PHR 1010 x Raj 4038 (3.92) having high sca effects for grain yield and representing combinations among poor x poor, good x good and poor x good general combiners, respectively, may be exploited (Table 4). This also indicated that gca in general has no bearing on the sca effects of the crosses. Further the cross KYZ 9712 x GW 323 involved both the parents with high gca and there are ample chances to get transgressive segregants in large populations. Thus such cross may be exploited to select better transgressive segregants either in large segregating populations or by recurrent selection method or by diallel selective mating designs or by biparental mating (Comstock *et al.*, (1949) and Jensen (1980). GW 344 x GW 337 (leaf area at spike initiation), KYZ 9712 x Inqualab 91 and GW 323 x ABV 2002-120 (leaf area at maturity and leaf area ratio), PHR 1010 x GW 323 (flag leaf area) and Lok Bold x KYZ 9636 (1000-grain weight) were the other crosses that involved both parents having high gca and may be exploited to have transgressive segregants for specific characters.

The cross, GW 344 x KYZ 9636 that illustrated the highest and significant sca effects for grain yield per plant also exhibited positive and significant sca effects for the characters like leaf area at spike initiation, leaf area at maturity, leaf area index and leaf area ratio (source attributing characters); number of spikelets per spike and spike length (sink attributes) and 1000-grain weight and hectoliter weight (source to sink carriage attributes). The second best specific cross combination viz., KYZ 9712 x GW 323 for grain yield per plant also manifested significant sca effects

Table 3 Estimates of gca effects for various attributes impacting source and sink development in wheat under high temperature condition

Genotype	Chlorophyll content	Leaf area at spike initiation (cm^2)	Leaf area at maturity (cm^2)	Leaf area index	Leaf area ratio	Flag leaf area (cm^2)	No. Spikelet per spike	Spike length (cm)	1000-grain weight (g)	Harvest index (%)	Protein content (%)	Sedi-mentation value	Hecto-liter weight (kg/hl)	Grain yield/ plant (g)
PARENTS														
PHR 1010	-1.87*	-40.55**	-63.89**	-5.78**	-0.43**	4.73**	1.32**	1.89**	-1.21**	-2.64**	0.17 *	-1.29**	-3.83**	-0.53**
GW 344	1.20	23.02**	-22.07**	-1.98**	-0.15**	-3.00**	1.09**	-0.30**	-3.10**	-4.62**	-0.06	-0.40	-2.57**	-0.41 *
KO 123	-4.85**	9.94**	16.53**	-0.17	0.11**	-3.73	0.29	-0.37**	-3.44**	-1.84 *	-0.25**	-1.82**	1.56 *	0.45 *
KYZ 9712	-2.31**	40.51**	141.83**	5.41**	0.95**	1.60**	1.10**	1.32**	-3.01**	-0.42	-0.40**	-0.87**	-0.60	1.10**
GW 273	-4.42**	-1.48	-40.53**	-0.92**	-0.07**	0.01	0.54**	0.36**	-1.34**	-1.22	0.05	1.39**	-2.34**	-0.89**
GW 323	-0.24	24.28**	77.38**	7.52**	0.52**	3.54**	1.29**	0.58**	1.67**	3.42**	0.1	1.10**	0.17	0.63**
Inqualab 91	-0.14	-10.08**	61.77**	3.71**	0.41**	0.12	-0.13	0.14*	-0.02	1.23	0.24**	-0.23	-021	0.52**
ABV-2002-120	3.98**	3.05	50.54**	0.48	0.34**	-4.50**	0.16	0.29**	1.55**	2.64**	-0.68**	0.34**	-1.29	1.48**
Raj-4081	-0.30	24.26**	-7.38**	-0.56	-0.05**	-2.44**	-0.64**	-0.12*	0.87**	-2.91**	0.58**	1.65**	1.67**	-0.38 *
Raj-4038	3.60**	19.00**	30.63**	0.48	0.27	-0.03	0.17	-0.24**	-0.73**	0.82	0.21**	0.47 *	2.44	0.36 *
Lok Bold	-0.27	-42.16**	-87.85**	-2.59**	-0.59**	0.65	-0.91**	-0.85**	3.59**	3.06**	0.91**	-0.72 *	1.63**	-0.92**
GW 173	0.74	-19.19**	-81.06**	-2.32**	-0.54**	0.41	-1.76**	-0.97**	0.35	1.39	-0.11	-0.44	1.72**	-1.19**
GW 337	5.11**	27.96**	24.13**	-0.74*	0.16**	4.42**	-1.13**	-1.17**	2.25**	0.74	-0.57**	1.02**	2.01**	0.86**
KZY 9636	-0.23	-58.56**	-100.86**	-2.53**	-0.67**	-1.78	-1.37**	-0.56**	2.28**	0.36	-0.22**	-0.18	0.03	-1.07**
S E gi	0.8	2.82	3.76	0.29	0.02	0.58	0.18	0.05	0.19	0.80	0.06	0.33	0.59	0.18
SE (gi - gl)	1.21	4.11	5.53	0.42	0.03	0.85	0.19	0.11	0.28	1.17	0.09	0.48	0.86	0.27

** Significant at p = 0.05 and 0.01 level of significance, respectively

Table 4 Three best crosses on the basis of sca effects along with per se performance and gca combinations for different traits impacting source, sink and quality attributes in wheat under high temperature condition.

Characters	Crosses	sca effects	gca of the parents	*Per se* performance	Rank recorded to *per se* performance
Source attributes					
Chlorophyll content	GW 344 x Lok Bold	23.44	AxA	91.47	3
	ABV 2002-120 x Raj 4081	21.29	GxA	92.07	2
	GW 173 x GW 337	19.72	AxG	92.57	1
Leaf area of spike initiation (cm^2)	GW 344 x GW 337	356.98	GxG	711.27	1
	Inqualab 91 x GW 337	256.00	PxG	578.00	2
	KO 123 x Inqualab 91	219.67	GxP	522.83	3
Leaf are at maturity (cm^2)	KYZ 9712 x Inqualab 91	754.52	GxG	1477.87	1
	GW 344 x GW 337	477.63	PxG	999.00	2
	GW 323 x ABV 2002-120	327.10	GxG	937.33	4
Leaf area index	GW 323 x BAV 2002-120	20.79	GxA	57.95	1
	GW 344 x GW 337	17.16	PxP	43.59	7
	KO 123 x Inqualab 91	16.29	AxG	48.98	2
Leaf area ratio	KYZ 9712 x Inqualab 91	5.03	GxG	9.85	1
	GW 344 x GW 337	3.18	PxG	6.66	2
	GW 323 x ABV 2002-120	2.18	GxG	6.49	4
Flag leaf area (cm^2)	PHR 1010 x GW 323	21.74	GxG	53.27	1
	KYZ 9712 x Lok Bold	18.80	GxA	44.91	2
	GW 344 x Lok Bold	14.74	PxA	36.24	7
Sink attributes					
No. of spiklets per spike	GW 344 x Lok Bold	6.63	GxP	19.17	32
	PHR 1010 x GW 337	2.85	GxP	21.40	3
	KYZ 9712 x KYZ 9636	2.81	GxP	20.90	5
Spike length	PHR 1010 x GW 173	3.08	GxP	16.45	1
	KYZ 9712 x KYZ 9636	2.59	GxP	15.80	3
	GW 344 x Lok Bold	2.37	PxP	13.67	18
1000 grain weight (g)	Lok Bold x GW 337	19.85	GxA	68.83	1
	Lok Bold x KYZ 9636	17.22	GxG	66.53	2
	PHR 1010 x Inqualab 91	10.76	PxA	52.57	4
Harvest index	PHR 1010 x KYZ 9712	13.43	PxA	45.66	9
	GW 344 x Lok Bold	11.96	PxG	45.69	10
	KO 123 x GW 337	11.81	PxA	15.01	6
Quality attributes					
Protein content	KYZ 9712 x KYZ 9636	3.04	PxP	13.96	4
	KO 123 x GW 173	2.98	PxA	14.17	2
	GW 323 x Raj 4081	2.89	AxG	15.12	1
Sedimentation value	PHR 1010 x Raj 4038	10.14	PxA	41.73	1
	GW 323 x KYZ 9636	7.96	GxA	41.30	2
	Raj 4081 x Lok Bold	7.89	GxP	41.23	3
Hectoliter weight	PHR 1010 x GW 344	9.88	PxP	66.99	24
	GW 344 x KYZ 9712	8.74	PxA	66.08	36
	ABV 2002-120 x KYZ 9636	8.41	PxA	70.67	6
Grain yield per plant (g)	GW 344 x KYZ 9636	10.72	PxP	18.78	1
	KYZ 9712 x GW 323	5.09	GxG	9.20	47
	PHR 1010 x Raj 4038	3.92	PxG	13.30	9

for chlorophyll content, harvest index and protein content and third best cross, PHR 1010 x Raj 4038 for leaf area at maturity, chlorophyll content, leaf area ratio, flag leaf area (source attributes); spike length, harvest index and sedimentation value. Three best crosses with respect to sca effects were given in Table 4 along with their per se performance and ranking. A perusal of data revealed that none of the cross registered high sca effects for all the characters. Although, six crosses with top ranking in sca effects for one characters also exhibited top ranking sca effects for some other important characters. They were, PHR 1010 x Raj 4038, (grain yield per plant, sedimentation value), GW 344 x GW 337 (leaf area of spike initiation, leaf area at maturity, leaf area ratio and leaf area index), KO 123 x Inqualab 91 (leaf area at spike initiation and leaf area index), GW 323 x ABV 2002-120 (leaf area at maturity, leaf area index and leaf area ratio), GW 344 x Lok Bold (chlorophyll content, spikelets per spike, spike length and harvest index) and KYZ 9712 x KYZ 9636 (spikelets per spike, spike length and protein content). Thus, crosses like GW 344 x GW 337 and KO 123 x Inqualab 91 can be exploited for the amelioration of source development that is so precarious and affected most under high temperature growing conditions in wheat. Similarly KYZ 9712 x KYZ 9636 can be exploited for improvement of sink.

For grain yield per plant and other characters, it was observed that the crosses which exhibited the highest sca effects were not necessarily good in per se performance (Table 4). From this, it can be ascertained that additive and/or non-additive gene effects were involved in the expression of yield and other traits among top ranking hybrids. The data given in Table 4 palpably indicated that the crosses having high sca effects involved all combinations of good x good, good x average, average x good, good x poor, poor x good, poor x poor, poor x average and average x poor general combining parents. This indicated the involvement of non-additive gene effects along with inter-allelic interaction. Better performance of hybrids having poor x poor or average x poor general combiners indicated interaction of recessive epistasis. This indicated possibility to obtain desirable transgressive segregants from these crosses by adopting cyclic method of selection or bi-parental mating.

It is evident form the Table 4 that for most of the traits, there was no correspondence between high ranking sca and *per se* performance of the crosses. Thus it can be concluded that the high magnitude of sca effects alone is not sufficient for explaining the good performance of any cross.

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Heterosis studies in cowpea (*Vigna unguiculata* L.walp)

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ABSTRACT

In cowpea (*Vigna unguiculata L. Walp*) nine parents crossed in diallel (excluding reciprocals) to study heterosis over mid-parent (MP), better parent (BP) and standard check (SC) for ten characters. Maximum positive heterosis for green pod yield per plant over MP,BP,SC was observed 55.62, 47.99 and 20.32% respectively. The heterosis in green pod yield per plant was due to heterosis found in yield components, *viz.*, mainly pods per plant, seed per pod, pod length and branches per plant.

Key words : Heterosis, pod yield, cowpea

Cowpea is an important legume crop of the tropics area, having various uses like vegetable, grains, dry haulms and as fodder. It is an expensive source of vegetable protein and a handy crop well adapted to relatively dry environment. The exploitation of hybrid vigour in any crop depends on substantial heterosis for yield, coupled with an economical method of producing hybrid seeds. The heterosis reveals, type of gene action involved and therefore, it help in the selection of suitable breeding methodology and parameters which are to be employed for crop improvement. Very little work, has been done in studying characters in relation to green pod yield in cowpea, which would be helpful in the development of cultivars for long tender green poded cowpea.

MATERIALS AND METHODS

Nine parents having different origin, *viz.*, Pusa falguni, GC-4, CGD-25, CGD-118, CGD-77, CGD-340, CGD-352, CGD-370 and CGD-402 were crossed in all possible combinations (excluding reciprocals) to get 9x9 diallel set. The 45 genotypes (36 F_1s, and 9 parents) were laid out in randomized block design (RBD) with three replications at Agronomy Instructional farm, Sardarkrushinanagar Dantiwada Agricultural University, Sardarkrushinager during summer 2007-08. The seeds were planted at 45 cm between rows 15 cm within row. The recommended agromic practices and plant protection measures were adopted for raising a good crop. Observation were recorded by selected randomly five plants for days to 50 per cent flowering, days to first picking, plant height (cm), number of branches per plant, pod length (cm) number of seed per pod, pod per plant, green pod per plant (g), protein content(%) and crude fiber content(%). Heterosis over mid-parent, better parent and standard check was calculated as per standard formula.

RESULTS AND DISCUSSION

The mean sum of squares due to genotypes were highly significant for all the character, indicating the diversity of parents. The range of heterosis exhibited by hybrid over the respective mid parent, better parent and standard check for green pod yield(g) per plant was -17.63 to 55.62%, -27.28 to 47.99% and -30.22 to 20.32% respectively (Table 1) and 24,15 and six hybrids showed significant positive heterosis over mid, better parent and standard check. These finding are in agreement with Bhaskaraish *et al.*, (1978) and Singh (1983).

For the development of the character *viz.*, days to 50 per cent flowering, days to first picking and plant height negative heterosis will be desirable. For the character days to 50% flowering highest heterosis was recorded in CGD-370 x CGD-118 (-8.67%), CGD-370 x CGD-118 (-6.44%) over mid parent and better parent and none of heterosis over standard check. Out 36

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Table 1 Range of heterosis over Mid parent (MP), Better parent (BP) and Standard Check (SC) for different character along with best hybrids in cowpea.

Characters	Range of heterosis (%) and Best hybrid		
	MP	BP	SC
Days of 50% flowering	-8.67 to 13.76 CGD-370 x CGD-118	-6.44 to 21.16 CGD-370 x CGD-118	4.84 to 29.26 CGD-370 x CGD-118
Days to first picking	-6.72 to 12.81 CGD-402 x CGD-25	-6.03 to 16.79 CGD-402 x CGD-25	3.43 to 24.38 pusa falguni x CGD-352
Plant height (cm)	-35.66 to 18.81 GC-4 xCGD-370	-21.92 to 35.36 CGD-118 x CGD-402	-15.78 to 47.78 pusa falguni x CGD-370
Branches per plant	-0.39 x 39.53 CGD-118 x CGD-340	-21.92 to 38.43 CGD-118 x CGD-402	-10.77 x 33.31 CGD-118 x CGD-402
Pod length (cm)	-14.97 to 35.79 GC-4 x CGD-370	-19.49 to 32.31 GC-4 x CGD-370	-10.77 x 33.31 CGD-118 x CGD-402
Seeds per pod	-13.41 to 52.26 pusa falguni x CGD-402	-21.45 to 50.41 pusa falguni x CGD-402	6.94 to 60.45 pusa falguni x CGD-402
Pods per plant	-17.28 to 58.24 CGD-370 x CGD-25	-19.73 to 57.48 CGD-370 x CGD-25	-24.14 to 29.07 GC-4 x CGD-402
Green pod yield(g)	17.63 to 55.62 CGD-370 to CGD-25	-27.28 to 47.99 CGD-370 x CGD-25	-30.22 to 20.32 pusa falguni x CGD-402
Protein content	-21.17 to 16.33 CGD-77 x CGD-340	-24.82 to 13.46 CGD-352 x CGD-25	-20.40 to 7.86 CGD -370 x CGD-352
Crude fiber	-24.22 to 80.94 CGD-370 x CGD-352	-35.08 tp 70.7 CGD-370 x CGD-402	-32.49 to 22.13 pusa falguni x GC-4

crosses, 4, 1 and zero showed desired heterosis over MP, BP and SC respectively, Bhushana *et al.*, (2000) and Mehta (2000) obtained similar results.

For days to first picking 4, 1 and none hybrids showed highest heterosis over MP, BP and SC respectively. The result are in agreement with Sawarkar (1998)
Out of 36 crosses, 23, 2 and 7 showed significant heterosis over MP, BP and SC respectively and hybrid GC-4 x CGD-118 (-35.66%)CGD-118 x CGD-402 (-10.54%) and Pusa falguni x CGD-340 (-15.78) showed highest heterosis for MP, BP and SC respectively for plant height. Similar observations were made by Mehta (2000) and Haibatpure (2003)
The highest heterosis recorded for branches per plant were 39.53% (CGD-118x CGD-340), 38.43% (CGD-340 x CGD-25) and 24.05% (CGD-352 x CGD-118) over MP, BP and SC respectively. The number of positive significant hybrids were 4, 15 and 12 respectively. These results are in agreement with Singh (2004)

For Pod length and number of seeds per pod exhibited highest heterosis recorded GC-4 x CGD-370 (35.79%) GC-4 x CGD-370 (32.31%) and CGD-118 x CGD-402 (33.31%) and Pusa falguni x CGD-402 (52.26%), Pusa falguni x CGD-402 (50.41%) and Pusa falguni x CGD-402 (60.45%) over MP, BP and SC respectively, out of these 20, 17 and 16 and 20,17 and 31 crosses showed significant over MP, BP and SC respectively. These finding are closely related with Sawarkar (1998) and Valarmathi and Surendran (2007) findings.
For number of pods per plant, which is main component of yield, 21, 16 and 13 hybrids manifested significant positive heterosis over MP, BP and SC respectively and CGD-370 x CGD-25 (58.24%) CGD-370 x CGD-25 (57.48) and GC-4 x CGD-402 (29.07) showed highest heterosis over MP, BP and SC respectively. Similar result are obtained by Sawarkar (1998).
The cross combinations CGD-77 x CGD-340 (16.33%),CGD-352 x CGD-25 (13.45%) and CGD-370 x CGD-352(7.86%) and CGD-370 x CGD-352 (80.94%) CGD-370 x CGD-402 (70.7%) and

Table 2 Comparative study of most promosing heterotic hybrid for green pod yield with useful and component characters showing desired heterosis.

Hybrid	Heterosis for green yield over			Useful and significant heterosis over MP for component trait	Useful and significant heterosis over BP for component trait	Useful and significant heterosis over BP for component trait
	MP	BP	SC			
Pusa falguni x CGD-370	50.11**	24.48**	20.52**	PH,PL,SP,PP,GP	PL,SP,PP,GP	PL,SP,PP,GD
GC-4 x CGD-25	63.37**	39.88**	19.43**	PH.BP.SP.PP.GP	BP,SP,PP,GP	BP,SP,PP,GP
Pusa falguni x CGD-402	34.67**	22.62**	18.53**	PL,SP,GP	PL,SP,GP	PL,SP,GP

** Signigicant at 1% level

Where, BP=Branches per plant PP=Pod per plant PL = Pod length (cm) GP=Green pod yield(g)
PH=Plant height (cm) SP=Seeds per pods

Pusa falguni x GC-4 (22.13%) exhibited highest heterosis over MP, BP and SC respectively for protein content and crude fiber content. The number of positive heterosis 16, 9 and 10 and 22, 16 and 3 for protein content and crude fiber content over MP,BP and SC respectively. Similar result obtained by Valarmathi and Surendran (2007)

The comparative study of most promosing three cross combinations for green pod yield per plant (g) with useful and component characters showing desired heterotic hybrids for green pod yield did not show all component characters in common. In fact, appreciable heterosis for one or two components was sufficient to manifest heterosis for green pod yield. The result are agreement with the findings of Patil and Shete 1987. The high heterotic effects of grain yield in these cases were mainly with significant heterotic effects of pods per plant, seed per pod, pod length and branches per plant.

The crosses of Pusa falguni x CGD-370, GC-4 x CGD-25 and pusa falguni x CGD-402 were found high heterotic hybrids for green pod yield per plant(g). They also had high heterosis for mainly yield attributing characters in desired direction. These combinations offer best possibilities of further exploitation for development of high yielding varieties.

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Feasibility of drip irrigation in fennel (*Foeniculum vulgare* Miller)

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ABSTRACT

Different nine fertigation treatments and surface method of irrigation were tested under RBD with four replications during 2005-06 to 2007-08 at Centre for Research on Seed Spices, SDAU, Jagudan to study the "Feasibility of drip irrigation in fennel". Effect of different fertigation treatments on growth and yield attributes as well as yield of fennel was significant during course of investigation and in pooled results where as, oil content was not influenced significantly. Crop irrigated at 0.8 ADPEF with 80% RDN recorded maximum umbels per plant, seeds per umbellate and test weight, whereas, no. of branches per plant was the highest when crop receive irrigation at 1.0 ADPEF with 80% RDN. The tallest plants were observed under 0.8 ADPEF with 100% RDN. Application of 80 kg N ha^{-1} through drip at 0.8 ADPEF ratio (T5) recorded maximum seed yield during the period of experimentation and in pooled data also and was statistically near to equal with 1.0 ADPEF + 80 kg N ha^{-1} (T8). Water use efficiency increased with increased in application of nitrogen levels from 60 to 80% of RDN then it was reduced drastically with further increase in nitrogen *i.e.*, 100% of RDN, which was the minimum. Maximum gross and net realizations were obtained when crop was irrigated at 0.8 ADPEF + 80% of RDN (80 kg N ha^{-1}). It was closely followed by 1.0 ADPEF + 80% of RDN. However, the highest BCR was recorded under surface method of irrigation with RDF (100 + 60 kg NP ha^{-1}).

Key words : Fertigation, fennel, feasibility, irrigation

Spices crops play an important role in Indian economy. Demand of spices increase at 10-12% per annum in world market due to change in food habit and established as ayurvedic medicines. Arid to semi arid regions of Gujarat are well know in India and abroad for their quality production. Soils of these regions are poor in fertility and water retentive capacity. Irrigation water and fertilizer are costly and scare inputs for crop production. Adoption of fertigation through drip irrigation is only alternative for economic use of water and fertilizer, which reduced consumption of costly inputs and increased yields. Fennel is well remunerative spice crop of north Gujarat which grown during *kharif* and *rabi* seasons. Scientific information regarding application of water and fertilizer through drip irrigation system is scanty. Hence the present experiment was planned.

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MATERIALS AND METHODS

The experiment was conducted for three consecutive years from 2005-06 to 2007-08 at Centre for Research on Seed Spices, SDAU, Jagudan (Gujarat). The soil was loamy sand in texture, neutral in soil reaction, with low in organic carbon, medium in available Phosphorus and Potash. An experiment comprising a set of nine fertigation treatments and surface method of irrigation (Table 1) were laid out in randomized block design with four replications. The crop was transplanted at 90 x 60 cm spacing by using seedling of cv. Gujarat fennel 2. The drip irrigation system was laid out at lateral spacing of 90 cm with dripper spacing of 60 cm and operated at pressure of 1.2 kg cm^{-2} with 4 LPH discharge rate. The scheduling of irrigation was done with 0.6, 0.8 and 1.0 ADPEF and 100, 80 and 60% RDN was applied as per treatment At the time of transplanting 60 kg P and 20% N ha^{-1} were applied as basal dose, whereas, remaining 80% N was applied in four equal splits at one month interval through drip system starting 30 days after transplanting. In surface

method of irrigation fertilizer dose applied in *i.e.*, 40 + 60 kg NP ha^{-1} as basal dose and remaining nitrogen applied in two equal splits at 30 and 60 days after transplanting. All the recommended package of practices was followed during the crop period as per need of the crop.

RESULTS AND DISCUSSION

Effect on growth and yield attributes

Effect of different fertigation treatments on growth and yield attributes of fennel was significant in pooled results. Crop irrigated at 0.8 ADPEF with 80% RDN recorded maximum umbels per plant, seeds per umbellate and test weight, whereas, no. of branches per plant was the highest when crop receive irrigation at 1.0 ADPEF with 80% RDN. The tallest plants were observed under 0.8 ADPEF with 100% RDN. The minimum values of all the growth and yield attributes were recorded when crop was irrigated under surface irrigation method with 100% RDF (Table 1).

Effect on yield

Seed yield of fennel was significantly influenced by various fertigation treatments during the course of investigation and in pooled data (Table 2). Application of 80 kg N ha^{-1} through drip at 0.8 ADPEF ratio (T5) recorded maximum seed yield during the period of experimentation and in pooled data also and was statistically near to equal with 1.0 ADPEF + 80 kg N ha^{-1} (T8). These both the treatments (T5 and T8) recorded 25 & 19, 36 & 27, 29 & 27 as well as 30 & 24 per cent higher seed yield than control (surface method with 100+60 kg NP ha^{-1}) during 2005-06, 2006-07, 2007-08 and pooled data, respectively. Application of adequate amount of water and nitrogen in root zone as per need of crop during crop growth period might be increased yield and save 20 per cent nitrogen *i.e.* 20 kg per hectare and water. According to patel *et al.*, (2000), drip irrigation system in fennel save the water.

Effect on quality

Effect of different ADPEF ratios with various nitrogen levels under drip and surface irrigation method on volatile oil content was non-significant during course of investigation and in pooled data also. However, beneficial effect of fertigation was observed on quality (Table 1).

Water Use Efficiency

Water use efficiency increased with increased in application of nitrogen levels from 60 to 80% of RDN

Table 1 Growth and yield attributes of fennel as influenced by different treatments of fertigation (Pooled data of 2005-06, 2006-07 and 2007-08)

Treatments	Plant height (cm)	No. of branches per plant	No. of umbels per plant	No. of umblt. per umbel	No. of seeds per umbrella.	1000 Seed weight (g)	Volatile oil (%)	Water applied (mm)	WUE (kg ha-mm^{-1})
T1 0.6 ADPEF + 100% RDN	178.85	9.71	26.77	39.68	37.98	7.96	1.22	366	5.30
T2 0.6 ADPEF + 80% RDN	182.88	9.73	27.57	41.85	37.90	7.84	1.18	366	5.47
T3 0.6 ADPEF + 60% RDN	181.13	9.49	25.30	39.80	34.63	7.45	1.17	366	4.99
T4 0.8 ADPEF + 100% RDN	185.83	10.43	27.22	41.82	40.37	7.78	1.17	487	4.46
T5 0.8 ADPEF + 80% RDN	183.63	10.14	28.75	45.58	38.85	8.23	1.43	487	4.99
T6 0.8 ADPEF + 60% RDN	180.97	10.22	26.39	43.62	38.75	7.49	1.22	487	4.14
T7 1.0 ADPEF + 100% RDN	184.77	10.05	27.37	42.93	37.78	7.90	1.28	610	3.46
T8 1.0 ADPEF + 80% RDN	185.52	10.67	28.37	44.40	40.68	7.85	1.36	610	3.78
T9 1.0 ADPEF + 60% RDN	182.18	10.15	26.40	41.38	37.33	7.70	1.27	610	3.20
T10 Control (0.8 IW/CPE ratio 50mm depth) + RDF 100 + 60 kg NP ha-1	174.58	8.92	23.93	36.48	35.00	7.47	1.07	533	3.66
S.Em.±	1.83	0.314	0.690	1.034	0.905	0.127	0.074	-	-
C.D. at 5 %	5.13	0.88	1.94	2.91	2.54	0.36	NS	-	-
C.V.%	3.30	10.98	9.15	8.52	8.08	5.78	14.99	-	-
Y X T	NS	NS	NS	NS	NS	NS	0.26	-	-

then it was reduced drastically with further increase in nitrogen i.e. 100% of RDN, which was the minimum. Crop receives irrigation water at 0.6 ADPEF recorded maximum WUE. Where as, it was the lowest under 1.0 ADPEF. Higher water use efficiency was recorded under drip irrigation system then surface method of irrigation and fertilized with 100% RDF (Table 1). As compared to surface method of irrigation with 100% RDF, fertigation treatments with 0.6 and 0.8 ADPEF increased yield, WUE and save water considerably. Similar results were reported by Annonymus (2009) in chilly.

Economics

Maximum gross and net realizations were obtained when crop was irrigated at 0.8 ADPEF + 80% of RDN (80 kg N ha-1). It was closely followed by 1.0 ADPEF+ 80% of RDN (Table 2). However, the highest BCR was recorded under surface method of irrigation with RDF due to minimum cost of cultivation. The lowest net realizations was recorded with 0.6 ADPEF + 60% of RDN (60 kg N ha^{-1}). Crop was irrigated at 0.8 ADPEF + 80% of RDN (80 kg N ha^{-1}) recorded 28 percent higher yield than surface method of irrigation with 100% RDF. This treatment also saves the water up to 10 per cent. Thus, saved 10% water can irrigate additional 0.10 ha land under drip method, which will give an additional net profit of ₹ 7365/ha.

Table 2 Seed yield, net return, net BCR and ICBR (kg/ha) of fennel as influenced by different treatments of fertigation

Treatments	Seed Yield (kg ha^{-1})				Gross Income (₹ ha^{-1})	Gross Expen-diture (₹ ha^{-1})	Net Return (₹ ha^{-1})	Net BCR	ICBR
	2005-06	2006-07	2007-08	Pooled					
T1 0.6 ADPEF + 100% RDN	1575	2225	1999	1933	96650	38250	58400	1.52	1:0.39
T2 0.6 ADPEF + 80% RDN	1764	2212	2014	1997	99850	37987	61863	1.63	1:0.78
T3 0.6 ADPEF + 60% RDN	1549	2101	1820	1823	91150	37725	53425	1.42	-
T4 0.8 ADPEF + 100% RDN	1789	2548	2179	2172	108600	39832	68768	1.73	1:1.48
T5 0.8 ADPEF + 80% RDN	2088	2762	2435	2428	121400	39568	81832	2.07	1:2.77
T6 0.8 ADPEF + 60% RDN	1672	2277	2093	2014	100700	39305	61395	1.56	1:0.76
T7 1.0 ADPEF + 100% RDN	1744	2475	2112	2110	105500	41439	64061	1.55	1:1.02
T8 1.0 ADPEF + 80% RDN	1976	2591	2352	2307	115350	41175	74175	1.80	1:1.88
T9 1.0 ADPEF + 60% RDN	1585	2289	1989	1954	97700	40913	56787	1.39	1:0.39
T10 Control (0.8 IW/CPE ratio 50mm depth) + RDF 100 + 60 kg NP ha-1	1664	2034	1889	1863	93150	29368	63782	2.17	-
S.Em.±	78	127	109	58					
C.D. at 5 %	225	368	317	163					
C.V. %	8.90	10.78	10.45	10.33					
Y X T	-	-	-	NS					

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Studies on nutrient management on growth and yield of lucerne (*Medicago sativa* L.) - paddy (*Oryza sativa* L.) sequential cropping

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ABSTRACT

A Field experiment was conducted on "nutrient management on lucerne (*Medicago sativa* L.) and their residual effect on succeeding kharif rice (*Oryza sativa* L.)" during *rabi* and *kharif* seasons of 2004-2005 and 2005-2006. The growth and yield attributing characters of Lucerne significantly enhanced due to application of 2nd cutting then left for seed production + 50% RD of Phosphorus + PSB (T_9) over rest of the treatments during both the years as well as in pooled data. The highest values of growth and yield attributes like grain and straw yield of rice were recorded under the treatment combination of application of 2nd cutting then left for seed production + 50% RD of Phosphorus + *PSB* (T_9) to preceding Lucerne and 100 per cent recommended dose of fertilizer (F_3) to rice being at par with treatments combinations T_8F_3, T_7F_3 and T_6F_3 indicating that the treatment combination of $T_9 \times F_3$ was adequate for obtaining comparable grain and straw yields from succeeding rice.

Key words : Lucerne, paddy, cropping sequence

Lucerne is one of the crops that respond well to *phosphatic* fertilizers as compared to nitrogen and potassium fertilizers in all the territories and in all soil types. It plays a vital role in plant nutrition. It is a key nutrient in cell division and tends to be concentrated in actively growing young plants tissues. Its deficiency in soil severely limits root and shoot growth and thereby decreases the yield. Since phosphorus fixation is usually more common in heavy textured soil and under heavy irrigation, the deficiency of phosphorus to Lucerne is most likely under South Gujarat conditions requiring heavy demand to support luxuriant plant growth. It is reported by many scientists that yield of Lucerne increases with increase in dose of phosphorus up to 120 to 150 kg P_2O_5ha^{-1} (Jaisingh and Bajpai, 1972 and Anon., 1989).

The demand of rice in India is projected to be 100 million tonnes in 2006, which is to be produced from 42.3 million hectares of paddy area. Therefore, country has to reach an average production level of 2454 kgha^{-1}, from the present level of 1851 kg ha-1 (Siddiqui *et al.* 1999). In India, 45 per cent of yield advantage obtained with modern technologies over traditional package of practices could be attributed from a single factor *viz.*, fertilizer, which had played a significant role in the success of green revolution. Fertilizer management seems to be the most important component influencing rice yields with the increase in the intensity of cropping in the rice multiple cropping system and continuous removal of plant nutrients. Nitrogen is one of the costliest and perhaps the most crucial nutrient limiting rice yield. The second mineral element, phosphorus plays a key role in vigorous root growth and proliferation, early tillering with more panicles, higher percentage of filled spikelates, early maturity/ripening and good grain quality of rice.

Phosphorus fertilizers after their application in the soil undergo changes and enrich the soil with non-liable phosphate pool which in turn, benefits the succeeding crops. Legumes respond well to phosphate application and the residual phosphorus left in the soil can be an important source of P for the succeeding crop in legume-based cropping system. Further

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residual effect of P fertilization to rabi/summer crops on succeeding kharif crops has been found more profitable. Therefore, attempts are being made to recommend a dose of P fertilizer for a cropping system rather than individual crop.

Lucerne is one of the legume crop included in an Indian cropping system. Similarly, rice is main cereal grown in kharif season. The increased irrigation potential in south Gujarat has made it possible to raise summer legume in crop root action.

MATERIALS AND METHODS

Field experiments were conducted at Navsari Agricultural University, Navsari, during *Rabi*-summer and *kharif* seasons of 2004-05 and 2005-06, in Ten treatments for *rabi* Lucerne comprised of T_1-Entire cutting + RD of Nitrogen and Phosphorus, T_2-Entire cutting + 100% RD of Phosphorus, T_3-Entire cutting + 50% RD of Phosphorus + PSB, T_4-1st cutting then left for seed production + RD of Nitrogen and Phosphorus, T_5-1st cutting then left for seed production + 100% RD of Phosphorus, T_6-1st cutting then left for seed production + 50% RD of Phosphorus + PSB, T_7-2nd cutting then left for seed production + RD of Nitrogen and Phosphorus, T_8-2nd cutting then left for seed production + 100% RD of Phosphorus, T_9-2nd cutting then left for seed production + 50% RD of Phosphorus + PSB and T_{10}-Fallow and replicated four times in a Randomized Block Design. The succeeding kharif rice crop was superimposed on the same layout keeping rabi Lucerne treatments as main plots and three fertility levels as sub-plot (50% + Azotobacter (F_1), 75% (F_2) and (F_3) as 100 % of the recommended dose of 120 kg N + 30 kg P_2O_5 + 0kg K_2O ha^{-1}), with total thirty treatment combinations in a Split Plot Design with four replications. The experiments were conducted on the same site during both the years. The pure seed of Lucerne variety, Anand-2 was obtained and sowing was done manually by broad casting, using recommended seed rate of 5 kg ha^{-1}. The seeds were treated with bacterial culture *i.e. Rhizobium meliloti* having 10^7 bacterial count per gram of soil covered with soil manually and the crop was irrigated with tube well water.

The certified seeds of rice variety Gurjari were obtained from the College Farm, Navsari and treated with the fungicide thirum @ 3 g kg^{-1} seed. To assess the effect of treatments on the growth and development of crop plants, periodic observations (At 30 day's interval from sowing/transplanting to harvesting) were recorded.

A heights of 10 randomly selected plants were measured from ground level to the tip of the upper most axis of shoot. Average value of each plot was computed and recorded at 30 and 60 days after sowing.

The yield of green forage and seed per net plot was worked out at every cutting. The weight of green forage and seed from the total weight of the produce in each net plot and then converted into kilogram per hectare.

The height of randomly selected five hills was measured from ground level to the tip of the longest upper leaf in case of juvenile plants and for panicle plants^{-1}; it was measured from ground level to the tip of the tallest panicle of the hill. The total number of tillers was counted from the randomly selected five hills and their mean was recorded as number of total tillers hill^{-1}. The produce of each net plot was threshed, cleaned and the grain and straw yield was recorded in kilogram net plot^{-1}. The grain and straw yield net plot^{-1} obtained was converted to yield in quintals hectare^{-1}.

RESULTS AND DISCUSSION

The magnitude of significantly increase in growth and yield (fodder + seed) of Lucerne recorded by treatment T_9 (2nd cutting than left for seed production + 50% RD of Phosphorus + PSB) was to the tune of 92.30 and 62.76 per cent over T_4 (1st cutting + RD of Nitrogen and Phosphorus); 72.25 and 50.83 over T_5 (1st cutting + 100% RD of Phosphorus) and 60.00 and 43.11 per cent over T_6 (1st cutting + 100% RD of Phosphorus +PSB alone) during 2004-2005, 2005-2006 and in pooled data, respectively. Therefore, increase in yield with application of 2nd cutting then left for seed production + 50% RD of Phosphorus + PSB (T_9), 2nd cutting then left for seed production + 100% RDF of Phosphorus (T_8) and 2nd cutting then left for seed production + RD of Nitrogen and Phosphorus (T_7) along with Rhizobium and *PSB* may be due to improvement in yield attributes (Table 1). The increase in yield under these treatments (T_9, T_8 and T_7) may be due to combined effect of RD of N and P, 100% RD of P, Rhizobium, PSB with 50% RD of P may be attributed to improve nitrogen and phosphorus nutrition and therefore, better root and shoot growth, more nodulation and higher nitrogen fixation and release of growth promoting substances by PSB. Significant improvement in seed and straw yields of gram with *Rhizobium* inoculation in the presence of phosphorus fertilizer were also observed by Sonboir and Sarawgi

(2000) who had reported significant increase in yield attributes and seed yield due to application of N, P and bio-fertilizers.

The various yield attributes of rice *viz.*, Number of panicles per hill, Number of filled grains per panicle, test weight and eventually the grain yield per hill were increased significantly with successive increase in levels of fertilizer application except panicle length during both the years. This was due to the significant improvement in growth characters of rice which favorably reflected on the yield attributes with increased levels of fertilizer application.

A perusal of data in Table 2 would evince that application of 100 per cent recommended level of fertilizers (120 kg N + 30 P_2O_5 ha^{-1}) (F_3) increased the grain yield of rice significantly over the 75 per cent recommended level of fertilizer (90 kg N + 22.5 kg P_2O_5 ha^{-1}) (F_2) and 50 per cent recommended level of fertilizer (60 kg N + 15 kg P_2O_5 ha^{-1}) (F_1) during both the seasons as well as when the data were pooled over seasons. Further, it was observed that the increase in grain yield of rice over the 50 per cent recommended level of fertilizer (F_1) was 13.22, 19.82 and 17.08 per cent with the application of F_3 (100 per cent of the recommended level of fertilizers) during 2005, 2006 and in pooled data, respectively. The increase in grain yield of rice with increasing levels of fertilizers was due to the significant improvement in yield attributes like number of panicles per hill, number of filled grains per panicle and grain yield per hill which finally resulted in increase in the grain yield, similar results were observed by Chavan (2003) with the application of 20 kg P ha^{-1} to preceding green gram over control and 10 kg P ha^{-1}.

Table 1(a) Plant height and number of tillers per plant of Lucerne at various growth stages as influenced by different nutrient management treatments.

Treatments	Plant height (cm)				Numbers of tillers plant^{-1}			
	At 30 DAS		At 60 DAS		At 30 DAS		At 60 DAS	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
T_1	35.28	37.19	53.89	56.34	69.80	76.87	88.20	95.71
T_2	37.53	39.56	57.15	58.46	73.40	82.44	94.75	101.23
T_3	38.22	40.58	57.45	59.68	75.30	84.49	95.60	101.91
T_4	39.76	41.75	58.00	60.50	75.80	84.81	95.90	102.46
T_5	40.14	42.39	59.15	62.20	76.70	85.35	96.85	103.74
T_6	40.38	42.68	60.25	62.95	78.50	87.65	97.80	104.28
T_7	41.06	43.76	61.37	65.25	80.60	88.76	101.30	107.48
T_8	42.12	44.81	63.22	66.76	82.30	92.53	105.20	112.68
T_9	43.84	46.52	64.80	68.15	88.80	95.41	110.7	116.81
S.Em +	1.18	1.29	1.55	1.82	2.36	2.51	2.76	3.25
C.D.at 5 %	3.43	3.77	4.52	5.31	6.87	7.32	8.05	9.49
C.V. %	5.90	6.13	5.20	5.84	6.04	5.80	5.60	6.18
G. M.	39.83	42.14	59.49	62.25	77.58	86.48	98.20	105.14

Table 1(b) Plant height (cm) and total number of tillers hill^{-1} of rice at various growth stages as influenced by different treatments

Treatments	Total number of tillers hill^{-1}						Plant Height (cm)					
	At 30 DAT		At 60 DAT		At harvest		At 30 DAT		At 60 DAT		At harvest	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
T_1	8.13	9.17	14.43	15.47	14.01	17.56	63.44	65.56	81.30	88.15	106.72	119.12
T_2	8.21	9.26	14.60	15.66	14.18	17.99	64.42	65.87	81.83	90.35	107.07	122.4
T_3	8.31	9.31	14.78	15.83	14.91	18.32	64.55	66.03	82.12	90.56	107.30	122.76
T_4	8.37	9.37	14.93	15.97	15.36	18.57	64.73	65.82	84.70	90.69	107.51	123.19
T_5	8.53	9.53	15.03	16.07	15.69	18.90	65.32	66.78	82.96	90.89	107.68	123.55
T_6	8.72	9.72	15.12	16.83	16.55	19.36	65.53	66.98	83.46	91.19	107.84	123.83
T_7	8.87	9.92	15.21	16.91	17.35	19.5	65.75	67.13	84.88	91.42	109.05	124.10
T_8	8.99	10.06	15.32	17.02	17.80	19.69	66.24	67.67	85.54	93.27	110.03	127.87
T_9	9.22	10.31	15.40	17.10	18.44	20.49	67.10	68.33	87.39	95.22	116.00	130.60
T_{10}	8.07	9.09	14.36	15.39	13.50	17.33	62.95	65.04	80.50	87.28	103.42	119.06
S.Em. +	0.18	0.25	0.23	0.26	0.39	0.57	1.13	1.24	1.42	1.46	2.13	1.99
CD at 5%	0.52	0.72	0.68	0.48	1.14	1.64	NS	NS	4.13	4.22	6.19	5.77
CV %	7.32	8.96	5.49	5.18	8.66	10.44	6.03	6.44	5.91	5.55	6.83	5.57
Fertilizer levels												
F_1	7.35	8.38	13.81	14.81	14.10	16.55	60.64	62.97	78.91	85.07	101.24	118.58
F_2	8.48	9.51	14.87	15.87	15.96	18.84	65.74	66.94	83.39	91.47	108.92	123.59
F_3	9.79	10.83	16.08	18.00	17.28	20.92	68.62	69.66	88.11	96.18	114.63	128.78
S.Em. +	0.09	0.14	0.12	0.13	0.21	0.10	0.71	0.77	0.84	0.86	1.02	1.04
CD at 5%	0.27	0.41	0.34	0.38	0.60	0.29	2.003	2.18	2.37	2.44	2.90	2.93
CV %	6.14	8.30	4.43	4.47	7.37	3.04	5.97	6.34	5.51	5.19	5.18	4.59
Interaction												
S.Em. +	0.26	0.39	0.33	0.29	0.58	0.29	1.94	2.11	2.30	2.36	2.81	2.84
CD at 5%	NS	NS	NS	1.03	NS	0.81	NS	NS	NS	NS	NS	NS
CV %	6.14	8.30	4.430	4.47	7.37	3.04	5.97	6.34	5.51	5.19	5.18	4.59
G.M.	8.54	9.58	14.92	16.23	15.78	18.77	65.00	66.52	83.47	90.90	108.26	123.65

Table 2 Yield of Lucerne and rice (grain & straw) as influenced by different treatments under lucerne-paddy cropping sequence

Treatments	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})			Lucerne Yield (q ha^{-1}) (Fodder +Seed)		
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2005-06
Residual effect on nutrient management in succeeding Rice									
T_1	51.04	56.44	53.74	61.75	66.15	63.95	226.16	238.85	232.51
T_2	51.33	56.60	53.965	62.58	68.57	65.57	237.62	250.31	243.97
T_3	51.47	56.74	54.11	63.31	69.28	66.29	243.65	256.34	250.00
T_4	51.96	56.99	54.48	63.94	71.94	67.94	54.36	67.85	61.11
T_5	52.50	59.54	56.02	64.31	72.13	68.22	58.34	71.83	65.08
T_6	55.98	63.40	59.67	65.66	73.99	69.83	62.26	75.75	69.01
T_7	55.05	63.57	59.31	66.23	75.23	70.73	66.11	79.60	72.85
T_8	56.35	64.85	60.60	67.44	76.11	71.77	70.25	83.75	77.00
T_9	57.48	65.59	61.54	70.10	78.40	74.23	72.22	85.71	78.97
T_{10}	50.77	54.74	52.76	59.95	64.62	62.28	-	-	-
S.Em. +	1.60	1.85	1.22	1.73	2.02	0.59	4.42	4.81	4.62
CD at 5%	4.65	5.37	3.47	5.03	5.85	1.69	12.91	14.03	13.48
CV %	10.39	10.72	10.58	9.30	9.75	6.20	7.30	7.15	7.23
Fertilizer levels									
F_1	44.73	50.10	47.41	54.95	59.90	57.42	-	-	-
F_2	54.56	59.33	56.94	66.71	74.50	70.57	-	-	-
F_3	60.89	70.10	65.50	71.95	80.57	76.26	-	-	-
S.Em. +	0.79	0.92	0.52	0.51	0.64	0.35	-	-	-
CD at 5%	2.24	2.59	1.47	1.44	1.82	0.99	-	-	-
CV %	8.12	8.39	8.29	4.31	4.92	4.66	-	-	-
Interaction									
S.Em. +	2.20	2.51	1.66	1.39	1.76	1.12	-	-	-
CD at 5%	NS	7.10	4.64	NS	4.98	3.14	-	-	-
CV %	8.12	8.39	8.29	4.31	4.92	4.66	-	-	-
G.M.	53.39	59.84	56.62	64.52	71.64	68.08	121.22	134.45	127.84

CONCLUSION

Application of 2nd cutting then left for seed production + 50% RD of Phosphorus + PSB (T_9) and 2nd cutting then left for seed production + 100% RD of Phosphorus (T_8) increased the yield (fodder and seed) per hectare of Lucerne during both the years as well as in pooled analysis recorded almost identical, higher net realization and benefit cost ratio.

The yield attributes, *viz.*, number of panicles per hill, panicle length, number of filled grains per panicle, test weight, biological yield and eventually grain and straw yields per hectare of succeeding rice with the application of 2nd cutting then left for seed production + 50% RDF of Phosphorus + PSB (T_9) to preceding Lucerne recorded higher grain, straw and biological yields of succeeding rice than Fallow (T_{10}) and rest of the treatments except the treatment T_8 (2nd cutting

then left for seed production + 100% RD of Phosphorus) during both the years as well as in pooled data during both the individual years of experimentation.

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Effect of integrated nutrients management on yield and economics of cowpea (*Vigna unguiculata* (L.) Walp.) under rainfed conditions

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ABSTRACT

A field experiment was conducted at Centre of Excellence for Reseach on Pulses, S.D. Agricultural University, Sardarkrushinagar during rainy season of 2005, 2006 and 2007 on "Effect of integrated nutrients management on yield and economics of cowpea". Results revealed that application of 10 kg N + 20 kg P_2O_5 per ha alongwith *Rhizobium* + PSB inoculation significantly increased seed yield over application of 20 kg N + 40 kg P_2O_5 per ha but was at par with application of 10 kg N + 20 kg P_2O_5 per ha alongwith PSB, which indicated that *Rhizobium* + PSB or only PSB inoculation saved 50 per cent nitrogen and phosphorus as chemical fertilizers. Seed inoculation with *Rhizobium* + PSB inoculation or PSB alone in combination with 10 kg N + 20 kg P_2O_5 or 20 kg N + 40 kg P_2O_5 per ha improved significantly all the parameters governing the seed yield *viz.*, number of pods per plant. number of seeds per pod and 100-seed weight. The highest BCR value of 3.01 was recorded with the application of 10 kg N + 20 kg P_2O_5 per ha along with *Rhizobium* and PSB inoculation followed by application of 10 kg N + 20 kg P_2O_5 per ha alongwith PSB inoculation.

Key words : Cowpea, rhizobium, PSB, net return.

Cowpea is an important legume crop and it has manifold uses such as vegetable, pulses, green manuring and fodder crop. Its productivity remains lower inspite of higher potential of the crop. The factors behind the low yield are poor management and imbalance use of nutrients *viz.*, nitrogen and phosphorus. Nitrogen being a major constituent of protein and chlorophyll, It must be adequately and timely supplied to the crop. P is required for better root growth, nodulation and nitrogen fixation and supplied as inorganic fertilizers. The use efficiency of P fertilizer is generally low (20-30%) and therefore enhancing of applied fertilizers (Jain and Trivedi, 2005). PSB hold promise in the present scenario of escalating price of phosphatic fertilizers in the country. A positive response of PSB inoculation has also reported by Srivastava and Ahlawat (1995) in pea. Besides minerals nutrition, biofertilizers play an important role in the cowpea production as these are eco-friendly, low cost, non-bulky agricultural inputs. *Rhizobium* have an enormous potential to fix atmospheric N_2 while, PSB have capacity to solubilize and mobilize P present in the non-available form in the soil. Therefore, there is need to evolve integrated nutrient supply system by judicious combination of chemical and biofertilizers. Therefore, present study was undertaken to study the effect of integrated nutrients management on yield and economics of cowpea.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* 2005 to *kharif* 2007 at Centre of Excellence for Reseach on Pulses, S. D. Agricultural University, Sardarkrushinagar (Gujarat) on "Effect of integrated nutrient management on yield and economics of cowpea." The soil was loamy sand having low in organic carbon (0.21%), medium available phosphorus (42 kg/ha) and high available potassium (254 kg/ha) with pH 7.6. Both the bio-fertilizers were prepared as peat based inoculants for this study. The treatment details are T_1: Control,

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T_2: *Rhizobium* inoculation, T_3: PSB inoculation, T_4: *Rhizobium* and PSB inoculation, T_5: 10 + 20 NP kg/ ha, T_6: 10 + 20 NP kg/ha + *Rhizobium* inoculation T_7: 10 + 20 NP kg/ha + PSB inoculation, T_8: 10 + 20 NP kg/ ha + *Rhizobium* and PSB inoculation, T_9: 20 + 40 NP kg/ha, T_{10}: 20 + 40 NP kg/ha + *Rhizobium* inoculation, T_{11}: 20 + 40 NP kg/ha + PSB inoculation, T_{12}: 20 + 40 NP kg/ha + *Rhizobium* and PSB inoculations. The experiment was conducted in randomized block design with four replications. Cowpea variety Gujarat Cowpea-5(GC-5) was sown in first fortnight of July during all the years of experimentation with 45 cm row spacing. Rainfall was received 527 mm, 1103 mm and 704 mm during *kharif* 2005, 2006 and 2007, respectively.

RESULTS AND DISCUSSION

Growth and yield attributes

On the basis of pooled, the results showed favourable response to integrated nutrient management in terms of number of pods per plant, number of seeds per pods, 100- seed weight, number of branches per plant and plant height (Table -1). The number of pods per plant and number of seeds per pod were significantly higher in treatment T_{12} and were found at par with treatments T_{11}, T_{10}, T_8 and T_7. Treatment T_{12} recorded significantly higher number of branches per plant and 100-seed weight as compared to control, T_2 and T_5 but was at par with rest of the treatments. Plant height was at par and significantly higher in treatment T_{12}.

Table 1 Effect of bio-fertilizers at different fertility levels on growth and yield attributes of cowpea

Treatments	Pods / plant	Seeds/ pod	100- seed weight (g)	Plant height (cm)	Branches/ plant
T_1 : Control	11.5	11.1	6.49	54.7	1.92
T_2 : *Rhizobium* inoculation	13.0	11.7	7.18	61.7	2.67
T_3 : PSB inoculation	14.5	12.0	7.59	65.3	3.18
T_4 : *Rhizobium* and PSB inoculation	15.2	12.2	7.48	64.7	3.18
T_5 : 10 + 20 NP kg/ha	13.7	11.8	7.26	64.1	3.00
T_6 : 10 + 20 NP kg/ha + *Rhizobium* inoculation	14.6	12.2	7.40	65.7	3.13
T_7 : 10 + 20 NP kg/ha + PSB inoculation	16.9	12.9	7.62	69.3	3.58
T_8 : 10 + 20 NP kg/ ha + *Rhizobium* and PSB inoculation	17.5	13.0	7.62	69.3	3.51
T_9 : 20 + 40 NP kg/ha	15.6	12.3	7.55	68.4	3.25
T_{10}: 20 + 40 NP kg/ha + *Rhizobium* inoculation	16.7	12.8	7.52	68.8	3.47
T_{11}: 20 + 40 NP kg/ha + PSB inoculation	18.5	12.9	7.83	70.2	3.37
T_{12}: 20 + 40 NP kg/ha + *Rhizobium* and PSB inoculation	18.6	13.2	7.86	71.4	3.68
S. Em. +	0.75	0.22	0.20	2.01	0.22
C. D. at 5 %	2.0	0.62	0.55	5.9	0.66
C. V. (%)	16.6	6.7	8.9	10.1	17.7

Table 2 Productivity and economics of cowpea under different treatments

Treatments	Seed yield(kg/ha)				Straw yield (kg/ha)	Gross income (₹/ha)	Cost (₹/ha)	Net return (₹/ha)	BCR
	2005	2006	2007	Pooled					
T_1: Control	600	863	1056	840	1767	14854	4884	9970	2.04
T_2: *Rhizobium* inoculation	712	945	1140	932	2001	16514	4934	11580	2.35
T_3: PSB inoculation	800	1018	1311	1043	2267	18502	4945	13517	2.73
T_4: *Rhizobium* and PSB inoculation	832	1053	1301	1062	2419	18927	4967	13960	2.81
T_5: 10 + 20 NP kg/ha	769	1065	1143	992	2125	17572	5445	12127	2.23
T_6: 10 + 20 NP kg/ha + *Rhizobium* inoculation	836	1127	1254	1072	2366	19045	5495	13550	2.47
T_7: 10 + 20 NP kg/ha + PSB inoculation	911	1293	1438	1214	2717	21598	5506	16092	2.92
T_8: 10 + 20 NP kg/ ha + *Rhizobium* and PSB inoculation	946	1307	1482	1245	2780	22144	5528	16616	3.01
T_9: 20 + 40 NP kg/ha	858	1177	1309	1115	2494	19836	6006	13830	2.30
T_{10}: 20 + 40 NP kg/ha + *Rhizobium* inoculation	897	1204	1426	1175	2685	20948	6056	14892	2.46
T_{11}: 20 + 40 NP kg/ha + PSB inoculation	921	1454	1467	1281	2862	22786	6067	16719	2.76
T_{12}: 20 + 40 NP kg/ha + *Rhizobium* and PSB inoculation	959	1461	1499	1306	3010	23304	6089	17215	2.82
S. Em. ±	64	78	93	44	106				
C. D. at 5 %	185	224	264	123	298				
C. V. (%)	15.5	13.5	14.0	14.4	16.2				

Input Price: *Rhizobium*: ₹ 10 per packet Urea: ₹ 5 per kg
PSB: ₹ 15 per packet Market Price: Seed; ₹16 per kg
DAP: ₹ 9.50 per kg Straw ₹ 0.8 per kg

T_{11}, T_{10}, T_9, T_8, T_7 and T_6 as compared to rest of the treatments. Significant increase in yield attributes, yield and harvest index of mungbean due to *Rhizobium* inoculation have been reported by Shukla and Dixit (1996). Raut *et al.* (2004) reported that seed dressing with *Rhizobium* + PSB micro-organisms in combination with half or full dose of RDF improved significantly all the parameters governing the yield in soybean at Nagpur.

Seed yield

The results presented in Table 2 indicated that the seed yield differences were found significant due to various treatments during individual years as well as in pooled data. An application of 20 kg N + 40 kg P_2O_5 per ha alongwith seed inoculation of *Rhizobium* and PSB recorded maximum seed yield in cowpea during all the individual years as well as in their pooled data. However, its seed yield was at par with the seed yields of the treatments T_{11}, T_{10}, T_9, T_8, T_7 and T_6 during the years 2005 and 2007. But it was remained at par with T_{11}, T_8 and T_7 during the year 2006 and in pooled data of three years.

On the pooled basis, seed yield increased in the treatments of T_{12}, T_{11}, T_8 and T_7 to the tune of 55, 53, 48, and 45 per cent, respectively as compared to

control. The seed yield increased in these treatments may be due to increase in yield attributing characters *viz.*, number of pods per plant, number of seeds per pod and 100-seed weight which were significantly higher in these treatments. These results indicated that the dual inoculation of *Rhizobium* and PSB has the ability to save about 50 per cent of inorganic N and P fertilizer in this crop. *Rhizobium* inoculation fixed nitrogen through root nodules of plant, whereas, PSB solubilizes native phosphorous and increasing availability to the plants. Thus, combined inoculation of seeds with *Rhizobium* and PSB improved N and P status of soil which ultimately increased N and P uptake and enhancement of growth, yield attributes and seed yield. Similar results have been reported in blackgram (Surendra *et al.*, 1993) and in clusterbean at Hisar (Haryana) (Rawat *et al., 2008*). Prabakaran *et al.*, (1999) reported that the dual inoculation of *Rhizobium* and PSB with 50 per cent of P_2O_5 per ha gave a comparable yield with 100 per cent P_2O_5 per ha alone in horsegram at Vamaban (Tamil Nadu) on red lateritic soil.

Straw yield

On the basis of pooled analysis (Table 2), significantly higher straw yield of cowpea was registered with an application of 20 kg N + 40 kg P_2O_5 per ha alongwith *Rhizobium* and PSB inoculations than that registered in the rest of the treatments, however, its straw yield was at par with the straw yield obtained from T_{11}, T_7 and T_8. Higher straw yield in these treatments was clearly reflected by growth characters *viz.*, plant height and number of branches per plant. Singh and Pareek (2003) reported that seed inoculation with bio-fertilizers proved superior to no inoculation with respect to straw yield of mungbean at Jobner (Rajasthan) on loamy sand soil.

Economics

Looking to the economics, an application of 10 kg N + 20 kg P_2O_5 per ha alongwith *Rhizobium* and PSB inoculation recorded the highest BCR value of 3.01 (net return of Rs. 16616 per ha) followed by the application of 10 kg N + 20 kg P_2O_5 per ha along with PSB inoculation (BCR 2.92 and net return Rs. 16092/ ha), 20 kg N and 40 kg P_2O_5 per ha along with *Rhizobium* + PSB inoculation (BCR 2.82 and net return Rs. 17215/ha) and 20 kg N + 40 kg P_2O_5 per ha alongwith PSB inoculation (BCR 2.76 and net return Rs. 16719/ha).Rajput and Pandey (2004) reported that 50% NPK with *Rhizobium* and PSB mixed with 25 kg FYM recorded the highest additional return over control with the BCR value of 3.73 in Pea at Morena(MP) and sowing in sandy loam soil.

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Delineation of sulphur deficient soil in Banaskantha district (Gujarat)

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ABSTRACT

Soil samples (0-15 cm depth) from Banaskantha district of north Gujarat were collected and analysed for determination of status of available sulphur in soil. On an average, the available sulphur was ranged from 5.24 to 60.17 mg kg^{-1} in soil with a mean value of 19.01 mg kg^{-1}. Out of 240 surface soil samples (0-15 cm depth), 30.0, 32.1 and 37.9 per cent samples were observed as deficient, medium and sufficient categories, respectively.

Key words : Delineation, sulphur, deficient

Sulphur recognized as fourth important plant nutrient after N, P and K and is gaining considerable importance in quality crop production in context of Indian agriculture, particularly when there is more and more use of non-S containing fertilizers as well as less use of organic manures. Sulphur deficiency in crops is gradually becoming widespread in different soils in several states of India (Tandon 1991). Eighty eight districts in India were reported to be deficient in sulphur in early 1980s, increasing to 120 by 1990 and at present this number is close to 250. Sulphur deficiency is prevailing in various states of India ranging from 15 to 84 per cent (Tewatia *et al.* 2006). Widespread sulphur deficiency in soils of different parts of Gujarat has also been reported by Patel *et al.* (2001). No detailed information is available on the status and delineation of sulphur in soils of Banaskatha district. This study aims to delineate sulphur deficient areas of Banaskantha district of Gujarat.

MATERIALS AND METHODS

In order to delineate the sulphur deficient area in soils of Banaskantha district of north Gujarat, 220 representative surface soil samples (0-15 cm) were collected from 12 talukas (20 villages in each taluka) of Banaskantha district during 2009. The soil samples were air dried, sieved through 2 mm sieve and analysed for important chemical properties using standard chemical procedure outlined by Jackson (1973). The soil samples were analysed for sulphur (heat soluble Williams and Steinbergs, 1959) by adopting turbidimetric methods (Chesnin and Yien, 1950).

RESULTS AND DISCUSSION

The important chemical properties of soil and content of available sulphur presented in the Table 2. The soils of Banaskantha district are sandy to sandy clay loam in texture and alkaline in reaction. These soils are low to medium in organic carbon, available nitrogen, available phosphorus and medium to high in available potassium. Available sulphur content ranged from 5.24 to 60.17 mg kg^{-1} in the surface soil with a mean value of 19.01 mg kg^{-1}, The values of available sulphur are in aggrement with those reported by Reddy and Mehta (1970), Patel and Patel (2008) and Singh *et al.* (2009). Plant roots absorb sulphur in the form of SO_4^{-2} from the soil solution. Keeping in view this fact the soil may be classified as deficient (< 10 mg kg^{-1}), medium (10 - 20 mg kg^{-1}) and sufficient (> 20 mg kg^{-1}) categories (Hariram and Dwivedi, 1994). According to this classification, out of 240 surface soil samples (0-15 cm depth), 30.0, 32.1 and 37.9 per cent samples were observed as deficient, medium and sufficient categories, respectively (Table 2).

The maximum deficiency was observed in Tharad and Vav taluka, while maximum sufficiency was observed in Danta and Kankarej talukas of district This was

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Table 1 Chemical characteristics of soils in Banaskantha district

Name of Taluka	E.C. (dSm^{-1})	pH	Organic carbon (%)	Available nutrients (Kg/ha)		Available sulphur (mg kg^{-1})		
				P_2O_5	K_2O	Range	Mean	S.D.
Palanpur	0.04 - 0.40	7.56 - 8.85	0.08 - 0.52	20.62 - 63.58	142.5 - 345.4	5.89 - 28.90	17.54	5.86
Danta	0.06 - 0.39	7.02 - 8.41	0.16 - 1.92	18.90 - 70.46	170.7 - 927.4	9.16 - 60.86	29.54	13.30
Vadgam	0.08 - 0.35	7.55 - 8.12	0.09 - 0.66	15.47 - 42.96	134.4 - 533.6	6.54 - 32.07	17.86	8.24
Amirgadh	0.07 - 0.37	7.18 - 7.85	0.10 - 0.83	17.18 - 60.14	119.6 - 459.6	6.54 - 34.68	18.74	8.41
Deesa	0.10 - 0.41	7.40 - 8.05	0.10 - 0.53	15.47 - 61.86	114.2 - 462.3	7.77 - 29.45	16.07	7.01
Dhanera	0.10 - 0.72	7.47 - 8.60	0.05 - 0.48	12.03 - 51.55	159.9 - 346.8	5.89 - 30.76	17.11	8.20
Dantiwada	0.08 - 0.28	7.39 - 8.05	0.12 - 0.64	18.90 - 44.68	155.9 - 384.3	7.85 - 30.76	18.13	7.09
Kankarej	0.15 - 1.13	7.35 - 8.12	0.08 - 0.55	20.62 - 58.43	204.3 - 576.6	5.24 - 60.86	23.29	13.19
Tharad	0.20 - 0.77	7.72 - 8.60	0.03 - 0.40	10.31 - 41.24	200.3 - 322.6	6.87 - 30.76	13.97	6.82
Bhabhar	0.12 - 1.21	7.40 - 8.30	0.05 - 0.45	17.18 - 53.27	170.7 - 412.6	7.20 - 62.17	20.66	14.10
Deodar	0.13 - 0.70	7.35 - 8.20	0.03 - 0.77	20.62 - 60.14	201.6 - 590.0	7.85 - 46.76	21.20	10.98
Vav	0.20 - 1.20	7.75 - 8.25	0.04 - 0.75	10.31 - 46.40	190.8 - 583.3	5.51 - 41.23	13.87	9.32
Overall Mean	0.04 - 1.21	7.02 - 8.85	0.03 - 1.92	10.31 - 70.46	114.2 - 927.4	5.24 - 62.17	19.01	10.39

probably due to leaching losses of SO_4^{-2} in coarse textured soils.

From the data, it was found that more than 62 per cent soils of the Banaskantha district are deficient or below sufficient level (> 20 mg kg^{-1}), while remaining 32 per cent soils of the district are found sufficient in available sulphur. Thus the study suggests that there is a need for sulphur fertilsation in more than 62 per cent of the soils of the district. Similar deficiencies were reported by Maliwal (1986), Patel and Kalyansunderam (1988), Patel *et al.* (2001) for soils of Gujarat. Tandon (1986) also reported that the soils of Banaskantha are prone to sulphur deficiency. Similar type of results were also reported by Raina and Tanawade (2005), Jat and Yadav (2006) and Tewatia *et al.* (2006) for different soils of India.

Table 2 Talukawise sulphur (heat soluble) deficient soil samples of Banaskantha district (0-15 cm)

Name of Taluka	No. of samples	Deficient (<10 mg kg^{-1})	Medium (10-20 mg kg^{-1})	Sufficient (>20 mg kg^{-1})
Palanpur	20	03 (15)	11 (55)	06 (30)
Danta	20	01 (05)	05 (25)	14 (70)
Vadgam	20	06 (30)	07 (35)	07 (35)
Amirgadh	20	05 (25)	07 (35)	08 (40)
Deesa	20	08 (40)	06 (30)	06 (30)
Dhanera	20	07 (35)	07 (35)	06 (30)
Dantiwada	20	05 (25)	07 (35)	08 (40)
Kankarej	20	04 (20)	04 (20)	12 (60)
Tharad	20	10 (50)	07 (35)	03 (15)
Bhabhar	20	06 (30)	07 (35)	07 (35)
Deodar	20	05 (25)	05 (25)	10 (50)
Vav	20	12 (60)	04 (20)	04 (20)
Total	240	72 (30.0)	77 (32.1)	91 (37.9)

* figure in parenthesis shows per cent of samples

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Growth and yield of *rabi* castor as influenced by INM grown on *Vertic Ustrochrepts* of South Gujarat

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ABSTRACT

A field experiment was conducted at College Farm, Navsari Agricultural University, Navsari, (Gujarat-India) during *rabi* 2004-2005 to study the effect of integrated nutrient management (INM) in *rabi* castor (GCH-4). The plant height, number of branches/plant, length of spike, number of capsules/spikes, yield of seeds and stalk were recorded significantly higher over control due to application of 5 t bio compost/ha along with 100 per cent RDF, however, higher number of spikes/plant was observed with application of 5 t bio compost along with 75 per cent RDF.

Key words : INM, organic manure, fertilizers, growth, yield, castor

Oil seed crops have a unique significance in recent era of energy crisis as they play pivotal role in the agricultural industry and export trade of India. Castor holds first position among the non-edible oilseeds and occupies 38 and 36 per cent production and area, respectively in India. The integrated management of plant nutrient resources through the judicious use of organic, inorganic and bio-fertilizers offer an opportunity to sustain agriculture along with minimizing any soil and environmental damage. On the contrary, it has been clearly evidenced that the balanced and integrated nutrient management improves the soil organic matter content as well as soil quality which is an index of better soil health and sustainability of the system (Nambiar and Ghosh, 1989; Katyal, 1992 and Rajendra Prasad, 2000). However, the quantification of growth and yield attributes as well as yield of *rabi* castor under South Gujarat condition has not been studied so far, hence, the present study was planned to assess the impact of Integrated Nutrient Management on growth and yield of *rabi* castor.

MATERIALS AND METHODS

A field experiment was conducted during the *rabi* season 2004-05 at College Farm, NAU, Navsari (Gujarat-India), situated at 21° 07' N latitude and 73° 40' E longitude, with an elevation of 10 m above mean sea-level to study The Integrated Nutrient Management (INM) on growth and yield of castor (GCH-4) in South Gujarat. The experiment was laid out in randomized block design with factorial concept (FRBD) with 16 treatments composed of 4 levels of fertilizers (F_0: No fertilizer, F_1: 50 % RDF, F_2: 75 % RDF, F_3: 100 % RDF) and 3 source of manures (M_0 – No organic manure, M_1 – Farm Yard Manure @ 5 t/ha, M_2 – Bio compost @ 5 t/ha, M_3 – Vermi compost @ 2 t/ha) and it was replicated thrice. The experimental soil is classified under the order 'Inceptisols' comprises members of fine, montmorillonitic, isohyperthemic family of *Vertic Ustrochrepts* and soil series Jalalpur. The color of dry soil is dark brown and texture is clay and neutral to slightly alkaline in reaction. The experimental soil was low in available N, medium in available P_2O_5 and high in available K_2O with slight problem of excess soluble salts and compactness due to the puddling for *kharif* rice crop. Statistical analysis was carried out as per the methods described by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The mean data of growth and yield attributes as well as yield of castor as influenced by different levels of inorganic fertilizers, source of organic manures and their interactions are presented in Table 1.

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Table 1 Effect of INM on growth parameters of castor crop

Treatments	Plant height (cm)					No. of branches/plant				
	M_0	M_1	M_2	M_3	Mean	M_0	M_1	M_2	M_3	Mean
F_0	78.33	102.40	106.60	125.67	103.25	6.07	6.73	7.60	6.73	6.78
F_1	120.40	143.53	123.40	113.13	125.12	6.53	6.40	8.33	7.67	7.23
F_2	101.67	126.13	168.47	124.27	130.13	7.00	9.53	13.13	12.00	10.41
F_3	123.20	128.67	170.33	146.27	142.12	9.26	14.60	15.06	14.80	13.43
Mean	105.90	125.18	142.20	127.33		7.21	9.31	11.03	10.30	
	S. Em. +		C.D. at 5 %			S. Em. +		C.D. at 5 %		
M	5.65		16.31			0.43		1.26		
F	5.65		16.31			0.43		1.26		
M x F	11.29		32.65			0.87		2.53		
C. V. %	15.63					16.03				

Table 2 Effect of INM on yield attributes of castor crop

Treatments	Length (cm) of main spike					Number of spikes/plant				
	M_0	M_1	M_2	M_3	Mean	M_1	M_1	M_2	M_3	Mean
F_0	27.73	26.87	27.13	25.73	26.87	7.13	6.80	6.27	6.80	6.75
F_1	28.33	28.40	29.13	29.00	28.72	6.60	7.20	7.47	7.67	7.23
F_2	31.33	30.60	38.87	38.80	34.90	7.07	8.93	14.13	8.93	9.77
F_3	32.87	44.27	46.87	41.60	41.40	7.47	11.53	8.33	11.73	9.77
Mean	30.07	32.53	35.50	33.78		7.07	8.62	9.05	8.78	
	S. Em. +		C.D. at 5 %			S. Em. +		C.D. at 5 %		
(M)	1.01		2.93			0.52		1.51		
(F)	1.01		2.93			0.52		1.51		
M x F	2.03		5.86			1.04		3.01		
C. V. %	10.65		21.56							
	Number of capsules per spike					Shelling percentage				
	M_0	M_1	M_2	M_3	Mean	M_0	M_1	M_2	M_3	Mean
F_0	22.13	21.27	28.47	25.53	24.35	46.6	57.8	60.4	59.5	56.1
F_1	23.47	30.60	30.73	35.00	29.95	46.3	59.3	58.9	55.5	55.0
F_2	28.67	34.33	37.87	40.07	35.23	52.5	58.7	59.2	61.9	58.1
F_3	28.60	45.03	48.47	44.67	41.69	60.8	63.3	66.8	62.8	63.4
Mean	25.72	32.81	36.38	36.32		51.6	59.8	61.4	59.9	
	S. Em. +		C.D. at 5 %			S. Em. +		C.D. at 5 %		
(M)	1.10		3.18			1.7		5.1		
(F)	1.10		3.18			1.7		5.1		
M x F	2.20		6.36			3.5		NS		
C. V. %	11.63					10.60				

The plant height (142.12 cm) and number of branches/ plant (15.06) were significantly higher with the application of 100 per cent RDF over control and 50 per cent RDF. It might be due to the fact that application of higher quantity of nitrogen and phosphorus might have accelerated the synthesis of chlorophyll and amino acids which are associated with major photosynthetic processes of plants. The results of the present investigation are in confirmation with those of earlier workers Thadoda (1996), Hans *et al.* (2001) and Sree and Reddy (2003). Significantly smaller plant (13.43 cm) and less number of branches (6.78) were recorded when no fertilizers were applied. The data further revealed that application of bio compost @ 5 t/ha (M_2) produced identical effects on plant height (142.20 cm) and number of branches/ plant (11.03) at harvest of the crop. The pronounced effect from bio compost over vermi compost was noted might be due to the higher rate of application, poor response of FYM might be due to the poor macro and micronutrient content. Application of bio compost might have created better soil condition due to the higher rate of application leading to better mobilization of bound nutrients and improvement in soil aggregates resulting in better root proliferation and thereby efficient absorption of water and nutrients. Secondly, the bio compost has a material which was predigested and also because of presence of pressmud which might have kept the pH of the soil low and thereby increased the availability of micronutrients. Significantly the lowest plant height (105.90 cm) and number of branches/plant (7.21) at harvest were recorded when organic manures were eliminated from the treatment. The interactions arising due to the sources of organic manure and levels of inorganic fertilizer significantly altered the growth parameters at the harvest of castor crop. The interaction M_2F_3 (100 % RDF + bio compost @ 5 t/ha) resulted taller plants (170.33) and more number of branches/plant (15.06). The shorter plants were produced when inorganic fertilizers were not applied along with any source of organic manures except, M_3F_0 (Table 1). The influence might be because of continuous supply of available nutrients from inorganic and organic sources on decomposition and due to the production of bio-active substances. The organic manures might have activated the certain growth characters due to the production of bio-active substances and higher fixation of N in the soil.

A perusal of the results presented in table 2 indicated that length of spike (41.40 cm), number of spikes/ plant (9.77), number of capsules/spike (41.69) and shelling percentage (63.4) were significantly higher with the application of 100 per cent RDF through inorganic fertilizers (F_3). This might be due to the increase in growth traits which helped to increase in synthesis of carbohydrates which was utilized for the development of crop. The data further indicated that application of organic manures significantly changed the length of spike (35.50 cm), number of spikes/plant (9.05), number of capsules/spike (36.38) and shelling

Table 3 Effect of INM on seed and stalk yield (kg/ha) of castor

Treatments	Seed					Stalk				
	M_0	M_1	M_2	M_3	Mean	M_0	M_1	M_2	M_3	Mean
F_0	1256.7	1241.5	1373.6	1345.3	1304.3	1083.8	1095.9	1116.6	1097.6	1098.5
F_1	1301.1	1339.8	1439.4	1291.6	1343.0	1144.2	1294.4	1303.0	1337.5	1269.8
F_2	1374.0	1584.5	1663.9	1390.7	1503.3	1270.2	1427.3	1479.1	1543.7	1430.1
F_3	1486.6	1731.2	2288.0	1485.3	1747.8	1348.1	1651.7	2121.7	1473.7	1648.8
Mean	1354.6	1474.3	1691.2	1378.2		1211.6	1367.3	1505.1	1363.1	
	S. Em. +		C.D. at 5 %			S. Em. +		C.D. at 5 %		
M	52.01		50.3			43.0		124.1		
F	52.0		150.3			43.0		124.1		
M x F	104.1		300.6			85.9		248.2		
C. V. %	12.20					10.90				

percentage (61.4) with the application of 5 t bio compost/ha (M_2). The interaction between organic manures and inorganic fertilizers (M x F) significantly changed the yield attributes of the crop (Table 2). Significantly higher length (46.87 cm) of spike, number of capsules/plant (48.47) and shelling percentage (66.8) were observed when 100 per cent RDF along with 5 t bio compost/ha (M_2F_3) were applied. While higher number of spikes/plant (14.13) was noted due to application of 75 per cent RDF along with 5 t bio compost/ha (M_2F_2) The scrutiny of results showed the supremacy of organic manures over its no application (M_0). The different organic manures failed to differentiate themselves so far the number of spikes/ plant was concerned.

Castor seed and stalk yield was significantly affected due to the different levels of inorganic fertilizers (Table 3). Application of 100 per cent RDF through inorganic fertilizers (F_3) significantly produced 34 per and 50 per cent higher seed and stalk yields of castor, respectively over control treatment (F_0). The 50 per cent RDF through inorganic fertilizers failed to increase the seed yield in the experiment might be due to the lack of translocation of these nutrients from vegetative parts to yield contributors or might be due to the short supply of nutrients. Similar results were also reported by Sree and Reddy (2003). Application of bio compost @ 5 t/ha produced more seed (1691.2 kg/ha) and stalk (1505.1 kg/ha) yield over control while vermi compost and FYM showed more or less similar yield over control. The results evidenced the supremacy of bio compost (M_2) over vermi compost (M_3), FYM (M_1) and no application (M_0) of organic manures could be because of better nutrient supply through out the cropping period and also might be due to the better aggregate formation in soil. Another reason might be increase in yield attributes such as number and length of spikes and number of capsules per spike due to the application of 5 t bio compost/ha over no manure. Application of vermi compost and FYM though produced positive effect over control but, failed to increase the seed yield might be due to the different rate of application and quantity of nutrients supplied through them. Significantly 84 and 49 per cent higher castor seed and stalk yields were registered at 100 per cent RDF along with 5 t bio compost/ha (M_2F_3) over the treatment combinations M_1F_0 and M_0F_0, respectively. This was possible due to the improvement in all the growth and yield attributes which might have generated a cumulative effect on seed yield. Another reason might be due to the additive effect of bio compost which might be possible because of better soil condition, mineralization of essential plant nutrients, addition of micronutrients in the soil, the enhanced activities of microbes and release of growth stimulants (enzymes) due to the increased activities of microorganisms. Similar results were also reported by Arangarasan *et al.* (1999) and Laxminarayana (2004).

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A study on physiological changes of sapota varieties in cold storage with application of GA_3

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ABSTRACT

Investigations was conducted to study the effect of different temperatures *i.e.*, 5°C, 12°C, 15°C and ambient condition on post harvest life of sapota *(Manilkara achras)* fruits of different varieties (Kalipattai, PKM-1, Co-2, Singapore and Kirthibarthi). Post harvest application of GA_3 (150 mg l^{-1}) was evaluated for its effect on post storage fruit quality. Sapota fruits stored at 5°C sustained chilling injury manifested as uneven ripening, pitting and hardened pulp. Fruit stored at 12°C had improved shelf life and delayed ripening compared to fruit stored at 15°C and control (ambient condition). "Kalipatti" variety was superior in terms of longer shelf life and required quality attributes. Although 'CO-2' variety exhibited good post harvest quality but Singapore and Kirthibarthi varieties had poor fruit quality and limited shelf life. Thus, 'Kalipatti' variety of sapota fruit can be stored at 12°C temperature for a period of 12 days with edible acceptable quality.

Key words : Sapota, cold storage, physiological changes

Sapota or sapodilla *(Manilkara achras* (Mill) Fosberg), synonym *(Achrcis zapota* L.) commonly known as *chiku* is an evergreen fruit tree native of tropical America and spreaded to other countries like Philippines, Malaysia, USA, Srilanka and India where it adopted very well (Chadha, 1992). Fruit industries are being faced many challenges among them the most important is the post harvest losses. These losses, in India, are inevitable due to lack of modern cold storage, lack of technical knowhow, lack of proper handling and packing systems, lack of quick transportation facilities and common use of post harvest treatments.

When fruits were treated with GA_3 and stored at low temperature immediately after the harvest, the metabolic activities, like rate of respiration, ethylene release, build up of the respiration heat, thermal decomposition and microbial spoilage could be reduced with the retention of quality and freshness for a longer period (Krishnamurthy and Rao, 1999). The study was undertaken by keeping the problems in view faced during storage and transportation.

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MATERIALS AND METHODS

The present investigation was carried out for extending the shelf life and to know the physiological changes in sapota fruits at Department of Post Harvest Technology, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari in collaboration with Cold Storage Unit, Post Harvest Technology Centre, N.A.U., Navsari during the year 2008. The experiment was laid out in a Completely Randomized Block Design with factorial concept (FCRD) with three repetitions comprised cold storage temperature viz. fruits stored at C_1- (5°C), C_2- (12°C), C_3- (15°C) and C_4 control (ambient temperature) and sapota varieties V_1- Kalipatti. V_2- PKM-1, V_3- CO-2, V_4- Singapore and V_5- Kirthibarthi with post harvest dipping of GA_3 (150 mg l^{-1}) for 10 minutes. The data were recorded at alternate day. Statistical analysis of data was done by following the Fisher's analysis of variance techniques as given by Panse and Sukhatme (1967).

RESULT AND DISCUSSION

Physiological weight loss (%)

The perusal of data presented in Table 1 indicated

that physiological weight loss (%) was significantly minimum in fruits stored at C_1 (5°C) as compared to other storage temperature treatments. While V_1 (Kalipatti) variety noted lowest weight loss (%) throughout storage period. This could be attributed to the low temperature which slowed down the metabolic activities like respiration and transpiration, delayed ripening and due to restriction of ethylene accumulation in the fruits during ripening. Similar results were also reported by Madhavi and Srihari (2002), Sahoo and Munsi (2004) in sapota fruits. The highest weight loss percentage was recorded under treatment C_4 (control condition) and in V_5 (Kirthibarthi) variety.

Ripening percentage

The data in Table 2 showed that significantly lowest percentage of ripened fruits was recorded in sapota fruits stored in cold storage temperature C_2 (12°C) due to retarded ripening percentage by antagonistic effect on biosynthesis of ethylene and thereby retardation of senescence and physiological changes and control the metabolic activities and reduced the respiration rate as compared to that of fruits stored at ambient temperature. This result is in line with findings of Waskar and Nikam (1998), Madhavi and Srihari (2002) in sapota and Trivedi (2003) in guava. The fruits stored in treatment C_1(5°C) not ripened throughout the storage period due to chilling injury when highest ripening percentage observed in treatment C_4 Control (ambient temperature). In V_1(Kalipatti) and V_2 (PKM-1) varieties recorded minimum and maximum ripening percentage respectively during entire period of storage.

Days taken to ripening

It is apparent from the data given in Table 3 that significantly highest days taken to ripening (10.110

Table 1 Effect of post harvest application of GA_3 on PLW (%) of sapota varieties in cold storage.

Treatments	Storage periods (days)						
	2nd	4th	6th	8th	10th	12th	14th
Cold storage temperature							
C_1 - 5°C	0.758	0.935	1.1 10	1.280	1.460	1.594	1.736
C_2-12°C	1.392	3.664	6.324	9.030	11.976	14.822	0.00
C_3-15°C	3.736	7.402	12.358	15.886	19.928	0.00	0.00
C_4-Control	4.954	8.706	14.872	21.310	0.00	0.00	0.00
S.Em +	0.059	0.083	0.115	0.142	0.093	0.058	0.013
C.D. at 5 %	0.168	0.238	0.328	0.406	0.266	0.165	0.036
Varieties							
V_1 -Kalipatti	2.543	5.068	8.535	11.743	8.248	4.050	0.423
V_2-PKM-1	2.645	5.198	8.653	1 1.875	8.343	4.100	0.423
V_3-CO-2	2.580	4.853	8.400	1 1.525	8.040	3.953	0.403
V_4 -Singapore	2.743	5.280	8.758	1 1.958	8.473	4.138	0.433
V_5 - Kirthibarthi	3.040	5.485	8.985	12.283	8.603	4.280	0.470
S.Em±	0.066	0.093	0.129	0.159	0.104	0.065	0.014
C.D. at 5 %	0.187	0.266	0.367	0.454	0.297	0.185	0.040
Interaction (CxV)							
S.Em ±	0.131	0.186	0.257	0.318	0.208	0.129	0.080
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS
CV %	8.36	6.21	5.12	4.63	4.31	5.44	11.13

days) were recorded with cold storage temperature treatment C_2 (12°C) which was at par with treatment C_3 (15°C). The cold storage temperature treatment C_2 (12°C) delayed the ripening of sapota fruits by 3.922 days over C_4 (Control). This delay has been consequence of slower ripening change in reduced weight loss and other physiological process controls the metabolic activities and thereby controlling respiratory breakdown. Corroborative results obtained by Gautam and Chundawat (1990), Ramkrishna and Rao (1989) in sapota. The V_1 (Kalipatti) variety took significantly highest days (6.395 days) while the fruits of V_4 (Singapore) variety took minimum days (5.948 days) to ripe.

Shelf life

The result presented in Table 3 revealed that the different cold storage temperature treatments had significant effect on shelf-life of sapota fruits. The significantly the highest shelf-life 12.620 days and 8.188 days was recorded in cold storage treatment C_2 (12°C) and variety V_1 (Kalipatti) respectively due to delayed ripening, restrict ethylene production and the preclimacteric respiration rate were reduced and their activities peaks were postponed. The pectinmethylesterase (PME) and catalase activities were reduced in treated fruits compared with control. The shelf life goes on increasing with the decrease in storage temperature. These findings are in close proximity with the Sahoo and Munsi (2004) and Bhanja and Lenka (1994) in sapota. The lowest shelf-life (8.322 days) was recorded in treatment C_4 (Control) and V_4 (Singapore) variety (7.623 days).

Table 2 Effect of post harvest application of GA_3 on ripening percentage (%) of sapota varieties in cold storage

Treatments	Storage periods (days)					
	2nd	4th	6th	8th	10th	12h
Cold storage temperature						
C_1 - 5°C	0.00	0.00	0.00	0.00	0.00	0.00
C_2-12°C	13.028	25.458	43.678	65.724	84.592	99.230
C_3-15°C	24.408	42.652	64.630	83.870	99.392	0.00
C_4-Control	34.558	56.952	76.372	99.112	0.00	0.00
S.Em ±	0.293	0.412	0.431	0.558	0.598	0.268
C.D. at 5 %	0.837	1.177	1.231	1.595	1.707	0.766
Varieties						
V_1 - Kalipatti	16.878	30.040	44.925	61.765	45.685	24.718
V_2-PKM-1	17.908	30.778	45.860	62.138	45.888	24.785
V_3-CO-2	18.008	31.065	46.210	62.063	46.053	24.813
V_4-Singapore	18.668	32.420	47.025	62.533	46.207	24.870
V_5-Kirthibarthi	18.533	32.025	46.830	62.385	46.165	24.853
S.Em±	0.328	0.461	0.482	0.624	0.668	0.300
C.D. at 5 %	0.936	1.316	1.376	NS	NS	NS
Interaction (CxV)						
S.Em ±	0.655	0.921	0.963	1.248	1.336	0.599
C.D. at 5 %	NS	NS	NS	NS	NS	NS
CV %	6.30	5.10	3.61	3.47	5.03	4.18

Table 3 Effect of post harvest application of GA_3 on days taken to ripening and shelf life (days) of sapota varieties in cold storage

Treatments	Storage periods (days)	
	Days taken to ripening	Shelf life
Cold storage temperature		
C_1 - 5°C	0.00	0.00
C_2 -12°C	10.110	12.620
C_3 -15°C	8.226	10.468
C_4 -Control	6.188	8.322
S.Em±	0.084	0.090
C.D. at 5 %	0.240	0.256
Varieties		
V_1 - Kalipatti	6.395	8.188
V_2 - PKM-1	6.090	7.733
V_3 - CO-2	6.185	7.940
V_4 - Singapore	5.948	7.623
V_5 - Kirthibarthi	6.038	7.780
S.Em±	0.094	0.100
C.D. at 5 %	0.268	0.286
Interaction (CxV)		
S.Em ±	0.188	0.200
C.D. at 5 %	NS	NS
CV %	5.30	4.41

SUMMARY

The combined treatments of GA_3 (150 mg l^{-1}) dipping and fruits stored at 12°C cold storage temperature found to be more effective for extending the shelf life of fruits and reducing post harvest losses without any adverse effect on quality of Sapota fruits. The Kalipatti variety was found to be superior and recorded maximum shelf life and good physiological parameters when stored at 12°C cold storage temperature.

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Field efficacy of bio-pesticides against *Thrips tabaci* (Lindeman) in onion

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ABSTRACT

Studies on the effect of three fungal and one bacterial based bio-pesticides against onion thrips, *T. tabaci* were conducted at Agronomy Farm, Junagadh Agricultural University, Junagadh during 2006-07. Spinosad 0.009 %, endosulfan 0.07 % and spinosad 0.0045 % + endosulfan 0.035 % were found the most effective in reducing the thrips population. Combinations of *B. bassiana* @ 1.0 kg/ha + endosulfan 0.035 % and *V. lecanii* @ 1.0 kg/ha + endosulfan 0.035 % were found middle in order of their efficacy whereas, *V. lecanii* @ 2.0 kg/ha, *B. bassiana* @ 2.0 kg/ha and *P. fumusoroseus* @ 2.0 kg/ha alone were found least effective in reducing the thrips population. The highest (1:61.38) cost benefit ratio was found in the treatment of endosulfan 0.07 %, followed by *B. bassiana* @ 1.0 kg/ha + endosulfan 0.035 % (1:40.35) and *V. lecanii* @ 1.0 kg/ha + endosulfan 0.035 %. It was lowest in spinosad 0.009 % (1:18.44).

Key words : Onion, thrips, biopesticides

Onion is the most important vegetable crop because of its outstanding characteristics of pungency, mild flavour, medicinal qualities and spice value. India is the second largest producer next to China and third largest exporter of onion to the world. Area under onion cultivation in the world is about 20 lakh hectares. Area under this crop has been increasing year by year owing to its high demand in the market and for obtaining higher remunerative price. Among the various factors responsible for limiting crop yield, insect pests are considered as the major constrains. The onion crop is attacked by the thrips, *Thrips tabaci* (Lindeman) that is the most common and serious pest, causing considerable damage to the crop. Chemical insecticides have been already recommended to manage the thrips in onion; however, minimization of insecticide load in onion ecosystem is highly required to confirm the export quality. For sucking insects, entomopathogenic fungi are appropriate microbial agents as they infect the insect cuticle directly through contact and do not require to be ingested for infection to set in. Fungal pathogens, *Verticillium lecanii*, *Beauveria bassiana* and *Paecilomyces fumosoroseus* have been reported pathogenic to *T. tabaci* (Vesterguard *et al.*, 1997). Hence, the investigation was conducted to determine the bioefficacy of bio-pesticides against *T. tabaci* that leads to have an alternate strategy for its management.

MATERIALS AND METHODS

To find out the suitable and effective control strategy for management of *T. tabaci* of onion an experiment was conducted during *rabi* 2006-07 at Agronomy Farm, Junagadh Agricultural University, Junagadh. The experiment was laid out in Randomized Block Design with three replications and ten treatments. The crop was transplanted in plots of 4.0 × 2.10 m with spacing of 15 × 10 cm. All the recommended agronomical practices were followed. Four bio-pesticides *viz.*, *V. lecanii* @ 2.0 kg/ha, *B. bassiana* @ 2.0 kg/ha, *P. fumosoroseus* @ 2.0 kg/ha and spinosad 0.009 % and, combinations of these bio-pesticides at half recommonended doses with endosulfan 0.035 % were evaluated and compared with already recommended endosulfan 0.07 % against *T. tabaci*. The spray was carried out, when the pest population crossed the economic threshold level (15 thrips/leaf), whereas the subsequent spray was done after one month of 1st

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spray. Spray of bio-pesticides was done with the help of knapsack sprayer with 500 lit of water per hectare. The care was taken to obtain the uniform coverage of biopesticide in each plot. Observations on thrips population were recorded from five randomly selected and tagged plants in each plot before spray and after 3, 5, 7 and 10 days of spraying. Three inner leaves of each of the selected plants were observed to count the number of thrips. The data were converted to percent mortality by using the formula given by Abbott (1925). The data thus obtained were transformed into Arcsin percentage and analyzed statistically. The yield of onion bulbs from each net plot was recorded separately and data were subjected to statistical analysis. Cost benefit ratio (CBR) was worked out to compare the economics of different treatments.

RESULTS AND DISCUSSION

The per cent mortality of thrips (Table 1) recorded at 3rd DAS revealed that spinosad 0.0045 per cent + endosulfan 0.035 per cent proved to be significantly superior and most effective treatment as it gave 81.94 per cent mortality of the pest. However, it was statistically at par with spinosad 0.009 per cent and endosulfan 0.07 per cent as they also registered 77.08 and 75.59 per cent mortality, respectively. The treatments of *B. bassiana* @ 1.0 kg/ha + endosulfan 0.035 per cent, *V. lecanii* @ 1.0 kg/ha + endosulfan 0.035 per cent and *P. fumosoroseus* @ 1.0 kg/ ha + endosulfan 0.035 per cent were the next best treatments, which gave 57.65, 55.48 and 51.48 per cent mortality, respectively. In case of entomopathogenic fungi *V. lecanii*, it registered the highest mortality of 46.47 per cent, followed by *B. bassiana* and *P. fumosoroseus* as they registered 42.37 and 37.75 per cent mortality, respectively. Similar trend of mortality was recorded at 3rd, 5th, 7th and 10th days after spraying. Similar results were also found after second spraying.

The results showed that the nymphal mortality in chemical insecticides alone was attributed immediately *i.e.*, after one day of treatment. Fungal bio-pesticides, initially less effective, their efficacy slowly increased and caused considerable mortality. However, the nymphal in all the treatments was increased with the increase in day intervals following the fungal treatment. The effectiveness of endosulfan 0.0035 % against *T. tabaci* has been reported by Butani and Kapadia (1999). However, Mustaq *et al.* (2001) and Zezlina and Blazic (2003) have reported the superiority of spinosad to control the *T. tabaci*. Gindin *et al.*, (1996) indicated that *T. tabaci* was susceptible to *V. lecanii, B. bassiana, P. fumosoroseus* and *Metarhizium anisopliae*. Similarly *T. tabaci* was susceptible to *V. lecanii* (Trujillo *et al.*, 2003) and *B. bassina* (Castineiras *et al.*, 1996).

The yield of onion bulbs in different treatments varied from 29286 to 42857 kg/ha and they were found significantly superior to the control. The highest yield of onion bulbs (42857 kg/ha) was recorded in the treatment with spinosad 0.009 %. However, it was statistically at par with spinosad 0.0045 % + endosulfan 0.035 % (41429 kg/ha). The moderate yield of onion bulb was obtained from the treatments of endosulfan 0.07 % (37143 kg/ha), *B bassiana* @ 1.0 kg/ha + endosulfan 0.035 % (35000 kg/ha), *B bassiana* @ 2.0 kg/ha (34286 kg/ha), *V. lecanii* @ 1.0 kg/ha + endosulfan 0.035 % (33714 kg/ha) and *V. lecanii* @ 2.0 kg/ha (33571 kg/ha). Whereas, low yields were recorded from the treatments of *P. fumosoroseus* @ 2.0 kg/ha (32857 kg/ha) and *P. fumosoroseus* 1.0 kg/ ha + endosulfan 0.035 % (32143 kg/ha). While, significantly the lowest yield (29286 kg/ha) was recorded from the water sprayed plot.

The highest cost benefit ratio (1: 61.38) was obtained in the treatment of endosulfan 0.07 % and it was followed by *B. bassiana* 1.0 kg/ha + endosulfan 0.035 % (1: 40.15), *V. leacanii* @ 1.0 kg/ha + endosulfan 0.035 % (1: 34.33), *V. leacanii* @ 2.0 kg/ha (1: 32.96) and *B. bassiana* @ 2.0 kg/ha (1: 31.91). Whereas, the low cost benefit ratios were obtained from the treatments, spinosad 0.0045 % + endosulfan 0.035 % (1: 28.11), *P. fumosoroseus* @ 2.0 kg/ha (1: 22.79), *P. fumosoroseus* @ 1.0 kg/ha + endosulfan 0.035 % (1: 20.07) and spinosad 0.009 % (1: 18.44).

CONCLUSION

Based on results obtained in the study it is concluded that the application of *B. bassiana* or *V. lecanii* @ 1 kg/ha combined with endosulfan 0.035 % is more effective in controlling the *T. tabaci* as compared to the individual spores of fungal pathogens at higher doses. The reason for obtaining the higher mortalities may be attributed to the increased susceptibility of insects to fungal infection when exposed to insecticides. Therefore, joint action of fungal pathogens and insecticides is practically useful to narrow down the complete dependence on synthetic compounds and also useful in reducing the environment pollution and other hazards to beneficial organisms and human beings caused by them. Hence, using the insecticides in combination with bio-pesticides is advocated in IPM.

Table 1 Mortality of *T. tabaci* as influenced by different treatments on onion in field during *rabi* 2006-07

Sr. No	Treatments	First Spray					Second Spray					Onion bulb yield (kg/ha)	CBR
		3 DAS	5 DAS	7 DAS	10 DAS	Mean	3 DAS	5 DAS	7 DAS	10 DAS	Mean		
1	*B. bassiana* @ 2.0 kg / ha	40.61 (42.37)	42.17 (45.08)	43.12 (46.72)	44.74 (49.55)	42.66 (46.03)	43.32 (47.06)	44.99 (49.97)	45.72 (51.26)	47.21 (53.85)	45.31 (50.54)	34286	1:32.91
2	*Verticillium lecanii* @ 2.0 kg / ha	42.97 (46.71)	44.70 (49.48)	47.77 (54.82)	50.72 (59.92)	46.54 (52.67)	43.94 (48.15)	45.78 (51.35)	47.92 (55.08)	50.29 (59.18)	46.98 (53.44)	33571	1:32.96
3	*P. fumosoroseus* @ 2.0 kg / ha.	37.91 (37.75)	39.81 (41.00)	41.56 (44.01)	43.61 (47.57)	40.72 (42.58)	38.88 (39.39)	40.47 (42.13)	43.65 (47.65)	45.27 (50.47)	42.07 (44.91)	32857	1:22.79
4	Spinosad 0.009 %	61.40 (77.08)	62.48 (78.64)	63.50 (80.09)	63.84 (80.56)	62.81 (79.09)	62.60 (78.82)	62.88 (79.22)	63.28 (79.79)	64.62 (81.63)	63.35 (79.87)	42857	1:18.44
5	Endosulfan 0.07 %	0.40 (75.59)	60.45 (75.68)	61.56 (77.72)	61.81 (77.69)	61.06 (76.57)	60.33 (75.50)	61.67 (77.48)	62.38 (78.51)	63.42 (79.99)	61.95 (77.87)	37141	1:61.38
6	*B. bassiana* @ 1.0 kg / ha + Endosulfan 0.035 %	49.40 (57.65)	50.14 (58.93)	51.98 (62.06)	53.70 (64.96)	51.31 (60.90)	49.02 (56.99)	50.42 (59.41)	52.75 (63.36)	54.58 (66.41)	51.69 (61.54)	35000	1:40.41
7	*V. lecanii* @ 1.0 kg / ha + Endosulfan 0.035 %	48.15 (55.48)	50.14 (58.92)	50.73 (59.92)	51.44 (61.15)	50.11 (58.87)	46.42 (52.47)	48.04 (55.30)	51.79 (61.74)	52.92 (63.64)	49.79 (58.29)	33714	1:34.33
8	*P. fumosoroseus* @ 1.0 kg / ha + Endosulfan 0.035 %	45.85 (51.48)	46.42 (52.48)	47.66 (54.64)	48.44 (55.98)	47.09 (53.65)	45.13 (50.23)	47.44 (54.25)	48.37 (55.86)	49.33 (57.33)	47.57 (54.47)	32143	1:20.07
9	Spinosad 0.0045 % + Endosulfan 0.035 %	64.85 (81.94)	65.18 (82.38)	65.50 (82.80)	65.39 (82.65)	65.23 (82.44)	63.70 (80.36)	64.83 (81.92)	66.72 (84.38)	66.88 (84.58)	65.53 (82.81)	41429	1:28.11
10	Control (Water spray)	6.20 (1.17)	6.99 (1.48)	6.96 (1.47)	7.8 (1.84)	6.99 (1.49)	7.02 (1.49)	6.85 (1.42)	7.23 (1.58)	7.62 (1.76)	7.18 (1.56)	29286	—
S. Em±		2.13	2.21	2.39	2.43	—	1.99	2.21	2.39	2.31	—	1136	—
C. D. at 5 %		6.32	6.56	7.11	7.22	—	5.92	6.58	7.11	6.85	—	3298	—
C. V. %		8.04	8.16	8.62	8.56	—	7.50	8.10	8.46	7.95	—	8.60	—

Arcsin percentage transformation. Figure in the parentheses are retransformed values DAS = Days after spraying

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Population fluctuation of *Scutellera nobilis* Fabricius on jatropha

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ABSTRACT

Investigation on population fluctuation of shield-backed bug (*Scutellera nobilis* Fabricius) in jatropha was carried out at Anand Agricultural University, Anand during 2006-07. The incidence of the pest began from 2nd week of June and continued till 2nd week of March with a peak activity in first week of January. The higher activity of the pest was noticed during last week of October to third week of February. The egg parasitoids (*Psix sp.* and *Anastatus sp.*) had significantly positive correlation with the number of egg masses of *S. nobilis*. It was also observed that temperature, vapour pressure, wind speed and rainfall had significantly negative association with all the stages of *S. nobilis* on jatropha.

Key words : Population fluctuation, Jatropha, *Scutellera nobilis*

Jatropha is a soft wooded shrub or small tree found in almost all the tropical and sub-tropical regions of the world. The oil can be converted into biodiesel by transesterification. This crop is attacked by a few insect pests and diseases, which cause severe reduction in production and deterioration in the quality. The important and common insect pests found on jatropha crop in this region are leaf webber, semilooper (*Archaca janata*), shield-backed bug (*Scutellera nobilis* F.), blotch miner, termite, aphids, jassids and thrips. Of these shield-backed bug (*Scutellera nobilis* F.) is the key pest which damaging jatropha crop by suck the cell sap from leaves, tender parts of the plant, flowers and capsules. The proper management of the pest it is necessary to have an idea about its activity but past work indicated that there were lacunae in the information. Considering the importance of the pest and present need of the work a study was conducted to know the population fluctuation of this pest on jatropha crop.

MATERIALS AND METHODS

The study on population fluctuation of *S. nobilis* on *jatropha curcas* was conducted at Anand Agricultural University, Anand during June 2006 to May 2007. Available jatropha plants as border shrubs at Agronomy farm were used to record the observations. For the purpose, equal aged (3 years old) and sized (3 m height) of 50 jatropha shrubs were randomly selected. The observations on number of egg masses, nymphs and adults per plant were recorded at weekly interval throughout the year. Data, thus obtained were correlated with biotic and abiotic factors to determine its effect on fluctuation of *S. nobilis* infesting jatropha.

RESULTS AND DISCUSSION

Egg

The eggs of *S. nobilis* on jatropha was first time (0.10 egg masses/plant) observed during 23rd standard week (2nd week of June). The number of egg masses increased in subsequent meteorological standard weeks and reached to the highest level (1.22 egg masses/plant) during first standard week (first week of January). The egg parasitism (*Psix sp. and Anastatus sp.*), temperature, relative humidity, vapor pressure, bright sunshine and wind speed noted as 26.42%, 19 °C, 70%, 10.7 mm, 9.0 hrs and, 2.5 kmph, respectively. The higher number of the egg masses were registered during 43rd to 5th standard week (4th week of October to 1st week of February). The number of egg masses gradually reduced from 2nd standard week (2nd week of January) till 10th standard week (2nd week of March) and it was not seen on jatropha plants from 11th standard week (3rd week of March) to 22nd standard week (1st week of June).

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Table 1 Population abundance of *S. nobilis* on jatropha in relation to biotic and abiotic factors

Std week	Month and week	*S. nobilis* / plant			Egg parasitism (%)	Abiotic factors					
		Nymph	Adult	Egg mass		Temp (°C)	RH (%)	VP (mm)	BSS (hrs)	WS (kmph)	RF (mm)
22	June I	0.00	0.00	0.00	0.00	32.1	68	23.0	6.5	6.4	56.7
23	II	0.00	0.24	0.10	0.00	30.7	66	21.9	9.1	6.8	6.0
24	III	0.34	0.30	0.14	0.00	31.6	61	20.5	11.1	7.6	0.0
25	IV	0.44	0.52	0.14	0.00	32.8	62	22.4	8.4	6.2	4.4
26	July I	0.62	0.64	0.24	0.00	30.2	81	24.9	4.1	4.9	51.8
27	II	0.62	0.82	0.22	0.00	29.4	84	25.4	5.3	7.7	216.0
28	III	0.76	0.70	0.28	5.00	29.4	79	23.9	1.3	9.0	23.1
29	IV	1.14	1.40	0.24	0.00	28.8	83	23.9	0.2	5.6	6.7
30	V	0.84	1.44	0.28	4.35	27.6	86	23.9	3.7	7.7	355.4
31	Aug I	0.88	1.48	0.26	8.00	26.5	90	23.6	1.1	8.3	255.2
32	II	1.12	1.22	0.28	3.85	27.1	94	23.9	1.0	9.7	270.8
33	III	1.54	1.64	0.30	0.00	27.5	90	24.1	2.0	6.0	63.8
34	IV	1.32	1.76	0.28	0.00	27.2	88	23.8	1.4	6.8	64.2
35	Sept I	1.90	2.20	0.28	3.70	27.9	83	23.0	4.1	7.4	10.3
36	II	1.96	2.64	0.28	3.13	28.4	81	23.3	3.7	5.5	26.1
37	III	2.36	2.84	0.28	0.00	29.4	75	23.6	5.8	2.8	0.5
38	IV	2.08	2.80	0.28	0.00	29.4	81	23.9	6.2	3.5	3.9
39	V	2.54	3.06	0.32	0.00	29.2	84	23.8	5.9	3.7	0.0
40	Oct I	2.48	2.72	0.24	0.00	30.3	73	22.9	7.0	3.9	0.0
41	II	2.56	3.04	0.28	0.00	28.5	65	19.3	8.8	2.3	0.0
42	III	2.64	3.20	0.36	6.67	29.3	56	16.2	9.5	2.4	0.0
43	IV	4.30	4.64	0.42	7.50	28.2	51	13.8	9.5	2.3	0.0
44	Nov I	4.48	5.32	0.40	9.38	26.2	54	14.0	10.0	3.4	0.0
45	II	5.60	7.90	0.44	45.83	26.1	60	14.6	9.8	2.8	0.0
46	III	5.42	8.40	0.46	45.65	25.1	71	17.2	9.6	2.5	0.0
47	IV	6.22	9.92	0.36	47.62	24.8	62	13.0	8.9	2.4	0.0
48	Dec I	7.02	10.10	0.34	42.00	22.5	61	11.9	8.2	2.8	0.0
49	II	8.92	10.72	0.36	32.65	23.6	70	14.3	8.6	2.4	0.0
50	III	9.68	11.52	0.48	44.68	20.7	70	13.0	9.2	3.3	0.0
51	IV	10.06	11.98	0.50	37.25	21.6	65	11.9	9.7	3.2	0.0
52	V	10.99	11.99	0.86	33.33	22.0	68	12.9	8.4	3.1	0.0
1	Jan I	11.00	12.22	1.12	26.42	19.0	70	10.7	9.0	2.5	0.0
2	II	10.00	10.23	0.98	18.52	18.8	58	8.8	8.5	4.5	0.0
3	III	7.00	9.66	0.76	19.61	19.1	58	9.0	9.7	3.0	0.0
4	IV	7.00	9.96	0.52	6.00	21.3	58	10.4	9.6	3.7	0.0
5	Feb I	6.22	6.58	0.33	10.20	22.1	64	11.6	8.3	2.6	0.0
6	II	5.20	5.77	0.23	8.33	23.4	66	13.1	8.8	3.4	2.4
7	III	4.30	5.66	0.17	9.52	21.2	62	10.4	9.8	3.8	0.0
8	IV	1.36	2.08	0.12	0.00	24.9	54	11.0	9.8	3.0	0.0
9	March I	1.96	1.68	0.11	0.00	23.3	59	11.5	9.8	3.5	0.0
10	II	0.56	0.38	0.33	3.85	24.2	49	10.2	10.1	3.3	0.0
11	III	0.00	0.00	0.00	0.00	25.5	51	11.0	9.8	4.2	0.0

Nymphs

The activity of *S. nobilis* nymphs was found through out the year except second fortnight of March to first fortnight of June (Table 1). The data (Table 1 and Fig. 1) on population fluctuation of *S. nobilis* nymphs indicated that the pest appeared (0.34 nymph/plant) on jatropha crop from 24th standard week (3rd week of June) and gradually but slowly increased (2.64 nymphs/plant) up to 43rd standard week (4th week of October). Thereafter, the population was increased rapidly and reached to a peak (11 nymphs/plant) level in the first standard week (first week of January). The temperature, relative humidity, vapor pressure, bright sunshine and wind speed recorded during the peak activity of the pest were 19 °C, 70%, 10.7 mm, 9 hrs and 4.5 kmph, respectively. The higher number of nymphs noted during 42nd (3rd week of October) to 7th standard week (3rd week of February) on jatropha plants. After the first standard week, the nymphal population found in decreasing trend and reached the minimum in 10th standard week (2nd week of March) (0.56 nymphs/plant). The nymphs disappeared on jatropha crop from 11th standard week (3rd week of March).

Adults

The active of *S. nobilis* adults (Table 1 and Fig. 1) on jatropha plants (0.24 adult/plant) from 23rd standard week (2nd week of June). The population increased gradually and attained its peak (12.22 adults/plant) in the 1st standard week (1st week of January). The temperature, relative humidity, vapour pressure, bright sunshine hours and wind speed during the peak activity period were 19 °C, 70%, 10.7 mm, 9.0 hrs and 2.5 kmph, respectively. The higher activity *S. nobilis* adults on jatropha plants registered during 43rd (4th week of October) to 7th standard week (3rd week of February). The population of *S. nobilis* adults gradually decreased up to 10th standard week (2nd week of March) and disappeared from 11th standard week (3rd week of March) from jatropha plant The population of *S. nobilis* was 5 per bunch and reached maximum of 15 bugd per bunch on jatropha in Uttar Pradesh (Shankar and Dhyani, 2006).

The higher activity of *S. nobilis* (Eggs, nymphs and adults) was observed during 43rd standard week (last week of October) to 7th standard week (3rd week of February). During the higher activity period of the pest, the egg parasitism (*Psix sp. and Anastatus sp.*), temperature, relative humidity, vapor pressure, bright sunshine, wind speed and rainfall prevailing in the area were 6.00 to 47.62%, 18.8 to 28.2 °C, 51 to 71%, 8.8 to 17.2 mm, 8.2 to 10.0 hrs, 2.3 to 4.5 kmph and 0.0 to 2.4 mm, respectively. Maximum incidence of the *Bagrada cruciferarum* infesting mustard were noticed at 17 to 18 °C temperature with 61 to85 % RH (Srivastava and Srivastava, 1972) and 22 to 25 °C temperature with 54% RH (Singh *et al.*, 1993).

The above results on population abundance of *S. nobilis* reflected that the pest was active from 2nd week of June to first fortnight of March. The activity started with the commencement of rain. The pest was inactive from 3rd week of March to first week of June. During this dry period pest might have shifted on other crops or under went diapause or hidden in safe places. *Pachycoris klugii* adults, a pest of physic nut hiding in dry season (Grimm and somariba, 1998) which is in accordance with the present findings of *S. nobilis*. The higher activity of this pest was noted during the end of October to 3rd week of February with a peak level in first week of January, which coincides with the period of flowering and fruit setting on jatropha. It is suggested that the pest could be easily managed if proper monitoring is carried out and necessary spray application was made before it reached to the maximum level.

The correlation analysis (Table 2) revealed that all the tested biotic and abiotic parameters were significantly correlated with the pest (all three stages) activity except relative humidity (all three stages) and bright sunshine as well as wind speed (with egg population). The egg parasitoids had significantly positive correlation with the number of egg masses of *S. nobilis* (r = 0.611**). It indicated that the pest population increased and simultaneously parasitoids activity also increased. The temperature (r = -0.797** and -0.787**), vapor pressure (r = -0.662** and -0.659**), wind speed (r = -0.343* and -0.333*) and rainfall (r = -0.579** and -0.598**) had significantly negative correlation associated with the nymphs and adults population on jatropha crop. Of these parameters, temperature (r = -0.611**), vapor pressure (r = -0.407**) and rainfall (r = -0.404**) were also significantly negative correlated with number of egg masses. The bright sunshine had significantly positive relationship with *S. nobilis* nymphs (r = 0.437**) and adults (r = 0.448**) activity. The bright sunshine and wind speed positive and negative association but non-significant with the number of egg masses on jatropha crops. The relative humidity had negative correlation with pest activity (eggs, nymphs and adults) but it was non-significant.

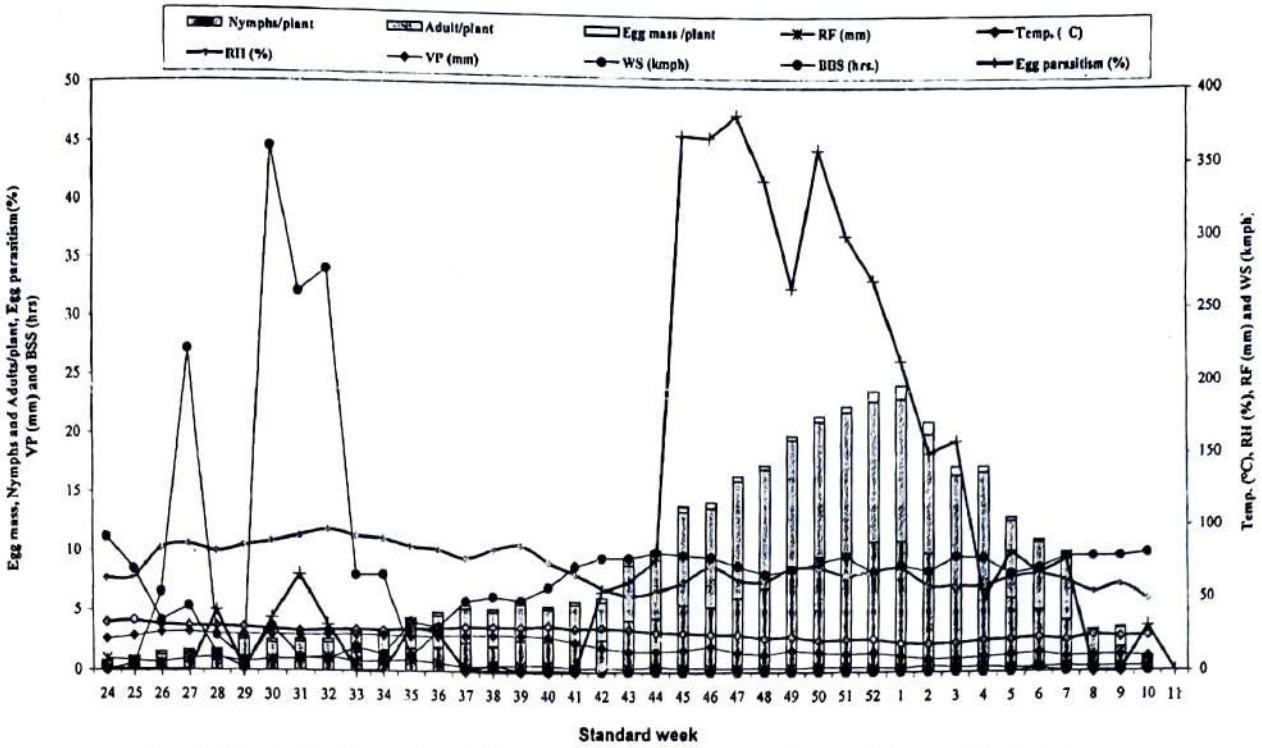

Fig. 1 : Population fluctuation of *S. nobilis* on jatropha in relation to biotic and abiotic factors

Table 2 Correlation coefficient (r) between *S. nobilis* numbers and biotic as well as abiotic factors on jatropha

S. nobilis stages	Egg parasitism (%)	Temp (°C)	RH (%)	VP (mm)	BSS (hrs)	WS (kmph)	RF (mm)
Nymphs	-	-0.797**	-0.302	-0.662**	0.437**	-0.343*	-0.579**
Adults	-	-0.787**	-0.307	-0.659**	0.448**	-0.333*	-0.598**
Egg mass	0.611**	-0.611**	-0.097	-0.407**	0.167	-0.138	-0.404**

* Significant at 5 % level, ** Significant at 1 % level. Temp: Temperature, RH: Relative humidity, VP: Vapour pressure, BSS: Bright sun shine, WS: Wind speed, RF: Rain fall

Thus, results suggested that the pest could be easily managed if proper monitoring is carried out and necessary spray application of botanical and synthetic insecticides should be made before it reached to the maximum level.

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Evaluation of Bio-Intensive Pest Management (BIPM) module for the suppression of insect pests infesting *Bt* cotton

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ABSTRACT

A field experiment to evaluate the impact of Bio-Intensive Pest Management (BIPM) module for the suppression of insect pests infesting *Bt* cotton. The results concluded that the Bt cotton grown with BIPM practices (such as seed treatment with *Trichoderma* @ 8 g /kg seed, border row of maize crop around the cotton field, installation of bird perches @ 10 /ha, three releases of *Trichogramma chilonis* @ 1.5 lakh / ha / week, two releases of 2 to 3 days old *Chrysoperla carnea* larvae @ 14,000 /ha and need based spray of NSKE @ 5 %) significantly reduced the population of three major sucking pests (aphid, jassid and whitefly as compared to farmers practices (insecticidal spray only) as check (FP). Incidence of spotted bollworm, *Earias* spp. and pink bollworm, *Pectinophora gossypiella* (Saund.) to developing buds, green bolls and locules was found to be significantly low in BIPM module over the treatment of FP. Relatively more number of biocontrol agents *(Chrysoperla carnea,* coccinellid beetles, predatory Geocoris bug and spiders) were registered in former treatment of BIPM module than latter treatment of FP. Reduction in pest incidence due to increased number of biocontrol agents reflected on seed cotton yield. The BIPM module yielded an average of 3990 kg/ha seed cotton as against 3245 kg/ha in case of FP which found to be significantly higher (22.96 %) than the FP.

Key words : BOPM module, insect, pests, *Bt.* Cotton

Cotton is an important fibre crop which greatly contributes to the national economy. The insect pests constitute one of the major limiting factors in the production as the crop is vulnerable to attack by about 162 species of insects and mites (Sundarmurthy, 1985). Though the problem of bollworms especially *Helicoverpa armigera* (Hubner) is solved with the introduction of Bt cotton, but the problem of sucking pests remains as such. Of the various methods used to control the pests infesting cotton, the use of chemicals is most popular among the farmers, however several studies have shown its deleterious effect on natural enemies of pests infesting cotton crop (Anonymous, 1983 and Yadav *et al.*,1983). Considering the negative impact of toxic chemical, the concept of Bio-Intensive Pest Management (BIPM) practices involving the use of biocontrol agents has been evoked. Very few attempts have been made in past to evaluate the BIPM practices in large scale on farmers field. Therefore, the present study was undertaken to evaluate the BIPM module in suppression of insect pests in Bt cotton.

MATERIALS AND METHODS

A field experiment to evaluate the impact of Bio-Intensive Pest Management (BIPM) module for the suppression of insect pests infesting *Bt* cotton was conducted on farmer's field during kharif season of 2007-08 and 2008-09. During first year, the experiment was conducted at Bamania campa village of Kapadvanj taluka (Dist. Kheda) whereas during subsequent year it was conducted at Shardapura village of Savli taluka (Dist. Baroda) of middle Gujarat. *Bt* cotton cultivar (Ankur-155) was used during both the years of experimentation. The crop was sown during last week of June at a spacing of 120 x 60 cm. A module of BIPM practices consisted (1) seed treatment with *Trichoderma harzianum* @ 8 g/ kg seed (2) border row of maize crop around the cotton field (3) installation of

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bird perches @ 10/ha. (4) three releases of *Trichogramma chilonis* Ishii. @ 1.5 lakh / ha/ week (5) two releases of *Chrysoperla cornea* (Stephens) larvae (2-3 days old) @ 14,000/ha at weekly interval during later stages when aphid incidence noticed and (6) need based spray application of Neem Seed Kernel Extract (NSKE) @ 5 %. The BIPM module was accommodated in one hectare area. Similarly, one hectare area was kept as farmers practices (FP) for comparison purpose in which routine need based insecticidal sprays were made. The crop was raised following normal agronomic practices.

The entire plot of one hectare area in each treatment was divided into five subplots. Five plants were randomly selected from each sub-plot and tagged for recording the various observations. Population of sucking pests viz., aphid *(Aphis gossypii* G.), Jassid *(Amrasca bigutulla bigutulla* Ishida) and whitefly *(Bemisia tabaci* Gen.) was recorded from three leaves (top, middle, bottom) of each tagged plant. Thus in all 15 leaves were examined and based on this mean population of each sucking pest per 3 leaves was worked out. The data subjected to statistical analysis following square root transformation and the mean population of sucking pests are presented in Table 1. The incidence of spotted bollworm *(Earias* spp.) and pink bollworm *(Pectinophora gossypiella*) on developing intact buds and green bolls was assessed by examining total and damaged buds as well as green bolls present on five plants from each sub-plot. Based on the observations, extent of bud and green boll damage due to bollworms in each treatment was calculated. Similarly, the extent of locules damaged by *Earias* and *P. gossypiella* was assessed at the time of harvesting. The values obtained were subjected to statistical analysis following arcsin transformed values and presented in Table 2.

To determine the impact of BIPM on natural enemies of cotton pests, their presence on five tagged plants from each sub-plot were recorded. The mean population of various biocontrol agents (chrysopa, coccinellids, Geocoris bug and spider) are presented in Table 3. Treatmentwise seed cotton yield harvested from each sub-plot was recorded during each picking and based on the data yield in ka/ha was calculated. The data on yield of seed cotton recorded in both the treatments are presented in Table 4. Economics of both the treatments under study was worked out based on the yields, its prevailing market price and cost of materials used in each treatment. The data on economics of the treatments evaluated are presented in Table 4.

RESULTS AND DISCUSSION

There was significant reduction in the population of aphid (*A. gossypii),* Jassid, *(A. bigutulla bigutulla)* and whitefly *(B. tabaci)* in the treatment of BIPM module as compared to farmers practices (Table 1). As per the report of Anonymous (2009), the incidence of sucking pest complex was comparatively lower in *Bt* cotton when grown with BIPM practices than farmers practices as it revealed from the results of various field experiments conducted on farmer's field in Andhra Pradesh and Maharashtra. They also registered lower population of leafhopper and aphid in *Bt* cotton grown with BIPM in Tamil Nadu. These reports are in

Table 1 Impact of BIPM practices in Bt cotton on incidence of sucking pests

Treatments	Sucking pests / 3 leaves								
	2007-08			2008-09			Pooled		
	Aphid	Jassid	W. fly	Aphid	Jassid	W. fly	Aphid	Jassid	W. fly
BIPM practices	9.42* (87.74)	1.71* (1.92)	1.33* (0.77)	2.82* (7.95)	1.46* (2.13)	0.99* (0.98)	6.20* (37.44)	1.74* (2.03)	1.47* (1.16)
Farmers' practices	11.40 (128.96)	1.97 (2.88)	1.87 (2.50)	4.44 (19.71)	1.89 (3.57)	1.36 (1.85)	7.98 (62.68)	2.06 (3.24)	1.73 (1.99)
S. Em. ±	0.15	0.01	0.01	0.23	0.04	0.02	0.17	0.02	0.01
C.D at 5 %	0.48	0.04	0.05	0.92	0.16	0.09	0.55	0.06	0.03
C.V. (%)	3.16	2.84	3.63	14.45	12.40	10.22	5.47	7.13	4.41

* $\sqrt{X+1}$ transformed values Figures in parentheses are retransformed values

Table 2 Impact of BIPM practices in Bt cotton on incidence of bollworms

Treatments	% Damage by bollworms											
	2007-08				2008-09				Pooled			
	Bud	Boll	Locules		Bud	Boll	Locules		Bud	Boll	Locules	
BIPM practices	7.06* (1.51)	2.60* (0.21)	4.34* (0.57)	3.72* (0.42)	9.22* (2.97)	8.85* (2.37)	9.05* (2.47)	6.70* (1.36)	8.57* (2.22)	6.15* (1.15)	6.70* (1.36)	5.21* (0.82)
Farmers' practices	10.83 (3.53)	4.60 (0.64)	5.67 (0.98)	4.80 (0.70)	13.52 (5.47)	13.00 (5.06)	11.40 (3.91)	9.15 (2.53)	12.04 (4.35)	9.37 (2.65)	8.54 (2.21)	6.97 (1.47)
S. Em ±	0.40	0.52	0.28	0.24	0.39	0.35	0.32	0.28	0.23	0.40	0.36	0.26
C.D at 5 %	1.56	1.50	0.92	0.79	1.55	1.37	1.06	0.90	0.75	1.30	0.97	0.78
C.V. (%)	22.16	7.71	12.61	12.74	16.80	14.25.	7.08	7.79	15.83	32.55	8.92	9.54

* Arc sin transformed values Figures in parentheses are retransformed values

accordance with the present finding. However, contradicting to above, Anonymous (2008) recorded relatively more number of leafhopper and whitefly population in the treatment of BIPM practices over the treatment of FP in Ludhiana, Punjab. Bollworm incidence to developing buds and green bolls as well as locules damaged by *Earias* spp. and *P. gossypiella* recorded at harvest also found to be reduced significantly in *Bt* cotton raised by following BIPM practices. These results are supported by the reports of Anonymous (2008) and Anonymous (2009). Reduction in pest population following the adoption of BIPM practices in *Bt* cotton reflected on seed cotton yield as it revealed that treatment of BIPM practices yielded significantly higher yield over the treatment of farmers practices. The former treatment produced an average of 3990 kg / ha seed cotton as against 3245 kg / ha in case of FP indicating 22.96 % higher yield due to adopting of BIPM practices. Increase in yield following BIPM practices in *Bt* cotton noticed in present study is in agreement with the earlier reports of Godhani *et al.* (2005) and Anonymous (2007). Relatively greater number of various indigenous biocontrol agents (coccinellids, Chrysopa, *Geocoris* and spiders) were registered in *Bt* cotton with BIPM than the plots treated with insecticides (FP). Anonymous (2008) recorded higher egg-parasitism, higher predators (coccinellids and spiders) in BIPM package compared to FP in Andhra Pradesh. Anonymous (2009) also recorded higher population of coccinellids in BIPM block as against FP in Maharashtra and Punjab. Further, they reported that the aphid population was significantly reduced in BIPM field in Tamilnadu due to the activity of *C. carnea*. These reports are corroborated with the above findings.

Table 3 Population of indigenous natural enemies in both the treatments under study

Treatments	Mean population of natural enemies / 25 plants											
	2007-08				2008-09				Pooled			
	C. carnea (E+L+A)	Coccinellids (E+L+P+A)	Geocoris bug (N+A)	Spiders (N+A)	C. carnea (E+L+A)	Coccinellids (E+L+P+A)	Geocoris bug (N+A)	Spiders (N+A)	C. carnea (E+L+A)	Coccinellids (E+L+P+A)	Geocoris (N+A)	Spiders (Adults)
BIPM practices	12.20	47.10	6.00	12.70	17.25	54.75	12.00	16.00	14.73	50.93	9.0	14.35
Farmers' practices	6.60	21.40	3.50	7.60	11.00	37.75	4.00	9.25	8.8	29.58	3.75	8.43

E= Eggs L= Larva P= Pupa A=Adult

Table 4 Impact of BIPM in Bt cotton on seed cotton yield and economics

Treatments	Yield (kg/ha)			Additional yield over FP (kg/ha)	Additional income over FP (₹ /ha)	Cost of BIPM (₹ /ha)	Net return (₹/ha)
	2007-08	2008-09	Pooled				
BIPM practices	4868	3114	3990	745	20488	10575	9913
Farmers' practices	4078	2356	3245	-	-	-	-
S. Em. ±	118	158	132	-	-	-	-
C.D at 5 %	335	446	373	-	-	-	-
C.V. (%)	13.16	28.81	18.41	-	-	-	-

The cost: benefit ratio was worked out as 1:1.71 and 1:1.81 in BIPM package compared to 1: 1.03 and 1:1.27 in case of field experiments conducted in Andhra Pradesh during *Kharif* 2007 (Anonymous, 2008) and 2008 (Anonymous, 2009). These reports are in agreement with the economics worked out in present study in which the BIPM module registered ₹ 9913 net return (₹ /ha) with CBR of 1: 1.07.

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An Economic study of production and value addition in potato

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ABSTRACT

A study was undertaken to find out cost of cultivation and value addition of potato. For this study, the Banaskantha district of Gujarat state where potato is grown extensively was selected purposively. For the study, five potato growing villages, 18 farmers and 10 processors from each village were purposively selected. In all, 90 farmers and 50 processors were selected for detailed study. The study was pertaining to the agricultural year 2006-07 and data were collected by survey method. On an average, the total cost of cultivation per hectare on the basis of Cost-C2 was ₹ 59,900. It was lowest (₹ 58,526) for small farmers and highest (₹ 61,209) for large farmers. Cost of manual processing per quintal potato was ₹ 915.58 for wafer and potato stick where as for perforated wafer it was about ₹ 988.58 due to higher cost in processing and less production. The investment cost, raw materials cost and labour cost for wafers and potato sticks was ₹ 121.00, ₹ 559.58 and ₹ 235.00 where as for perforated wafer, it was ₹ 121.00, ₹ 557.58 and ₹ 310.00, respectively. Farmers got ₹ 89 per quintal raw potato where as the processors got ₹ 326 per quintal processed potato. If the farmers sell potato after processing, they may get additional income of ₹ 326 per quintal potato.

Key words : Potato, cost of cultivation, value addition, processing

Potato (*Solanum tuberosum* L.) belonging to the family solanaceae is one of the most popular vegetables grown all over the world. It can be rightly called as the "King of Vegetables." The average per capita consumption of potato in India is less than 15 kg. Potato is a global crop and is a nourishing food that has sustained civilizations for centuries in South America and Europe. Potato has been the most useful food during war time experiences of American and European countries bearing testimony to the great value of potatoes as food. Potato is a winter crop with very high yield potentiality as compared to other food crops. It is an efficient food producer and has the potential to become a supplementary staple food besides cereals in the country. It has been recognized as a wholesome food and the richest source of energy in most of the countries where it forms an important part of the human diet. Potato cultivation in the state of Gujarat is largely concentrated in North and middle Gujarat comprising of Banaskantha, Mehsana, Kheda, Sabarkantha, Anand and Gandhinagar districts. Among these six districts, Banaskantha is having the first rank in terms of area and production. In Banaskantha district, potato was grown in 1,54,000 hectares with production of 46,06,000 tonnes during 2005-2006. Potato is a versatile food because it can be used in various forms both as staple and vegetables. At least 50 per cent of the total production of fruits and vegetables in the country is lost due to wastage and its value is estimated to be ₹ 50,000 crores each year. More recently, greater consideration is being given towards improving post-harvest storage systems and the development of export markets and processing as a means for disposal of the surplus. Potato processing in India has become important in view of the rising employment of women in cities leading to growing demand for processed products and the general increase in demand for processed foods in urban areas. Processing also helps in reducing demand for storage space and adds value to the crop leading to better returns to the growers. More processing means more value addition and better returns to the farmers. Potatoes can be processed into a number of products like chips, French fries, flakes, dice, granules, canned potatoes on commercial scale and home scale. Processing of

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potatoes can also be done to prepare dehydrated products like dehydrated chips, papad *etc.* Potato chips or wafers are one of the most popular snack items consumed throughout world. There is a need to expand potato-processing industries in India at small and large scale. Keeping this in mind a study was undertaken to work out the economics of home scale potato processing by the processors and to know the value addition in potato.

METHODOLOGY

The present investigation was done in Gujarat State with the overall objective of calculating the cost of cultivation of potato and enquiring into economics of processing and specific objective of estimating cost of processing at different stages for wafer, perforated wafer and potato sticks and to find out value addition in potato by processing. In order to achieve the objective of the present study, the purposive sampling technique was adopted for this purpose. Potato cultivation in the state of Gujarat is largely concentrated in Banaskantha, Mehsana, Kheda, Sabarkantha and other districts among which Banaskantha is having the first rank in terms of area and production which is about 50.49 % and 56.08% respectively. Hence, Banaskantha district was selected purposively for the study. From Banaskantha district, Deesa taluka was purposively selected for study due to more area and production under potato cultivation than any other taluka of the district which is about 70.28 % and 74.97 %, respectively. From the selected Deesa taluka, five villages, having larger area under potato cultivation, were purposively selected. From the selected five villages, 18 farmers and 10 processors were selected from each village. For that, a list of farmers and processors from the selected villages was prepared and six farmers were selected purposively category wise into small (up to 2.0 ha), medium (2.01 to 4.0 ha) and large (above 4.0 ha) farmers and processors having and higher quantity of potato used for processing as compared to other processors in the village were purposively selected for the present study. The final sample that emerged thus comprised of 90 farmers and 50 processors and the requisite data were collected from them with the help of well-structured and pre-tested interview schedules by personally contacting the individual farmers and processors. Most commonly used conventional tabular method of analysis was used to estimate the costs. The primary data obtained relates to agricultural year 2006-07.

RESULTS AND DISCUSSION

Cost of Cultivation of Potato

It is well known that potato being labour intensive crop requires relatively higher investment than other field crops. Factor-wise distribution of total cost per hectare is exhibited in the Table 1. The table reveals that on an average, total cost per hectare for potato crop was ₹ 59,900. On reviewing the size-wise total cost per hectare, it can be seen that it was highest (₹ 61,209) for large farmers followed by medium farmers (₹ 59,964) and small farmers (₹ 58,526). On an average, among the total cost per hectare, it was observed that seeds covered the lion's share of 38.17 per cent (₹ 22,863) of the total cost. The share of seed cost in all the farm categories was higher due to higher price of potato seed, but in the studied area during the year the price of seed was high ranging from ₹ 900 to ₹ 1,200 per quintal. Whereas, fertilizer accounted for 13.86 per cent (₹ 8,303) of the total cost, followed by cost of irrigation (7.69 %) and rental value of own land (6.92 %). Among the different categories of farmers, it was observed that seeds ranked the prime place in the range of ₹ 22,325 for small farmers to ₹ 2,3370 for medium farmers. Fertilizer cost was the highest (₹ 8,900) for large farmers and the lowest (₹ 7,910) for medium farmers while the irrigation cost was high (8.33 %) for medium farmers and low (6.63 %) for small farmers. The rental value of owned land varied in the range of ₹ 4,250 for medium farmers to ₹ 4,027 for small farmers. The average yield of potato for the selected farmers was 229 quintals per hectare. The yield was highest for large farmers (240 quintals) and lowest for medium farmers (220 quintals). The gross income per hectare was ₹ 80,033 for selected farmers. It ranged from ₹ 79,100 for small farmers to ₹ 84,000 for large farmers. On an average, potato growers realized net income of ₹ 20,133 from one hectare of potato cultivation. It was ₹ 20,574, ₹ 17,036 and ₹ 22,791 per hectare for small, medium and large farmers, respectively. The findings are supported by Singh and Gupta (1983), Gupta *et al.* (1984), Sinha (1998) and Leua (2001).

Cost of potato processing and value addition in potato at home scale

Home scale processing of potato involves following seven stages: (1) Buying - Raw potatoes are bought mainly from the local market or from the main potato research station of Deesa. (2) Grading - Raw potatoes bought from the market are graded in good and

Table 1 Factor wise distribution of total cost of potato crop per hectare in Banaskantha district of Gujarat state for the year 2006-2007

Particulars	Small farmers			Medium farmers			Large farmers			Average farmers		
	Physical Unit	Value (₹)	Per cent to total cost	Physical Unit	Value (₹)	Per cent to total cost	Physical Unit	Value (₹)	Per cent to total cost	Physical Unit	Value (₹)	Per cent to total cost
Hired labour	40.25	2214	3.78	51.20	2816	4.69	58.55	3220	5.26	50.00	2750	4.59
Bullock labour	7.50	1200	2.05	7.20	1152	1.02	6.75	1080	1.76	7.15	1144	1.91
Seed (kg)	2350	22325	38.15	2460	23370	38.98	2410	22895	37.40	2407	22863	38.17
Manure	8.92	3123	5.34	7.01	2454	4.09	8.15	2854	4.66	8.03	2810	4.69
Fertilizer (kg)												
N	275			265			260			267		
P	150	8100	13.84	143	7910	13.19	163	8900	14.54	152	8303	13.86
K	237			231			281			250		
Irrigation		3881	6.63		4995	8.33		4946	8.09		4608	7.69
Insecticides		500	0.85		415	0.69		405	0.67		441	0.74
Miscellaneous cost		2830	4.84		2690	4.48		2535	4.14		2685	4.48
Depreciation		515	0.88		480	0.80		494	0.80		496	0.83
Interest on working capital		1786	3.05		2017	3.36		1990	3.25		1931	3.22
Cost : A		46474			48299			49319			48031	
Rental value of own land		4027	6.88		4250	7.08		4160	6.80		4146	6.92
Interest on fixed capital (Excluding land revenue)		415	0.70		380	0.64		456	0.75		417	0.70
Cost : B		50916			52929			53935			52594	
Family labour	41.09	2290	3.92	28.8	1584	2.65	31.1	1710	2.79	33.66	1861	3.11
Cost : C1		53206			54513			55645			54455	
10 % of cost C1		5320	9.09		5451	9.10		5564	9.09		5445	9.09
Cost : C2		58526	100		59964	100		61209	100		59900	
Production												
Main product (q)		226			220			240			229	
Gross income (₹)			79100			77000			84000			80033
Net income (₹)		20574			17036			22791			20133	

Table 2 Cost of manual processing per quintal potato by the selected processors in Banaskantha district during the year 2006-2007

Particulars	Wafers				Perforated Wafers				Potato sticks			
	Physical unit	Qty. (kg.)	Value (₹)	Per cent to total cost	Physical unit	Qty. (kg.)	Value (₹)	Per cent to total cost	Physical unit	Qty. (kg.)	Value (₹)	Per cent to total cost
[A] Investment cost												
Peeling knife	1.00	-	5.00	-	1.00	-	5.00	-	1.00	-	5.00	-
Slicing knife	1.00	-	5.00	-	1.00	-	5.00	-	1.00	-	5.00	-
Hand slicing machine	1.00	-	100.00	-	1.00	-	100.00	-	1.00	-	100.00	-
Annual depreciation @ 10 %	-	-	11.00	-	-	-	11.00	-	-	-	11.00	-
Total	-	-	121.00	13.21	-	-	121.00	12.24	-	-	121.00	13.21
[B]Raw materials cost												
Potato	-	100.00	500.00	-	-	100.00	500.00	-	-	100.00	500.00	-
Salt	-	0.50	3.50	-	-	0.50	3.50	-	-0.50	3.50	-	-
Raw woods	-	15.00	45.00	-	-	15.00	45.00	-	-15.00	45.00	-	-
Alum	-	0.013	0.075	-	-	0.013	0.075	-	-0.013	0.075	-	-
Bags	-	4.00	10.00	-	-	3.20	8.00	-	-4.00	10.00	-	-
Candle	-	1.00	1.00	-	-	1.00	1.00	-	-1.00	1.00	-	-
Total	-	-	559.58	61.12	-	-	557.58	56.40	-	-	559.58	61.12
[C] Labour cost												
Transportation	0.31	-	25.00	-	0.20	-	25.00	-	0.31	-	25.00	-
Grading	0.08	-	6.50	-	0.05	-	6.50	-	0.08	-	6.50	-
Washing	0.08	-	6.50	-	0.05	-	6.50	-	0.08	-	6.50	-
Peeling	0.95	-	75.00	-	0.60	-	75.00	-	0.95	-	75.00	-
Slicing	0.95	-	75.00	-	1.20	-	150.00	-	0.95	-	75.00	-
Boiling	0.23	-	18.20	-	0.15	-	18.20	-	0.23	-	18.20	-
Drying	0.19	-	15.00	-	0.12	-	15.00	-	0.19	-	15.00	-
Bagging	0.21	-	13.80	-	0.13	-	13.80	-	0.21	-	13.80	-
Total	3.00	-	235.00	25.67	2.50	-	310.00	31.36	3.00	-	235.00	25.67
Total cost =[A]+[B]+[C]	-	-	915.58	100	-	-	988.58	100	-	-	915.58	100

damaged potatoes. The good potatoes are used for processing and the damaged potatoes are discarded immediately. (3) Peeling - The good potatoes are peeled with knife costing ₹ 5. It is laborious and time-consuming process. The care is exercised to ensure that potatoes are not damaged. Each labour is paid on the quantity of peeled potatoes. About ₹ 75 are paid for grading of a quintal potato. (4) Boiling - The peeled potatoes are boiled in water with salt and alum for 10-15 minutes. Mainly fire wood is used to boil potatoes. (5) Slicing - The boiled potatoes are sliced with the help of hand slicing machine, which is separate for all the three products viz, wafer, perforated wafer and potato sticks having the market price of ₹ 100. (6) Drying - Wafer, Perforated wafer and potato sticks are dried under sun for two to three days. Sun drying is the most preferred method for drying and (7) Packing - The dried products are packed in plastic bags of 5 kgs and 10 kgs capacity locally available in the market.

The cost of processing is studied under three major heads namely (1) Investment (2) Raw materials and (3) Labour cost. It is apparent from the table 2 that the processors have to incur cost of ₹ 915.58 for wafer and potato sticks where as ₹ 988.58 for perforated wafer. The investment, raw materials and labour cost share 13.21, 61.12 and 25.67 per cent of the total processing cost for wafer and potato sticks where as the share for perforated wafer is about 12.24, 56.40 and 31.36, respectively. The major costs being labour and raw materials cost which indicated that processing at home scale is labour intensive and highly capital intensive. The investment cost is the least accounting for only 13.21 per cent for wafer and potato sticks and 12.24 per cent for perforated wafer. The investment cost for potato processing works out to ₹ 121 per quintal potato for all the three products out of which the price for peeling knife and slicing knife is similar (₹ 5) where as for hand slicing machine the present value is ₹ 100. Here it should be kept in mind that a peeling knife and a slicing knife once bought works for three to five years and a hand slicing machine works for two to three years. Raw materials cost for processing came to ₹ 559.58 for wafer and potato sticks and ₹ 557.58 for perforated wafer. Again among the raw materials cost, the highest cost was for raw potato (₹ 500) and the lowest (₹ 0.013) for alum for all the three products. Among the labour cost, the highest cost accounted for slicing, which was about ₹ 150 for perforated wafer where as ₹ 75 for wafer and potato sticks. The total labour cost for wafer and perforated wafer was ₹ 235 for wafer and potato sticks and ₹ 310 for perforated wafer. Thus, the total processing cost for wafer and potato sticks was ₹ 915.58 and ₹ 988.58 for perforated wafer (1). The annual depreciation @ 10% (₹ 11) is calculated in investment cost. These findings are supported by Goutam *et al.* (1988), Sikka *et al.* (1989), Subrahmanyam *et al.* (1992) and Mayura *et al.* (1995).

In the present study, on an average, the net profit of processors for all the three products was about ₹ 326 for a quintal potato while net income of farmers for raw potato was about ₹ 89 per quintal potato which can be seen from Table 3. Thus, the farmers can earn ₹ 326 more for processed potato products as compared to raw potato per quintal potato and there might be value addition of ₹ 326 for a quintal potato.

Table 3 Estimated net profit due to processing for the farmers of Banaskantha district for a quintal of potato

Particulars	Total cost (₹)	Price (₹/qtl.)	Net profit (₹)
Potato	261	350	89
Processed potato	940	1266	326

CONCLUSION

Per hectare average total cost (Cost-C_2) of potato was ₹ 59,900. It was the highest (₹ 61,209) for large farmers followed by medium farmers (₹ 59,964) and small farmers (₹ 58,526). Further, the breakup of total cost for selected farmers indicated that seeds accounted for the lion's share of 38.17 per cent, followed by fertilizer (13.86 %), irrigation charges (7.69 %) and rental value of owned land (6.92 %). Cost-A shared about 80.19 per cent of total cost for selected potato growers. It varied from 79.40 per cent for small farmers to about 80.00 per cent for medium and large farmers. On an average, the total cost of cultivation per hectare on the basis of Cost-C_2 was ₹ 59,900. It ranged from ₹ 58,526 for small farmers to ₹ 61,209 for large farmers. The net income of potato growers were ₹ 20,574, ₹17036 and ₹ 22,791 per hectare for small, medium and large farmers, respectively. Thus, on an average, potato growers realized net income of ₹ 20,133 from one hectare of potato cultivation.

Potato processing at home scale is vital for converting raw potato into wafer, perforated wafer and potato sticks. The major cost components in processing are raw materials and labour cost. The total processing cost per quintal raw potato came to ₹ 915.58 for wafer and potato sticks and ₹ 988.58 for perforated wafer. It was observed that peeling and slicing are important operations at home scale which enables the farmer to obtain remunerative prices. The farmers got ₹ 89 per quintal raw potato where as the processors got ₹ 326 per quintal from processed potato. If the farmers sell potato after processing, they may get additiona income of ₹ 326 per quintal potato.

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Extension management ability of the programme coordinators of Farm Science Centres / Krishi Vigyan Kendras (KVKs) of India

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ABSTRACT

The study was carried out selecting a random sample of 160 Programme Coordinators of five years old KVKs of all the eight zones of India with full-fledged activities in the service of farmers. The Ex-Post-Facto Research Design was used for this study. The data were collected through mail questionnaire as well as interview schedules either by contacting through post or personal contacts. The suitable statistical tools were used to analyze data. The study reveals that slightly more than half of the programme coordinators of KVKs had high level of planning ability (51.25 per cent), majority of them had medium to high level of organizing capacity (85.00 per cent), high level of ability of directing their subordinates (76.87 per cent), high level of ability of communicating (58.13 per cent), medium to high level of capacity to maintain human relations (91.87 per cent), high level of lead taking behavior (61.88 per cent), high level of supervising ability (71.26 per cent), high level of coordinating ability (62.50 per cent) and medium level of overall extension management ability (68.12 per cent), whereas slightly less than half of the programme coordinators had high level of decision making capacity (45.00 per cent) and high level of controlling power (48.12 per cent). The personal variables of programme coordinators of KVKs such as; young age, higher education, vigorous status of health and rural native place, while organizational variables like; conducive organizational climate, needed organizational facility and better interpersonal communication, whereas socio-psychological variables for instance; extrovert personality and positive attitudes towards extension work and low level of job stress played significant role on their extension management ability. The positive attitude towards extension work, extrovert personality and favourable organizational climate together accounted 55.70 per cent variation in extension management ability of the programme coordinators of KVKs.

Key words : KKVs, programme coordinaters, extension management ability

Farm Science Centre which is known as Krishi Vigyan Kendra (KVK) is leading edged transfer of technology project initiated and run by the Indian Council of Agricultural Research (ICAR), which is central governing body of agricultural development established by Government of India. It is intended to create able human resource for agriculture development of the country. The Farm Science Centre or Krishi Vigyan Kendra (KVK) is one of the innovative programmes of the council designed to provide skill oriented vocational training to the farmers, farmwomen, rural youths and field functionaries. It helps in crafting competent practicing farmers, farmwomen, rural youth and extension personnel. Understanding such importance of KVK, it is expected to have ideal leader with certain useful qualities and positivism to improve the operational quality of the KVK to get desired results (Pathak *et al.*, 2005. The quantitative and qualitative functioning of the KVK depends on the unambiguous qualities of its leader. In the existing pattern of KVK, Programme Coordinator (PC) is working as the head of the center.

A creative and visionary leader with demonstrated integrity, enthusiasm, motivation, flexibility and confidence to act as programme coordinators has

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great chance to show the real impact of the KVK (Mangala Rai, 2006). The programme coordinator can establish and guide new research directions, lead technical and social research and development proposals, new technologies and capabilities and interact with in key clients. The programme coordinator as a key position holder should try to utilize opportunity to lead centre and offer at the forefront of the emerging technology (Patel *et al.*, 2004).

Thus, the effectiveness of the Krishi Vigyan Kendras mainly depends on how it is efficiently and successfully managed by its leader or the head. Generally it is observed that the KVKs are headed by postgraduates with specialization in different subjects of agriculture. They need to have sufficient experience in managing the multidisciplinary faculties of KVKs. The heads of KVKs have to perform multifold roles of planning, organizing, directing, communicating, controlling, supervising, coordinating, leading, human relation maintaining and decision-making. These managerial qualities make them able to perform role as per the mandate of the KVK. By managing all those qualities they have to create conducive condition for effective training.

The KVK, which is started with set objectives, needs be assessed by evaluating managerial ability of its leader to understand its utility and effectiveness. It was therefore, felt necessary to assess the qualities possessed by its heads or who the key persons in effective functioning of centers in terms of agricultural development. Such study helps to locate the strong and weak points of managers of KVKs in overall functioning. It also helps to give direction to the continued in building brining confidence and satisfaction. Understanding this, the present study was conducted with general objectives of measuring the extension management ability of Programme Coordinators (PCs) as heads of Krishi Vigyan Kendras with following specific objectives :

1. To measure the managerial ability of Programme Coordinators (PCs) of KVKs.
2. To find out the relationship between selected independent variables and managerial ability of programme coordinators of KVKs.
3. To estimate the functional relationship between managerial ability and various independent variables of the Programme Coordinators (PCs) of KVKs.

METHODOLOGY

The Krishi Vigyan Kendras of India are managed and functioned in India in the eight zones. The present study was carried out in all the eight zones of India. The study was carried out selecting half of KVKs with full-fledged activities in the service of Indian farmers and at least five years of working experience. At the time of investigation, about 320 well established KVKs were short listed. The representation of each zone was included in this study. A random sample of 160 KVKs was selected for this study. Ex-Post-Facto Research Design was used for this study. The Extension management abilities of the Programme Coordinators were measured with the help of the Scale developed by Patel (2001). The data were collected through mail questionnaire as well as interview schedules either by contacting through post or personal contacts. The statistical tools such as mean, standard deviation, coefficient of correlation and standard partial regression coefficient were worked out. The mean, standard deviations were used to classify the variable in low, medium and high groups while coefficient of correlation was used to know relationship between independent and dependent variables. The standard partial regression coefficient was used to predict the functional relationship.

RESULTS AND DISCUSSION

Extension management ability of the programme coordinators of KVKs

The extension management ability of Programme Coordinators was measured by selecting ten indicators; the studied indicators were planning, organizing, directing, communicating, controlling, human relation, leading, supervising, coordinating and decision making. The results are presented in following Table 1.

Planning

The Planning is one of the important indicators of extension management ability of the programme coordinators of KVKs. It shows scheduling style implemented by them to determine the objectives, training needs, process of transferring technologies, utilization of funds, extension facilities and monitoring and evaluation work. The result presented in Table 1 indicates that slightly more than half (51.25 per cent) of the programme coordinators of KVKs had high level of planning ability, followed by 33.75 per cent and 15.00 per cent with medium and low level of planning ability, respectively. It is concluded that (85.00 per cent) of the programme coordinators found with medium to high level of planning ability. Proper guideline, systematic direction and continuous

Table 1 Distribution of the respondents according to various extension management ability (n = 160)

Sr. No.	Types of extension management ability	Number	Per cent
Ability of planning			
I	Low	24	15.00
II	Medium	54	33.75
III	High	82	51.25
Ability of organizing			
I	Low	24	15.00
II	Medium	68	42.50
III	High	68	42.50
Ability of directing			
I	Low	15	09.38
II	Medium	22	13.75
III	High	123	76.87
Ability of communicating			
I	Low	34	21.25
II	Medium	33	20.62
III	High	93	58.13
Ability of controlling			
I	low	45	28.12
II	Medium	38	23.76
III	High	77	48.12
Ability to maintain human relation			
I	Low	13	08.13
II	Medium	70	43.75
III	High	77	48.12
Ability of leading			
I	Low	29	18.12
II	Medium	32	20.00
III	High	99	61.88
Ability of supervising			
I	Low	13	8.12
II	Medium	33	20.62
III	High	114	71.26
Ability of coordinating			
I	Low	43	26.87
II	Medium	17	10.63
III	High	100	62.50
Ability of decision making			
I	Low	23	14.38
II	Medium	65	40.62
III	High	72	45.00
Overall extension management ability			
I	Low	21	13.13
II	Medium	109	68.12
III	High	30	18.75

supervision by concerned officers and ICAR might have made them able with medium to high level of planning ability. The result is in the line of Popat (1991).

Ability of organizing

Ability to organize different functions is one of the important indicators of extension management ability requires in any head of organizations to arrange various activity on a regular basis. To call regular meeting to provide work opportunity according to specializations and to invite suggestions from subordinates as well as to divide activity into groups and to delegate authority according to responsibility are important functions which require proper ability to organize functions of organizations. It can be clearly stated that majority (85.00 per cent) of the programme coordinators of KVKs had medium to high level of organizing capacity in relation to extension management in their respective KVKs. The probable reason might be that have to carryout series of activities throughout the year; as a result of this, they might have understood the importance to systematize various activities for their effective implementations. The results are also supported by Patel (2001).

Ability of directing

The ability of directing was measured by knowing Programme Coordinators' frequency in directing their subordinates about different functions. This is an important activity any Programme Coordinators have to do to carry out for effectual functioning of the work. The results indicates that majority of the Programme Coordinators (76.87 per cent) took high level of interest to give clear instruction of work, to give due credit to a person, to appreciate good work done by their subordinates and to give continuous information.

Ability of communicating

It is well understood that effective extension management is possible through high ability among the head of the organization in communicating subordinates. Understanding importance of this ability as one of the indicators of extension management, it was studied. It can be seen from the result that majority of the Programme Coordinators had high level of ability of communicating. The result indicates that majority of the Programme Coordinators had taken constant interest to give timely instructions, to listen subordinates, to select proper medium for instructions and to receive feed back .the results are same with Patel *et al.*, (2004).

Ability of controlling

The ability of controlling is also an important sign

which requires any heads of the organization dealing with human resource development for its effective management. This variable was measured by knowing degree of frequency of Programme Coordinators' command of linking their subordinates and their different functions. It was seen that majority (71.88 per cent) of the Programme Coordinators of Krushi Vigyan Kendra had medium to high level of controlling power for effective functioning of extension activities in terms of monitoring the work, proper style of visits, determining standard for work, evaluating the work and measuring performance of staff.

Ability to maintain human relation

An ability to maintain human relation is very important excellence the Programme Coordinators of Krushi Vigyan Kendra need to retain effective extension management. This variable was measured by knowing degree of frequency of their touch with all the persons of the organization to carry out mandatory functions effectively. Accepting importance of this ability as one of the indicators of extension management, information was collected. It was obvious that majority of the Programme Coordinators of Krushi Vigyan Kendra had medium to high level of interest to make personal contacts, deal fairly, pay attention in development of juniors, adopt participative approach, understand others' behaviors and to offer good co-operation. The results are further supported by Patel (2001).

Ability of leading

It can be perceived from the results that great majority (81.88 per cent) of the Programme Coordinators of Krushi Vigyan Kendra had medium to high degree capacity to take lead in different functions such as promoting team work, taking initiative task, applying technical competency and inspiring subordinates.

Ability of supervising

An aptitude of supervising is another considerable trait required in the head of any extension organizations for upholding effective extension management. This quality was measured by knowing degree of Programme Coordinators' administering behaviour with various functions of KVK successfully. It was observed that great majority (91.88 per cent) of the Programme Coordinators of Krushi Vigyan Kendra had medium to high level of ability to regulate various functions by providing constant extensive counseling, focusing on quality work and giving valuable suggestions. Due to frequent involvement in various kinds of activity by the Programme Coordinators, they might have established such ability in them.

Ability of coordinating

The ability of coordination is one additional substantial attribute; head of extension organization requires for keeping efficient extension management. This element was calculated by insightful degree of Programme Coordinators' behaviour to organize, synchronize, harmonize, match up and brings together various on-campus and off-campus functions of KVK fruitfully. Considering core of this talent as one of the indicators of extension management ability of programme coordinators, facts were collected and presented in Table 1. It was interesting to note that majority of the Programme Coordinators of Krushi Vigyan Kendra had high level of ability to establish linkages, integrate the extension work, establish mutual trust and get co-operation from outsides. To fulfill the mandate of KVK, head of organization has to deal with internal and external personnel of various agencies, thus, while working with them, they might have realized importance to establish such ability. This might be the reason for above finding. This finding was in line of the results reported by Popat, (1991).

Ability of decision making

The ability of taking right decision at the right time is an added considerable characteristic; head of extension organization needs to have for keeping proficient extension management. This ingredient was studied by knowing degree of programme coordinators' behaviour to take different judgments to carry out various on-campus and off-campus activities of KVK at right time by proper ways. Taking into consideration role of this capacity as one of the indicators of extension management ability of programme coordinators, information was collected. It can be stated that great majority (85.62 per cent) of the Programme Coordinators of Krushi Vigyan Kendra had medium to high level capacity to take timely decision, find out facts for decision, adopt participative decision style, taking unbiased decision for implementation.

Overall extension management ability

The overall extension management ability of programme coordinators was measured by combining all the indicators including planning, organizing, directing, communicating, controlling, human relation, leading, supervising, coordinating and decision making. It can be seen that majority (68.12 per cent) of the heads of KVK were observed with the medium level of overall extension management ability, while 18.75 per cent of them with high and 13.13 per cent with low level of overall extension management ability. Thus, the extension management ability of the heads of KVK was predominantly medium. The same results were reported by Patel *et al.*, (2004).

Relationship between profile of the programme coordinators of KVKs and their extension management ability

To ascertain the relationship between personal, job related, organizational and socio-psychological variables of the programme coordinators of KVKs and their extension management ability, correlation coefficient was worked out. The results are given Table 2.

It was observed that the personal variables like education, health status and native place of the programme coordinators of KVK were observed positively, while age was observed negatively significant with their extension management ability. The variables *viz.*, size of family and type of family were non-significant with extension management ability of the programme coordinators of KVKs. The result was supported by Patel (2001). The Job related variables like total experience as TO, total experience in KVK and training received were negatively non-significant with extension management ability of the programme coordinators of KVKs. The organizational variables like organizational climate, organizational facility and interpersonal communication were observed positively significant with their extension management ability. While, other organizational variables like span of control was observed non-significant, only staff facility was observed negative not significant with their extension management ability. Same was reported by Patel (2001). The socio-psychological variables of the programme coordinators of KVK like personality and attitudes towards extension work were observed positively significant, while job stress was observed negatively significant with their extension management ability. The other socio-psychological variables; workload and job involvement observed non-significant with extension management ability. The results are in the line of the results reported by Popat (1991).

Table 2 Relationship between the profile of the programme coordinators of KVKs and their extension management ability n = 160

Sr. No.	Name of variables	Correlation coefficient	
I	Personal variables		
1	Age	-0.362	**
2	Educational qualification	0.238	*
3	Health	0.365	**
4	Type of family	-0.011	NS
5	Size of family	0.020	NS
6	Native place	0.384	**
II	Job related variables		
1	Total experience as TO	-0.060	NS
2	Total experience in KVK	-0.013	NS
3	Training received	-0.019	NS
III	Organizational variables		
1	Span of control	0.144	NS
2	Staff facility	-0.120	NS
3	Organizational climate	0.524	**
4	Organizational facility	0.537	**
5	Interpersonal communication	0.401	**
IV	Socio-psychological variables		
1	Personality	0.675	**
2	Attitudes towards extension work	0.622	**
3	Workload	0.023	NS
4	Job involvement	-0.047	NS
5	Job stress	-0.158	*

* Significant at 0.05 level of probability.
** Highly significant at 0.01 level of probability.

Table 3 Step-wise multiple regression analysis of extension management ability of the programme coordinators of KVK

Independent variable	Multiple co-relation co-efficient (R)	(R^2)	'F' values	Partial regression co-efficient (b)	't' value	Standard partial regression co-efficient (SPRC)	Rank
Positive Attitude towards extension work	0.675 (45.50 %)	0.455 **	131.952 **	1.700	11.487	0.443	I
Extrovert Personality	0.736	0.542 (54.20 %)	92.781 **	0.383	5.447 **	0.285	II
Positive Organizational Climate	0.746	0.557 (55.70 %)	65.376 **	0.236	2.320 *	0.155	III

* Significant at 0.05 level of probability. ** Highly significant at 0.01 level of probability.

Thus, it can be concluded that the personal variables of programme coordinators of KVKs such as; young age, higher education, vigorous status of health and rural native place, while organizational variables like; conducive organizational climate, sufficient needed organizational facility and better interpersonal communication, whereas socio-psychological variables for instance; extrovert personality and positive attitudes towards extension work and low level of job stress played significant role in improving their extension management ability.

The functional relation between extension management ability and independent variables of the programme coordinators of KVK

The results presented in Table 3 indicate that the 45.50 per cent variation in extension management ability of programme coordinators of KVKs was contributed by attitude toward extension work. However, positive attitude towards extension work + extrovert personality of the programme coordinators of KVK accounted for 54.20 per cent, while, positive attitude towards extension work, extrovert personality and favourable organizational climate together accounted 55.70 per cent variation in extension management ability of the programme coordinators of KVKs.

CONCLUSION

Slightly more than half of the programme coordinators of KVKs had high level of planning ability (51.25 per cent), majority of them had medium to high level of organizing capacity (85.00 per cent), high level of ability of directing their subordinates (76.87 per cent), high level of ability of communicating (58.13 per cent), medium to high level of capacity to maintain human relations (91.87 per cent), high level of lead taking behavior (61.88 per cent), high level of supervising ability (71.26 per cent), high level of coordinating ability (62.50 per cent) and medium level of overall extension management ability (68.12 per cent), whereas slightly less than half of the programme coordinators had high level of decision making capacity (45.00 per cent) and high level of controlling power (48.12 per cent).

The personal variables of programme coordinators of KVKs such as; young age, higher education, vigorous status of health and rural native place, while organizational variables like; conducive organizational climate, needed organizational facility and better interpersonal communication, whereas socio-psychological variables for instance; extrovert personality and positive attitudes towards extension work and low level of job stress played significant role on their extension management ability.

The 45.50 per cent variation in extension management ability of programme coordinators of KVKs was contributed by their positive attitude toward extension work. However, positive attitude towards extension work and extrovert personality of the programme coordinators of KVK accounted for 54.20 per cent, while, positive attitude towards extension work, extrovert personality and favourable organizational climate together accounted 55.70 per cent variation in extension management ability of the programme coordinators of KVKs.

IMPLICATIONS

The present study was highlighted direction on the new area in which, research work was needed to carry out. The following implications emerged from this study. A definite approach to craft India as developed nation in the shortest possible time is realized by a rapid agricultural growth. Today in first line of transfer of technology mission, Krishi Vigyan Kendra needs to play a role of key extension system to develop the farming communities. The findings of the study reveal that, to manage and run KVKs as per its mandate, there is need to appoint young, talented, well qualified, dedicated, enthusiast programme coordinators to reinforce role of KVKs. The results indicates that programme coordinators of KVKs with rural native background were observed more active and commanding in managing extension activities and KVK, thus it is suggested that person with rural background or feelings to work in rural and semi urban area should be appointed to work as programme coordinators of KVKs. During the study it was seen that training received by the programme coordinators of KVKs did not exhibit any impact in improving their extension management ability. Thus, there is need to give special trainings which can prepare programme coordinators of KVKs as good manager.

The positive relationship indicates that extension management ability of those programme coordinators of KVKs was seen better who had more workers to look after. The programme coordinators of KVKs with more members to control directly by them were more active in managing KVKs. It indicates that programme coordinators of KVKs who had adopted strategy to maintain direct control and observation on all members of their KVKs had better extension management ability. Thus, it is recommended that programme coordinators of KVKs should try to maintain direct contact with each member of KVK for effective management. It was seen that extension management ability of those programme coordinators of KVKs was

observed better who had better and favorable organizational climate. Thus, programme coordinators of KVKs are recommended to maintain conducive organizational climate to improve their level of extension management ability to manage KVKs in effective manner. To accomplish mandates of KVK, programme coordinators of KVKs have to perform many activities like training, publication of farm literature, edification and organization of demonstrations, e-extension, field visits etc. For this, they need many infrastructural facilities like land, laboratory, vehicles, audio-visual aids, reading materials, furniture, stationary and other communication facilities like telephone, Xerox machine, fax, computer and internet connections. Thus, it is recommended to provide all the facilities to manage their duty effectively. This was also reported by (Van de Ban, (2004). The interpersonal communication is key component in development of any organization. It is degree of contacts of head of organization with other officials. It is needed to gain knowledge from another individual to predict how they think, feel and act. Such act provides ability to achieve high level of extension management ability. Thus, it is recommended to develop better interpersonal and inter organizational communication ability among the programme coordinators of KVKs. The extension management ability of programme coordinators of KVKs was observed better who had extrovert type of personality. It is thus, dreamed that each KVK of India should have such kind of programme coordinators of KVKs. The job stress was seen negative significant with extension management ability of the programme coordinators of KVKs. The job stress is feedback of programme coordinators of KVKs with regards to their emotional and/or physical pressure for their job. The person who is head of KVK should have physically and mentally powerful outlook to do work in any adverse situation. He should be sufficient strong, punctual, nervousness free, matured, accommodating and talented to do any type of job successfully with whatsoever accessible staff he has. It was seen that extension management ability of those programme coordinators was seen better who had less job stress. Understanding this fact it is advisable that programme coordinators of KVKs working at KVKs should be given specific training to deal with high job stress. The results indicates that variables such as attitude towards extension work, extravert personality of the programme coordinators and organizational climate contributed 55.70 per cent variation in extension management ability of the heads of the KVKs, thus authority of KVK should try to do something considering these variables to create ideal and conducive situation in KVKs.

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Credibility of sources of information used by castor growers

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ABSTRACT

A study of sources of information about castor crop used by farmers in Banaskantha district of North Gujarat was conducted in three talukas through purposive sampling and three hundred castor growers were selected through random sampling technique. The findings of the study revealed that personal localite source of information is still important among castor growers.

Key words : Castor growers, credibility

In Agricultural, extension and transfer of technology communication have very important role not only for transfer of the useful message and information but also receiving the feedback from farmers side. In this context, the source and channels of information utilized by farmers in regard to farm technologies play an important role. For this purpose, farmers use many resources of information depending on the credibility of information source and channel perceived by them. The credibility of source of information depends on the type of farming, agronomic situation of farmers as well as economic and social status of farmers. In castor crops for transfer of technology farmers highly depend on State Agriculture Department, Crop Demonstration of farmers fields and knowledge of neighbouring farmers.

METHODOLOGY

The present study was conducted in the three talukas (Palanpur ,Deesa & Dhanera) of Banaskantha District of North Gujarat during 2007. From each talukas two villages were selected purposively. These villages were Patosan, Sagrosana, Ghada, Agdol, Shera and Malotra, respectively.

A sample of 300 castor growers was randomly selected from six selected villages(50 from each village). The data were collected with the help of well developed and structure schedule. The credibility sources of information was particular design as a degree which castor growers trust particularly sources of information to be accurate and useful in their own farming situations, it was measured with the help of least credibility index method developed by Sandhu (1973).

The sources of information included under the study were :

I. Personnel localite
   1. Neighbour farmers
   2. Progressive farmers/ contact farmers
   3. Friends/ relatives
   4. Elders farmers of society

II. Personnel cosmopolite:
   1. Officers and workers of Agricultural / Development Departments
   2. Research organizational personnel
   3. Inputs dealers
   4. Village Co-operative Society/ Oil factory

III. Mass media
   1. Radio/ Television
   2. News papers/ agricultural magazine and other print materials
   3. Agricultural Exhibition / Kishan goshti / Krishi mela/ field days
   4. Krushi Mahotsava

IV. Field Demonstrations
   1. Demonstration (Result/ Method)
   2. On Farm Trials

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The formers were interviewed to indicate most and least reliable sources used by them in receiving the information about castor production technology. The relative credibility index was worked out using the following formula :

$$\text{Credibility Index} = \frac{A}{R} \times \frac{100}{N}$$

Where,

A = No. of castor growers who believed the sources most credible

R = No. of castor growers who believed the sources least credible

N = Total no. of respondents

The credibility index of all sources of information was ranked in order according to their performance indicated by castor growers.

RESULT AND DISCUSSION

The data with regards to credibility of communication sources used by castor growers are given in Table1. The data revealed that castor growers gave first rank to progressive farmers/ contact farmers than *Krushi mahotsava*. Third, fourth, fifth and sixth rank were given to Demonstration (Result/ Method), On Farm Trials, Research Organization personnels and input dealers, respectively. The Mass Media have also a reasonable contribution in this regard. Almost these findings reported by Walke *et al.*(1988), Bhairmakvar *et.al.*(2003) and Surendrakumar *et.al.*(2007). It was observed that the Krushi mahotsava played significant role in the dissemination of the useful information in a nutshell form.

Table 1 Credibility of sources of information used by farmers (N: 300)

Sr. No.		Sources of Information	Most Credible	Least Credible	Relative credibility Index	Rank order
I	Personnel localite					
	i	Neighbour farmers	230	70	1.08	VII
	ii	Progressive farmers/ contact farmers	280	20	4.62	I
	iii	Friends/ relatives	220	80	0.91	VIII
	iv	Elders farmers of society	155	145	0.35	XIV
II	Personnel cosmopolite					
	i	Officers and workers of Agricultural / Development Departments	175	125	0.46	XII
	ii	Research organizational personnel	250	50	1.65	V
	iii	Inputs dealers	240	60	1.32	VI
	iv	Village Co-operative Society/ Oil factory	160	140	0.38	XIII
III	Mass media					
	i	Radio/ Television	195	105	0.61	X
	ii	News papers/ agricultural magazine and other print materials	180	120	0.50	XI
	iii	Agricultural Exhibition / Kishan goshti / Krishi mela/ field days	215	85	0.83	IX
	iv	*Krushi Mahotsava*	270	30	2.97	II
IV	Field Demonstrations					
	i	Demonstration(Result/ Method)	260	40		III
	ii	On Farm Trials	255	45		IV

CONCLUSION

The study has carefully stated that personal localite sources of information are still important among the castor growers. Thus, in modern age we can use a balance combination of advance information technology with mass media, interpersonal channel.

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Adoption behaviour of the tribal farmers of Sabarkantha district towards improved animal husbandry practices

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ABSTRACT

A study on adoption behaviour of the tribal farmers of Sabarkantha district towards improved animal husbandry practices was conducted in two talukas of Sabarkantha district. The findings of the study revealed that nearly half of the tribal farmers had medium level of adoption about improved animal husbandry practices. The study also revealed that knowledge of improved animal husbandry practices contributed significantly to the prediction of the adoption of the tribal farmers.

Key words : Adoption behaviour, animal husbandry practices, tribal farmer

Indian farming is an economic symbiosis between crop and animal husbandry. India lives in the villages and large majorities (74 per cent) of the families are dependent on agriculture with live stock constituting integral role, particularly for the rural poor. Livestock provides cheap nutritious food rich in animal protein to millions of the people. It offers a good employment generation opportunity. A large number of rural women find good opportunities to work in several operations of animal husbandry. Dairy development has been acclaimed as an effective instrument capable of bringing about speedy economic and social transformation of the weaker section of the rural community. In dairy farming, adoption of improved animal husbandry practices is considered worth useful to enhance milk production, productivity and profitability and ensure sustainability. Unless the improved practices are properly adopted by the dairy farmers, the target cannot be achieved. Therefore, it was felt necessary to conduct the present study with following objectives.

1. To find out the extent of adoption of improved animal husbandry practices by the tribal farmers.
2. To determine the relationship between selected independent variables of the tribal farmers and their adoption of improved animal husbandry practices.
3. To know the predictive ability of different characteristics to explain variation in adoption of improved animal husbandry practices by the tribal farmers.

METHODOLOGY

The present study was conducted in Sabarkantha district of Gujarat state. Gujarat has 74.81 lakh tribal population. Sabarkantha district ranks fifth among all the districts of the state with respect to tribal population (Census, 2001).

Out of the four tribal dominating talukas of the district 2 talukas viz., Bhiloda and khedbrahma were purposively selected having more Milk Producing Cooperative societies(MPCs) functioning for the minimum last five years. 10 MPCs from Bhiloda taluka and 5 MPCs form Khedbrahma taluka were randomly selected. Thus, total 15 villages having MPCs were selected for the study. From the list of members of each respective MPC, 10 respondents were selected using simple random sampling method making a sample of 150 respondents. The data were collected by personal interview method.

To know the association between independent variables with adoption, correlation coefficient was worked out. Similarly for studying the combine effect of all independent variables in explaining the variation in the adoption of improved animal husbandry practices the multipal regression analysis was carried out.

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RESULT AND DISCUSSION

Extent of adoption of improved animal husbandry practices by the farmers.

The data in Table 1 reveal that about half of the respondents (48.67 per cent) had medium extent of adoption followed by 32.00 per cent of them who had low extent of adoption. Remaining 19.33 per cent of the respondents had high extent of adoption of improved animal husbandry practices. The finding is in agreement with the findings of Meena and Chauhan (1999), Verma and Sharma (2003) and Dana and Kanabi(1998).

Table 1 Distribution of the tribal farmers according to their adoption of improved animal husbandry practices.

Sr. No	Extent of adoption	No. of farmers	Percent
1	Low	48	32.00
2	Medium	73	48.67
3	High	29	19.33
	Total	150	100.00

Relationship between independent variables of the respondents and their adoption of improved animal husbandry practices

To ascertain the relationship between selected independent variables and extent of adoption of dairy farming practices by the members of the MPCs, the correlation coefficient was calculated.

The results presented in Table 2 reveal that out of 17 independent variables, only three variables viz., family size , family type and herd size were found having non significant relationship with adoption of improved animal husbandry practices. The remaining 14 independent variables, viz., age(0.3219), education(0.5722), land holding (0.2651), occupation(0.3299), social participation(0.3678), milk production(0.2929), farm power possession(0.2997), material possession(0.5180), mass media exposure (0.3235), extension participation(0.4748), overall modernity(0.7095), knowledge about improved animal husbandry practices(0.8006), attitude toward MPC(0.7138), and attitude toward dairy farming technology(0.7145) were found significantly and positively related with the adoption of improved animal husbandry practices as the values of all these variables were found significant at 0.01 level of significance .

Table 2 Correlation coefficient showing relationship of selected independent variables with adoption of improved animal husbandry practices. (n=150)

Sr. No	Independent variable	Correlation coefficient 'r'
1	Age	0.3219**
2	Education	0.5722**
3	Family size	0.0466 NS
4	Family type	0.0630 NS
5	Land holding	0.2651**
6	Occupation	0.3299**
7	Social participation	0.3678**
8	Herd size	0.0638 NS
9	Milk production	0.2929**
10	Farm power possession	0.2997**
11	Material possession	0.5180**
12	Mass media exposure	0.3235**
13	Extension participation	0.4748**
14	Overall modernity	0.7095**
15	Knowledge about improved animal husbandry practices	0.8006**
16	Attitude toward MPC	0.7138**
17	Attitude toward Dairy farming technology	0.7145**

**Significant at 0.01 level of significance

NS=Non significant

Variables predicting addoption of improved animal husbundary pracitices

From the ranks of standard partial regression coefficient presented in Table 3, it can be found that the knowledge regarding improved animal husbandry practices is the most important variable followed by age, attitude toward dairy farming technology, land holding and extension participation. All these variables collectively contributed 87.31 per cent of total variation in adoption of improved animal husbandry practices by the tribal farmers. Hence, it implies that better exposure of these variables would influence in better adoption of improved animal husbandry practices.

Table 3 Step-wise multiple regression analysis of independent variables with adoption.

Sr. No.	Independent variable	Partial regression coefficient (bi)	Standard error of regression coefficient (SE of bi)	't' value	Standard partial regression coefficient (b'i)	Rank
1	Age	0.1446	0.0263	4.97**	0.1802	II
2	Land holding	0.0620	0.2535	3.08**	0.0080	IV
3	Extension participation	0.0245	0.3199	1.90	0.0026	V
4	Knowledge about improved animal husbandry practices	0.6713	0.0396	17.14**	0.9804	I
5	Attitude towards dairy farming technology	0.1485	0.0360	5.01**	0.1655	III

** Significant at 0.01 level of significance

Constant=3.4846 Multipal R=0.9344 R2=0.8731

CONCLUSION

From the above results, it can be concluded that nearly half of the tribal farmers had medium level of adoption about improved animal husbandry practices. The important variable positively and significantly affecting adoption were, age, education, land holding, occupation, social participation, milk production, farm power possession, material possession, mass media exposure, extension participation, overall modernity, knowledge about animal husbandry practices, attitude toward MPCs and attitude toward dairy farming technology. The study revealed that knowledge of improved animal husbandry practices contributed significantly to the prediction of the adoption of the tribal farmers. Hence, attempt shall be made to seek maximum involvement of this characteristic. It is recommended that in order to increase the knowledge of tribal farmers, they must be updated with the latest and improved scientific practices by organizing motivational tour programmers, method and result demonstrations as well as by providing on campus institutional training on dairy farming.

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Fertility response in relation to gross uterine involution and GnRH supplementation in Mehsani buffaloes

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ABSTRACT

Mehsani buffaloes of different groups were examined for reproductive rhythm at 10-days interval from the day of calving to evaluate the uterine involution and resumption of ovarian cyclicity. At day 35th postpartum 19 out of 29 buffaloes were injected i/m with 0.02 mg (5 ml) Buserelin acetate (GnRH analogue, Receptal, Intervet India Pvt. Ltd.). All the buffaloes were examined for their ovarian and uterine status and were monitored for signs of oestrus and subsequent fertility. Buffaloes of control group had gross uterine involution faster and among the buffaloes of treatment group those which had performance comparable with control group, responded better to the GnRH at 35th day postpartum. Non-significantly earlier uterine involution was associated with the early behavioural oestrus and conception within the treatment and control groups.

Key words : Gross uterine involution, mehsani buffaloes

Defective involution was associated with ovarian inactivity during first 3-4 weeks of parturition (Bostedt *et al.* 1976.). A varying average interval from calving to uterine involution has been reported for different buffalo breeds, viz. for Egyptian buffaloes 40 days (El Sheikh and Mohamed,1977) for suckled Murrah buffaloes 41.8 days (13), for suckled swamp buffaloes 28 ± 6 days (Jainudeen *et al.*, 1983.) and for suckled Nili-Ravi buffaloes 26 days (Usmani *et al.*,1985.), and for non-suckled Surti buffaloes 28.8 days (6). The time required for complete involution as 27.5 ± 8.3 days in Nili-Ravi buffaloes as reported (Chaudhry *et al.*,1987.), which was not significantly affected by lactation number. It was recorded 32.9 ± 8.2 days for uterine involution in Srilankan buffaloes based on rectal palpation (Pereraet *al.*, 1987) which was generally delayed with increase in parity, whereas in Kundhi / Murrah buffaloes, the value was 38.4 ± 2.46 days (Samoet *al.*,1987.), 35 days (Dhanani *et al.*,1988.), 39.50 ± 2.74 and 32.50 ± 3.01 days for winter and summer calved Murrah buffaloes (1) and average uterine involution period in fertile and infertile Surti buffaloes as 23.61 ± 0.78 and 24.75 ± 1.27 days (Shah, 1999). Through Ultrasonographic studies conducted on eight Murrah buffaloes It was reported that the mean size of horn and cervix decreased significantly to 4.09 ± 0.09 and 3.56 ± 0.08 cm by day 27 postpartum, respectively, as compared to values on day six (9.07 ± 0.74 and 8.58 ± 0.00 cm). (Lohanet *al.*,2004).

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MATERIALS AND METHODS

A total of 29 suckled postpartum Mehsani buffaloes of the farm in healthy state from the day of calving till 60 days post-breeding were utilized for the present study. All buffaloes had normal calving. All buffaloes of different experimental groups were examined for reproductive rhythm at 10-days interval from the day of calving to evaluate the uterine involution and resumption of ovarian cyclicity. A total of 19 buffaloes at day 35th postpartum were injected i/m with 0.02 mg (5 ml) Buserelin acetate (GnRH analogue, Receptal, Intervet India Pvt. Ltd.), a synthetic gonadotrophin releasing hormone and were examined for their ovarian and uterine status on 35th and on 42nd day. They were monitored for signs of induced oestrus and fertility. The animals, which failed to exhibit oestrus signs post-treatment, were considered to be non-responsive to the drug. The animals exhibiting normal oestrus were bred by natural

service. Among the non-respondents a second dose of GnRH was given at 45th day postpartum and were served naturally upon oestrus detection. Pregnancy was confirmed on 45th day post-breeding. Group-2: Control Group Ten animals, which were not given any treatment but were followed to know the reproductive status and bred at natural oestrus served at controls. Uterus and cervix were considered completely involuted when they returned to their normal size, tone and location in pelvic cavity. Measurements were taken by using palm and a centimeter scale following transrectal palpation of the reproductive tract and the findings were recorded /classified as follows:

1. Cervical diameter and length (cm)
2. Location of the uterus (entirely within the pelvis, or over the pelvic brim but completely palpable after retraction, or over the pelvic brim and not completely palpable)
3. Diameter and length of the (larger) uterine horn (in cm)
4. Symmetry of the uterine horns (yes or no)
5. Texture of uterine wall (thin or thick)
6. Palpable uterine lumen (yes or no)
7. Dominant palpable ovarian structure [corpus luteum (CL), follicle, cyst (>2.5 cm in diameter), or no palpable structures. When more than one structure was present, the order of dominance was cyst, CL, then follicle].

The days of gross uterine and cervical involution were estimated by subtracting two days from the day of palpation at which uterus and cervix were completely involuted.

RESULTS AND DISCUSSION

At day 7 postpartum the uterus was within the abdominal cavity and was felt like a flabby sac. It was over the brim and could be covered within the abdomen by hand and palm completely at an average of 9.53 ± 0.20 days. On 15th day, in 12 out of all 29 animals (41.38%), uterus was over the brim and completely palpable after retraction, whereas at an average of 18.40 ± 0.62 days it was possible to palpate the same in all animals under study as shown in the following Table.

Groups	OBNCP (days)	OBHPCP-Abdomen (days)	OBCP Retraction (days)	Entirely within Pelvis (days)
Treatment (n=19)	7.00	9.65 ± 0.26	19.35 ± 0.69*	23.50 ± 0.63
Control (n=10)	7.00	9.30 ± 0.30	16.50 ± 1.07	21.70 ± 0.73
Overall (n=29)	7.00	9.53 ± 0.20	18.40 ± 0.62	22.90 ± 0.50

* ($P < 0.05$). OBNCP: Uterus over the brim and not completely palpable OBHPCP-Abdomen: Uterus over the brim & covered by hand and palm completely within the abdomen OBCP-Retraction: Uterus over the brim and completely palpable after retraction in the pelvis

The uterus was entirely within the pelvis in 25 out of 29 (86.21%) buffaloes at day 25th postpartum and it took an average of 22.90 ± 0.50 days for all the 29 animals. Days at which uterus was entirely in the pelvis did not differ significantly in treatment and control groups of buffaloes, being 23.50 ± 0.63 and 21.70 ± 0.73 days, respectively. But the days when uterus was over the brim and completely palpable after retraction in the pelvis differed significantly ($P < 0.05$) being 19.35 ± 0.69 and 16.50 ± 1.07 days in treatment and control groups, respectively.

Overall gross uterine involution was found to occur by 23 to 31 days with an average of 27.80 ± 0.46 days (Table 1). In all the buffaloes, the size of uterus decreased slowly during the first week postpartum and there was a marked decrease in the uterine size between days 7 to 15 postpartum. These findings are in close agreement with those for Murrah buffaloes (Bhalla *et al.*,1966 ; Jainudeen*et al.*,1983) and for suckled swamp buffaloes (28 ± 6 days) (Pereraet *al.*, 1987). However, it was observed as 24.75 ± 1.27 and 31.12 ± 0.93 days in Surti buffaloes, respectively (Shah, 1999 ; Khasatiya, 2003).

An interval of 33 to 68 days was recorded for uterine involution in Murrah and Nili-Ravi buffaloes (Chauhan *et al.*,1977) and it was delayed with increasing lactation number. However, on the basis of rectal palpation the time required for complete involution was reported as 27.5 ± 8.3 days in Nili-Ravi buffaloes (Chaudhry *et al.*,1987), which was not significantly affected by lactation number. Further little longer interval of 35 to 39 days has been reported in Kundhi buffaloes (Dhanani *et al.*,1988 ; Samo *et al.*,1987) and in winter calved Murrah buffaloes (Bahga and

Table 1 Comparison of gross uterine involution measurements (cm) in different groups of buffaloes (Mean ± SE)

Days Postpartum	Organ Measurement (cm)	Treatment (n=19)	Control (n=10)	Overall (n=29)
7	Cervix length	17.40 ± 0.17	17.80 ± 0.36	17.50 ± 0.17
	Cervix diameter	7.30 ± 0.30 [a]	8.50 ± 0.40 [b]	7.69 ± 0.29
15	Cervix length	12.60 ± 0.32 [a]	10.70 ± 0.62 [b]	12.00 ± 0.34
	Cervix diameter	6.10 ± 0.20	6.20 ± 0.30	6.10 ± 0.14
	Uterus length	24.60 ± 1.28	21.40 ± 1.86	23.50 ± 1.08
	Uterus diameter	7.58 ± 0.48	5.90 ± 0.57	7.00 ± 0.39
25	Cervix length	7.20 ± 0.20	6.90 ± 0.20	7.07 ± 0.16
	Cervix diameter	3.45 ± 0.18	3.00 ± 0.33	3.29 ± 0.17
	Uterus length	13.40 ± 0.59 [a]	9.50 ± 0.87 [b]	12.00 ± 0.59
	Uterus diameter	4.00 ± 0.20	3.20 ± 0.40	3.72 ± 0.21
35	Cervix length	6.79 ± 0.22	6.80 ± 0.20	6.80 ± 0.20
	Cervix diameter	2.70 ± 0.20	2.40 ± 0.20	2.57 ± 0.12
	Uterus length	10.8 ± 0.43 [a]	8.30 ± 0.62 [b]	9.90 ± 0.40
	Uterus diameter	2.40 ± 0.20	2.40 ± 0.20	2.40 ± 0.11
Gross Involution (days)		28.60 ± 0.43 [a]	26.30 ± 0.90 [b]	27.80 ± 0.46
First Expressed Heat (days)		55.40 ± 6.32	43.10 ± 7.02	51.17 ± 4.85

n = number of animals; Means carrying different superscripts within a row differ significantly (P<0.05) between groups.

Gangwar, 1988) as 35.80 ± 0.63 days in cows (Sheshappa*et al.*, 2002.) and as 40 days in crossbred cows (Sinha *et al.*, 2002). This variation observed by different workers could be attributed to the breed of animals, effect of suckling or nonsuckling, season of calving, nutritional status and endocrine balance. In the present study, it seems that the season of calving and suckling enhanced the rate of uterine involution.

In the present study, control group of buffaloes were found to have gross uterine involution significantly ($P < 0.05$) earlier at 26.30 ± 0.90 days as compared to 28.60 ± 0.44 days for the treatment group (Table 1). The time taken for involution in the buffaloes that took more than 90 days for conception (MT 90) was also non-significantly higher than the buffaloes conceiving within 90 days (LT 90) postpartum in both treatment and control groups. However, it was observed significantly ($P < 0.05$) earlier (26.13 ± 1.13 days) in LT 90 buffaloes of control than the MT 90 buffaloes of treatment group (29.10 ± 0.74 days) (Table 2).

The uterine lengths were significantly higher ($P < 0.01$) on days 25th and 35th in buffaloes of treatment group (13.40 ± 0.59 and 10.80 ± 0.43 cm) as compared to buffaloes of control group (9.50 ± 0.87 and 8.30 ± 0.62 cm, respectively). While, on 35th day postpartum both the treatment and control group of buffaloes did not differ for the uterine diameter, cervix diameter and cervix length (Table 1). Twelve buffaloes of the treatment group conceiving within 90 days (LT 90) also had significantly higher values on 25th ($P < 0.05$) and 35th ($P < 0.01$) day for the uterine lengths as compared to LT 90 of control group (Table 2).

In the present study, the average rate of involution for the length of gravid uterus was more rapid during 7 to 15 days. On the basis of internal measurements of the involuting genitalia, it was measured to be 1.13 cm / day between 15 to 25 days which was almost 3.76 times speedier than the involution rate of 0.3 cm/day during days 25 to 35. Whereas, the average rate of involution for uterine diameter was almost twice during 15 to 25 days (0.32 cm / day) as compared to that during 25 to 32 days (0.16 cm / day). The average rate of involution in the length of cervix was 19.73 times and 12.89 times higher between days 7 to 15 (0.75 cm/day) and 15 to 25 (0.49 cm/day), respectively, as compared to the same during the 25 to 32 days (0.04 cm/day). It was 1.5 times higher during 7 to 15 days as compared to 15 to 25 days. Involution of cervix diameter occurred at the rate of 0.23, 0.28, 0.09 cm per day during 7 to 15, 15 to 25 and 25 to 32 days, respectively. Involution of cervix diameter was 2.5 and 3 times higher during 7 to 15

Table 2 Gross uterine involution measurements (Mean ± SE cm) in the buffaloes conceiving at more than 90 days (MT 90) and less than 90 days (LT 90) postpartum in different groups

Days Postpartum	Organ Measurement	Organ Measurement		Organ Measurement	
		LT 90 (n=12)	MT 90 (n=7)	LT 90 (n=8)	MT 90 (n=2)
7	Cervix length	17.50 ± 0.19	17.10 ± 0.34	17.8 ± 0.45	18.00 ± 0.00
	Cervix diameter	7.50 ± 0.45^{a}	6.86 ± 0.55^{ab}	8.13 ± 0.40^{ab}	10.00 ± 0.00^{b}
15	Cervix length	13.00 ± 0.40^{a}	13.00 ± 0.60^{ab}	11.00 ± 0.70^{b}	10.00 ± 1.00^{b}
	Cervix diameter	6.00 ± 0.21^{ab}	6.14 ± 0.26^{ab}	6.50 ± 0.19^{a}	5.00 ± 1.00^{b}
	Uterus length	24.00 ± 1.60	25.00 ± 2.20	23.00 ± 2.00	16.00 ± 2.00
	Uterus diameter	7.30 ± 0.60	8.00 ± 0.70	6.30 ± 0.60	4.50 ± 1.50
25	Cervix length	7.50 ± 0.29	6.57 ± 0.30	6.75 ± 0.16	7.50 ± 0.50
	Cervix diameter	3.42 ± 0.24	3.50 ± 0.31	2.88 ± 0.39	3.50 ± 0.50
	Uterus length	13.00 ± 0.82^{a}	14.00 ± 0.82^{a}	9.50 ± 1.00^{b}	9.50 ± 2.5^{ab}
	Uterus diameter	3.96 ± 0.36^{ab}	4.14 ± 0.26^{a}	3.00 ± 0.38^{b}	3.75 ± 1.25^{b}
35	Cervix length	6.958 ± 0.28	6.50 ± 0.36	6.63 ± 0.18	7.50 ± 0.50
	Cervix diameter	2.75 ± 0.18	2.57 ± 0.30	2.25 ± 0.13	2.75 ± 0.75
	Uterus length	10.83 ± 0.59^{a}	10.71 ± 0.64^{a}	8.13 ± 0.67^{b}	9.00 ± 2.00^{ab}
	Uterus diameter	2.50 ± 0.18	2.21 ± 0.26	2.38 ± 0.18	2.50 ± 0.50
Gross Involution (days)		28.25 ± 0.55^{ab}	29.10 ± 0.74^{a}	26.10 ± 1.12^{b}	27.00 ± 0.00^{ab}
First Expressed Heat (days)		48.42 ± 4.73^{a}	73.10 ± 13.00^{b}	42.25 ± 6.07^{a}	56.50 ± 28.00^{ab}

n = number of animals; Means carrying different superscripts within a row differ significantly ($P<0.05$) from one another.

and 15 to 25 days as compared to the same during 25 to 32 days, respectively.

On 7th day postpartum, the cervix diameter in the buffaloes of control group (8.50 ± 0.40 cm) was significantly ($P < 0.05$) larger as compared to treatment group (7.30 ± 0.30 cm), but the differences were not significant on day 15th, 25th and 35th postpartum between these groups (Table 1). While the 12.60 ± 0.32 cm length of the cervix in treatment group was significantly ($P < 0.01$) higher than that of 10.70 ± 0.62 cm in the control on day 15th whereas, it had non-significant differences at all other days of palpation. Moreover, there was no significant difference in the cervix length or diameter at different intervals postpartum in buffaloes conceiving and not conceiving within 90 days postpartum in either treatment or control group (Table 2). Using ultrasonography in Murrah buffaloes, the mean size of horn and cervix was recorded on day six (9.07 ± 0.74 and 8.58 ± 0.00 cm) and it decreased significantly to 4.09 ± 0.09 and 3.56 ± 0.08 cm by day 27 postpartum, respectively. (Lohan*et al.*, 2004). Early postpartum factors that influence cervix involution rate (CIR), but not uterine body involution rate (UBIR), may also influence the onset of ovarian activity. Afterwards, ovarian activity influences similarly both CIR and UBIR. (Marques and Horta 1987).

CONCLUSION

Overall findings in the study suggest that control group of buffaloes had gross uterine involution faster, and among the treated buffaloes those, which had comparatively similar involution rate responded better to the GnRH at 35th day postpartum. Non-significantly earlier uterine involution was associated with the early behavioural oestrus and conception within the treatment and control groups.

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Feeding practices followed by the poultry farmers of Banaskantha district of Gujarat state

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ABSTRACT

The results of the study conducted in Banaskantha district of Gujarat state with a sample size of 70 poultry farmers showed that maximum (68.58 %) number of respondents had medium level of adoption of scientific feeding management practice followed by 17.14 and 14.29 per cent respondents with high and low level of adoption respectively.

Key words : Poultry farmer, feeding practices

Feed represents about 70 per cent of the total cost of poultry production. Even minute saving of feed per bird can save good amount of money particularly in larger farm. Therefore, efficiency in feeding is one of the key factors for successful poultry production. Very few poultry farmers devote a comparable proportion of their managerial time to ensure that the feed supplies and feed intake by the birds are satisfactory. With proper management of finance and resources, poultry can give the needed momentum and direction to the aspirations of the large majority of people for better quality of life. The economic ability of the poultry unit mainly depends on the production and productivity of the birds for which the farmers should adopt scientific techniques. Hence this study was undertaken to analyse the level of adoption and the possible factors contributing for the same.

MATERIALS AND METHODS

A study was conducted in Banaskantha district of North Gujarat region. A sample size of 70 poultry farmers was selected based on the Purposive random Sampling Technique. A questionnaire containing 13 questions related to the feeding practice was prepared. The adoption level of poultry farming practices by the respondents were calculated based on the adoption score obtained by the individual on feeding practices for the study having 13 sub-practices.

On the basis of score obtained by the respondents the Adoption quotient was calculated for each respondent using mean and standard deviation (Sengupta, 1967). Based on the Adoption quotient, respondents were classified into three levels of categories *viz.*, High, Medium and Lower of Adoption.

RESULTS AND DISCUSSION

It is evident from the Table 1 that the 100 % respondents were found to provide mash feed, calculation of FCR, had provide the optimum feeding space to the birds and purchase of feed at short interval of time (fresh feed). These poultry farmers actually do not purchase the feed but the traders supply them. The results are in agreement with the suggestion of Kalita (1994). Purchase of fresh feed at a short interval is preferred in poultry farming to avoid fungal infection.

It was found that 61.43 and 38.57 per cent respondents feed birds once or twice a day respectively. Generally twice a day feeding is preferred to avoid wastage. This is affected by quantity of feed filled in feeder. It was found that 17.14 and 21.43 per cent respondents fill feeder one third and one half respectively. While 61.43 per cent respondents fill the feeder fully.

To avoid selective feeding in birds and also keeping in

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Table 1 Adoption of Scientific Poultry Farming related to Feeding (N = 70)

Sr. No.	Particulars	Total no. of Poultry Farmers (Frequency)	Per Cent
1.	Type of feed.		
	i. Mash	70	100.00
	ii. Grain / Pelleted	00	00.00
2.	Frequency of feeding		
	i. Once	43	61.43
	ii. Twice	27	38.57
3.	Quantity of feed filled in feeder		
	i. One third	12	17.14
	ii. One half	15	21.43
	iii. Full	43	61.43
4.	Frequency of feed stirring per day		
	i. No stirring	29	41.43
	ii. Once	28	40.00
	iii. Twice	13	18.57
5.	Method of feed shifting practice		
	i. Sudden	58	82.86
	ii. Gradually	12	17.14
6.	Knowledge of feed nutritive value		
	i. By name	65	92.86
	ii. By protein / energy value	05	07.14
7.	Observation of feed wastage		
	i. Yes	12	17.14
	ii. No	58	82.86
8.	Frequency of feed purchase		
	i. 7 to 10 days	70	100.00
	ii. 14 days	00	00.00
9.	Provision of store room		
	i. Yes	51	72.86
	ii. No	19	27.14
10.	Calculation of feed consumption per batch		
	i. Yes	70	100.00
	ii. No	00	00.00,
11.	Calculation of FCR		
	i. Yes	60	85.71
	ii. No	10	14.29
12.	Care for leftover		
	i. Mix with new feed	60	85.71
	ii. Mix with cattle feed	10	14.29
	iii. Through away	00	00.00
13.	Feed space per bird		
	i. Optimum	70	100.00
	ii. Less space	00	00.00

view the facts that minerals and vitamins are powdery and heavier, tend to settle down to the bottom of feeder. Stirring of feed at least once a day promotes proper utilization of minerals and vitamins in feed and reduces the selective feeding preferably by the stronger birds. The results revealed that 58.57 per cent of respondents were aware of the knowledge and were stirring the feed once or twice a day.

It was found that majority of poultry farmers (82.86 %) practice sudden shifting of feed from broiler starter to broiler finisher. While only 17.14 per cent respondents gradually shift over from one type of feed to another one. The results are not in agreement with the suggestions of Kalita (1994). Gradual Change over is preferred to minimize the stress level in birds due to sudden change in plain of Nutrition.

It was found that majority of respondents (92.86 %) were knowing the feed by name only. (Broiler mash, Starter, Finisher). While only 7.14 per cent respondent knew well aware of the protein and energy value of different types of feed they used. This indicates that for nutrition and feeding of birds, technical knowledge input is comparatively very poor.

It was found that 17.14 per cent respondent observe for feed wastage. While majority of respondents (82.86 %) do not paid much attention towards this vital components of poultry farming. This was might be due to lack of knowledge. It is essential to observe the feed wastage, even a minute feed saving can save to a bigger total in large flock size. The results are not in agreement with the suggestions of Kalita (1994). This might be due to lack of knowledge.

It was found that majority of poultry farms (72.86 %) were provided with storeroom facility for feed storage. The results are in accordance with the suggestion of Kalita (1994) that feed bags should be stored in good dry place of a godown prevented from rain water, dampness, insects, rats or free flying birds. Otherwise improper storage can cause degradation of feed quality, encourage mould growth and insect damage. 27.14 per cent of poultry farms do not have facility for feed storage. They store the feed either in corner of poultry house or in their resident.

It was found that all the farmers were found to calculate feed consumption per batch. About 85.71 per cent of farmers were found to calculate FCR. The results are in accordance with the suggestion of Kalita (1994). It was found that majority of poultry farmers (85.71 %) mix the left over feed to the feed of finisher feed of the next flock. 14.29 per cent respondents mix the left over feed with the cattle feed of animal.

It was found that all the poultry farmers were providing optimum feed space per bird. The results are in agreement with the suggestions of Hasnat Ahmed *et al.*, (1991) and Kalita (1994).

Relationship between the Characteristics of poultry farmers and extent of adoption

To study the relationship between the characteristics of poultry farmers and extent of adoption, the data were tested by calculating correlation co-efficient (r) and the results are presented in Table 2.

Out of five characteristics studied, the variables age, education, flock size and land holding had non-significant relationship with extent of adoption of poultry practices. These findings are not in agreement with those of Mathiyalagan and Subramanian (1995). Tie-up arrangement of poultry farmers and middlemen might be the cause for this result.

Income was found to have positive significant relationship with the relationship with extent of adoption of poultry practices. A sound economical condition probably minimizes the risk factor and also in adopting the new technologies.

Table 2 Relationship between Characteristic of poultry farmers and their adoption of Recommended poultry practices

Sr.No.	Independent Variable	Correlation co-efficient
1.	Age	0.1887^{NS}
2.	Education	$+ 0.09029^{NS}$
3.	Flock size	0.05568^{NS}
4.	Land Holding	0.6120^{NS}
5.	Income	0.2456^{*}

* Significant at 5 per cent level. NS = Non-significant

CONCLUSION

The majority of poultry farmers were found to provide mash feed, calculation of FCR, had provide the optimum feeding space to the birds, purchase of feed at short interval of time (fresh feed), practice sudden shifting of feed from broiler starter to broiler finisher, knowing the feed by name only. (Broiler mash, Starter, Finisher), having the facility of storeroom for feed

storage, calculate feed consumption per batch and FCR and providing optimum feed space per bird. Out of five characteristics studied, the variables age, education, flock size and land holding had non-significant relationship with extent of adoption of poultry practices and Income was found to have positive significant relationship with the relationship with extent of adoption of poultry practices. A sound economical condition probably minimizes the risk factor and also in adopting the new technologies.

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