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Genetic analysis for seed yield and its related parameters in Fieldpea (*Pisum sativum* L. var *arvense*)

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ABSTRACT

Combining ability analysis was carried out in 8x8 parental diallel progenies for seed yield and its related traits in Fieldpea. General combining ability and specific combining ability variances were highly significant for all the characters indicated that both additive and non-additive gene effects involved in the inheritance of the characters under study. The ratio of GCA & SCA genetic variance showed predominance of non-additive gene action for the expression of all the traits. An overall consideration of gca effects indicated that the parents DF-1, ADARSH and PRAKASH appeared to be good general combiners for seed yield per plant and harvest index. For seed yield per plant, the crosses PRAKASH X IPFD 10-13, ADARSH X APARNA and VIKAS X IPFD 10-13 recorded the highest sca effects.

Key words : Diallel, combining ability, GCA, SCA, fieldpea

Pulses occupy an important place in meeting the protein needs of people in the developing countries. Pulses are essential supplement to cereal based diet in India. The development of high-yielding varieties through hybridization requires knowledge of combining ability of the parents, particularly information on the nature and magnitude of gene effects controlling quantitative traits. For improving the genetic yield potential of the varieties and hybrids, choice of right type of parents for hybridization is important. This emphasizes the importance of testing the parents for their combining ability and their hybrids for manifestation of hybrid vigour. In self-fertilized crops where utilization of heterosis at commercial level is not realistic, the breeder will primarily be interested in higher magnitude of additive genetic variance for establishing superior genotypes. This analysis is a powerful tool to discriminate good as well as poor combiners and choose appropriate parental material in breeding programme. (Patil and Shete, 1986).

The present investigation aims at identification of superior parents, cross combinations and evaluation

of type of gene action for seed yield and its component traits.

MATERIALS AND METHODS

The eight diverse parental genotypes of Fieldpea viz., DF-1, KPMR 400, VIKAS, PRAKASH, ADARSH, IPFD 10-13, NDP-1 and APARNA were selected from germplasm maintained at Centre of Excellence for Research on pulses, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District: Banaskantha, during *rabi*, 2012-13 to create a diallel set. The complete set of 36 genotypes (8 parents + 28 hybrids) were evaluated in Randomized Block Design (RBD) with three replications. The observations were recorded both as visual assessment (days to flowering, days to maturity) and measurement on randomly selected five competitive individual plants (plant height, number of primary branches per plant, number of pods per plant, number of seeds per pod, seed yield per plant (g), test weight (g), protein content (%) and harvest index (%). All recommended agronomic practices along with plant protection measures were followed. Combining ability analysis was carried out according to the procedure given by Griffing (1956) as per Method 2 and Model I.

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RESULTS AND DISCUSSION

Analysis of variance for combining ability (Table 1) showed that general and specific combining ability variances were highly significant for all the characters suggested importance of both additive and non-additive type of gene actions in the inheritance of characters. The ratio of $gca : sca$ variance (σ^2gca/σ^2sca) was less than unity for all the characters under study. This indicated that non-additive type of gene action was primarily involved in the expression of these characters. Similar results were also reported by Dagla *et al.* (2013), Esposito *et al.* (2013), Kosev *et al.* (2013), Rebica *et al.* (2013) and Singh *et al.* (2013). The presence of predominantly large amount of non-additive gene action would be necessitate the maintenance of heterozygosity in the population.

The parent DF-1 ranked first as it was good general combiner for all the characters except plant height. The parent ADARSH was good combiner for days to maturity, number of pods per plant, number of seeds per pod, number of primary branches, seed yield, test weight, protein content and harvest index. The parent PRAKASH had good combiner for plant height, number of pods per plant, number of seeds per pod, number of primary branches, seed yield and harvest index. The parent NDP-1 was found to be good general combiner for number of pods per plant, seed yield per plant and protein content (Table 2).

Three best crosses selected on the basis of sca effects for each of the characters are presented in Table 3. A perusal of data revealed that none of the crosses had high ranking sca effects for all the characters. The sca for most of the characters were accompanied by top ranking *per se* performance also indicated predominant role of non-additive gene effects in expression of seed yield and its components. For seed yield per plant, it was observed that the crosses PRAKASH X IPFD 10-13, ADARSH X APARNA, VIKAS X IPFD 10-13 and VIKAS X ADARSH expressed top ranking sca effects for seed yield per plant had also top ranking in *per se* performance and they involved good x poor, good x poor, poor x poor and poor x good gca of the parents, respectively. The cross IPFD 10-13 X APARNA expressed the highest sca effects for seed protein (Table 3).

These crosses may be need for further improvement of genotype by utilizing biparental matting design to get superior transgressive segregates from advance generation in future.

Table 1 Analysis of variance for combining ability for various characters in Fieldpea

Source of variation	d.f.	Days to flowering	Days to maturity	Plant height	Number of primary branches per plant	Number of pods per plant	Number of seeds per pod	Seed yield per plant	Test weight	Protein content	Harvest index
GCA	7	39.39 **	73.03 **	4940.4 **	1.12 **	245.09 **	1.01 **	129.17 **	2.54 **	0.85 **	178.85 **
SCA	28	15.82 **	25.64 **	1103.8 **	0.34 **	157.04 **	1.53 **	74.53 **	2.60 **	0.92 **	92.01 **
Error	70	1.08	4.45	23.12	0.02	3.75	0.06	1.64	0.16	0.05	2.50
σ^2gca		3.83	6.85	491.72	0.11	24.13	0.09	12.75	0.23	0.07	17.63
σ^2sca		14.73	21.19	1080.71	0.32	153.28	1.47	72.88	2.44	0.86	89.51
σ^2gca/σ^2sca		0.26	0.32	0.45	0.34	0.15	0.06	0.17	0.09	0.09	0.19

* and ** indicates significant at P = 0.05 and P = 0.01 levels, respectively.

Table 2 Estimation of general combining ability (GCA) effects associated with each parental genotype in Fieldpea

Parents	Days to flowering	Days to maturity	Plant height	Number of primary branches per plant	Number of pods per plant	Number of seeds per pod	Seed yield per plant	Test weight	Protein content	Harvest index
DF-1	-3.30**	-4.37**	4.85**	0.36**	3.60**	0.46**	4.54**	0.27*	0.34**	7.63**
KPMR 400	0.56	1.92**	-16.58**	-0.30**	-4.44**	-0.38**	-2.44**	-0.00	-0.09	-2.92**
VIKAS	-1.10 **	-0.34	-23.40 **	-0.06	-1.30 *	-0.28**	-0.64	0.58**	0.17 *	0.18
PRAKASH	0.96 **	0.99	-8.72 **	0.40**	7.55**	0.38**	2.85**	-0.00	-0.48**	1.22 *
ADARSH	-0.53	-1.87 **	37.57 **	0.37**	3.18**	0.22**	3.81**	0.72**	-0.13	4.05**
IPFD 10-13	-0.46	-1.00	5.32**	-0.40**	-6.80**	-0.08	-4.62**	-0.57**	0.23 **	-4.79**
NDP-1	0.16	-0.07	23.87 **	-0.07	2.42**	-0.22**	0.81 *	-0.43**	0.23 **	-1.50 **
APARNA	3.70 **	4.75**	-22.91**	-0.28**	-4.21**	-0.1	-4.31**	-0.56**	-0.27**	-3.88**
S.E. ₍₉₎ ±	0.30	0.62	1.42	0.04	0.57	0.07	0.37	0.11	0.07	0.46

* and ** indicates significant at P = 0.05 and P = 0.01 levels, respectively.

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Table 3 Sca effects of three best crosses along with per se performance and gca combination for each traits in Fieldpea

Characters	Per se performance		Mean of Hybrids	Combining ability analysis		
	Parents	Hybrids		Hybrids	SCA effects	GCA of the parents
Days to flowering	KPMR 400 ADARSH NDP-1	DF-1 X VIKAS DF-1 X ADARSH DF-1 X NDP-1	51.33 52.00 56.33	DF-1 X VIKAS DF-1 X ADARSH VIKAS X IPFD 10-13	6.71** 6.61** 4.54**	GXG GXA GXA
Days to maturity	ADARSH IPFD 10-13 PRAKASH	DF-1 X ADARSH DF-1 X VIKAS VIKAS X IPFD 10-13	98.67 100.33 105.33	DF-1 X ADARSH DF-1 X VIKAS VIKAS X IPFD 10-13	7.42** 7.29** 5.65**	GXG GXA AXA
Plant height (cm)	APARNA VIKAS KPMR 400	KPMR 400 X IPFD 10-13 VIKAS X APARNA VIKAS X IPFD 10-13	19.40 60.65 72.07	KPMR 400 X IPFD 10-13 PRAKASH X NDP-1 KPMR 400 X NDP-1	78.39** 63.55** 44.27**	GXP GXP GXP
Number of primary branches per plant	ADARSH DF-1 KPMR 400	ADARSH X APARNA PRAKASH X IPFD 10-13 VIKAS X ADARSH	4.47 4.37 4.27	ADARSH X APARNA PRAKASH X IPFD 10-13 VIKAS X ADARSH	1.13** 1.11** 0.70**	GXP GXP PXG
Number of pods per plant	NDP-1 VIKAS PRAKASH	ADARSH X APARNA PRAKASH X IPFD 10-13 VIKAS X ADARSH	60.89 59.00 58.28	ADARSH X APARNA PRAKASH X IPFD 10-13 VIKAS X IPFD 10-13	20.51** 16.83** 14.99**	GXP GXP GXP
Number of seeds per pod	DF-1 ADARSH PRAKASH	ADARSH X APARNA DF-1 X ADARSH DF-1 X PRAKASH	7.51 6.23 6.90	ADARSH X APARNA NDP-1 X APARNA KPMR 400 X PRAKASH	2.10** 1.27** 1.62**	GXP PXP PXG
Seed yield per plant (g)	NDP-1 DF-1 VIKAS	ADARSH X APARNA PRAKASH X IPFD 10-13 VIKAS X ADARSH	36.01 36.04 28.90	PRAKASH X IPFD 10-13 ADARSH X APARNA VIKAS X IPFD 10-13	14.74** 14.41** 11.13**	GXP GXP PXP
Test weight (g)	VIKAS KPMR 400 ADARSH	ADARSH X APARNA DF-1 X VIKAS KPMR 400 X ADARSH	22.32 21.32 21.27	ADARSH X APARNA PRAKASH X IPFD 10-13 VIKAS X IPFD 10-13	2.90** 2.64** 2.00**	GXP PXP GXP
Protein content (%)	IPFD 10-13 DF-1 VIKAS	IPFD 10-13 X APARNA DF-1 X VIKAS KPMR 400 X ADARSH	22.44 21.50 21.88	IPFD 10-13 X APARNA KPMR 400 X ADARSH DF-1 X VIKAS	1.97** 1.22** 0.85**	GXP PXP GXG
Harvest index (%)	DF-1 VIKAS NDP-1	ADARSH X APARNA PRAKASH X IPFD 10-13 DF-1 X ADARSH	61.70 64.05 56.74	PRAKASH X IPFD 10-13 ADARSH X APARNA VIKAS X ADARSH	24.76** 23.38** 12.01**	GXP GXP AXG

G = Good; A = Average; P = Poor.

*, ** indicates significant at P = 0.05 and P = 0.01 levels, respectively.

Nitrogen and potassium requirements of processing variety of potato Kufri chipsona 3 under North Gujarat condition

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ABSTRACT

The field experiment was conducted during *rabi* season of the year 2012-13 at Potato Research Station, Sardarkrushinagar Dantiwada Agricultural University, Deesa with nine treatment combinations consisting of three levels of nitrogen viz., 225 kg N/ha, 275 kg N/ha and 325 kg N/ha and three levels of potassium viz., 225 kg K₂O/ha, 275 kg K₂O/ha and 325 kg K₂O/ha tested under factorial randomized block design with four replications. The yield of 'A' and 'B' grade tubers was increased upto 275 kg N/ha. nitrogen levels brought significant variation in chips colour index and content of reducing sugar. In case of Potassium, Potassium levels 325 kg K₂O/ha and 275 kg K₂O/ha behaved equally and produced significantly higher weight of 'A' and 'B' grade tuber with minimum weight of 'C' grade tubers. Maximum reducing sugar content and chips color index score were observed with the application of 325 kg K₂O/ha however increase was upto 275 kg K₂O/ha. Thus, for getting higher production of processing grade tuber yield and net realization, potato cv., Kufri Chipsona 3 should be fertilized with 275 kg N/ha and 275 kg K₂O/ha.

Key words : Potato, processing, nitrogen, potassium, tuber yield, chips colour

Increasing trends in potato production cannot be sustained without diversification in its utilization. Potato processing industry therefore has to be essential to sustain present growth rate. Potato grown in cooler North-Western plains have lower dry matter and high reducing sugar reflecting products, hence unfit for processing. In Gujarat warm dry and mild night temperature during the crop season favours for production of high dry matter and accumulation of low sugars. Therefore, the region is ideal for potato processing. This could help in reduction of market glut at peak season of harvest. Thus, commercialization of agriculture and stress on value addition through processing, have led to evaluate the newly released processing varieties for their chips quality and yield under Gujarat condition.

Hence a study was undertaken to standardize the nitrogen and potassium requirements of chipping cv

Kufri Chipsona 3 of potato for getting higher processing grade tubers yield and quality.

MATERIALS AND METHODS

The field experiment was conducted during *rabi* season of the year 2012-13 at Potato Research Station, Sardarkrushinagar Dantiwada Agricultural University, Deesa (24° 12' North latitude and 72° 12' East longitude with an elevation of 136.4 meters above the mean sea level). Nine treatment combinations consisting of three levels of nitrogen viz., N₁: 225 kg N/ha, N₂: 275 kg N/ha and N₃: 325 kg N/ha and three levels of potassium viz., K₁: 225 kg K₂O/ha, K₂: 275 kg K₂O/ha and K₃: 325 kg K₂O/ha were tested under factorial randomized block design with four replications. The soils of the experimental field was loamy sand in texture having good drainage, low in available nitrogen (192.0 kg/ha), medium in available phosphorus (26.7 kg/ha) and high in potash (346.0 kg/ha). The experimental crop cv Kufri Chipsona-3 was planted on 29th November. Potato tubers of variety Kufri

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Chipsona 3 were cut in pieces, keeping two to three eye bud with approximately 25 to 40 g weight and planted at the spacing of 50 X 20 cm spacing. Half dose of N and full dose K (As per treatments) along with full recommended dose of phosphorus (140 kg P_2O_5 /ha) were placed in bends below the seed pieces at the time of planting and remaining half dose of N was applied at earthing up 30 days after planting (DAP). Total eleven irrigations (approximately 50 mm each) were given to the experimental plot. The irrigations were discontinued one week before haulm killing. The dehaulming was done mechanically at full maturity and harvesting was done two weeks later. Tubers were graded in to three categories viz., 'A' grade (Large size, > 60 g), 'B' grade (Medium size, 20-60 g) and 'C' grade (Small size, <20 g). For determining chip colour ten tubers from each plot were washed, hand peeled and cut into 1.75 mm thick slices. Slices were washed in normal water to remove surface starch and then the slices were dried on paper towels. The dried slices were fried in edible oil at 180°C in a deep fat fryer (Moulinex make) till the bubbling stopped. The fried chips were drained to remove excess oil and then graded from 1 to 10 (1 being lightest and 10 the darkest, the chip colour grad up to 3 is considered acceptable) under the fluorescent tube light using chip colour cards (Ezekiel *et al.*, 2003). The specific gravity of potato was calculated as:

$$\text{Specific gravity of potato (g/cc)} = \frac{\text{Specific gravity of water} \times 5000}{5000 - \text{WIW}}$$

Five tubers from each plot were chopped and mixed and prepared composite mixed samples and it put into the boiling isopropyl alcohol (80 per cent v/v) in a flat bottomed flask. The samples were than boiled at 70°C for two minutes for fixing. The fixed samples were put to reflux at 70°C twice, and filtrate through Watman No. 1 filter paper. The filtrate was evaporated at 70°C to concentrate to 10 ml. The concentrated extract was diluted to 100 ml with double distilled water to make the final extract. The extract was used to determine the reducing sugar content by Nelson's method(1944).

RESULTS AND DISCUSSION

Weight of tubers grade viz., A, B and C were influenced significantly due to different nitrogen levels (Table 1). Both the higher levels of nitrogen N_2 (275 kg N/ha) and N_3 (325 kg N/ha) performed equally and

significantly the lowest value for 'A' and 'B' grade tuber yield were observed with N_1 whereas, the lowest values of 'C' grade tuber yield were beared by N_3 (325 kg N/ha)(Table 1). This indicate that curtailing of dose of up to 25 per cent optimized the nitrogen requirement to produced quality potato. This might be due to better assimilation of carbohydrate to the tubers, which ultimately helped in the enlargement of the tuber size and weight of tuber as reported by Malik *et al.*, (2002).

Nitrogen application of N_2 (275 kg N/ha) and N_3 (325 kg N/ha) realized spectacular improvement in total tubers yield of potato and increased total tubers yield to the tune of 12.99 and 13.02 per cent over N_1 (225 kg N/ha)(Table 1). Higher rate of nitrogen application provides better growth, development and translocation of photosynthesis from source to sink (tuber), which resulted in to higher yield of large size tubers, concluded by Patel and Patel (2001). These finding corroborate the reports of Singh *et al.* (2002) and Vijaya Lakshmi, *et al.* (2011). Nitrogen application @ 275 kg N/ha recorded highest gross and net realization of ₹ 289035 /ha.

Conspicuous difference in weight of different grades of tuber were observed due to potassium application (Table 1). Potassium levels K_3 (325 kg K_2O /ha) and K_2 (275 kg K_2O /ha) performed equally good and produced significantly higher weight of 'A' and 'B' grade tubers with minimum weight of 'C' grade tubers. The lowest value for 'A' and 'B' grade tuber yield were observed with K_1 (225 kg K_2O /ha) whereas, for 'C' grade tuber yield the lowest values were beared by K_3 (325 kg K_2O /ha). Potassium application @ 275 kg K_2O /ha recorded highest net realization of ₹ 279593 /ha. These finding corroborate the reports of Parveen Kumar *et al.*, (2004). Potassium promote large size tubers by increasing water accumulation in tubers (Vijya Lakshmi *et al.*, 2011).

Among the potassium levels, K_3 (325 kg K_2O /ha) and K_2 (275 kg K_2O /ha) did not differ from each other, and produced 8.61 and 8.37 per cent higher total tubers yield over K_1 (225 kg K_2O /ha) respectively (Table 1). Higher rate of potassium provides better yield attributes and translocation of photosynthesis from source to sink (tuber) which resulted in to higher yield of large size tubers. These finding corroborate the reports of Khandakhar *et al.*, (2004).

Nitrogen application did not show positive response on specific gravity of potato (Table 1). However, higher

Table 1 Grade wise total tuber yield (q/ha), net realization and quality parameters of potato as influenced by nitrogen and potassium fertilization

Treatments	Tuber yield (q/ha)				Net realization (₹ /ha)	Chips colour index (0-10 grade)	Specific gravity (gm/cc)	Reducing sugar mg/100 gm fresh wt.
	A grade	B grade	C grade	Total				
Nitrogen (Kg/ha)								
N ₁ : 225	124.06	115.30	59.74	301.85	248471	1.42	1.059	55.48
N ₂ : 275	142.14	145.38	50.74	341.09	289036	1.56	1.051	62.22
N ₃ : 325	143.29	148.61	46.48	341.17	288481	1.68	1.058	66.21
S. Em. ±	3.95	3.70	1.64	7.65		0.04	0.031	1.99
C.D. at 5%	11.53	10.80	4.78	22.32		0.13	NS	5.81
Potassium(Kg/ha)								
K ₁ : 225	126.21	126.63	54.95	310.46	253763	1.44	1.059	56.59
K ₂ : 275	140.63	139.02	53.90	336.45	279593	1.59	1.045	62.93
K ₃ : 325	142.65	143.63	48.11	337.20	278913	1.63	1.064	64.40
S. Em. ±	3.95	3.70	1.64	7.65		0.04	0.031	1.99
C.D. at 5%	11.53	10.80	4.78	22.32		0.13	NS	5.81
Interaction								
N × K	NS	NS	NS	NS		Sig	NS	NS
C.V. %	10.03	9.39	10.84	8.08		9.64	10.27	11.24

Table 2 Interaction effect of nitrogen and potassium on chips colour index potato

Nitrogen (Kg/ha)	Potassium (Kg/ha)		
	K ₁ :225	K ₂ :275	K ₃ :325
N ₁ :225	1.38	1.38	1.51
N ₂ :275	1.45	1.72	1.50
N ₃ :325	1.49	1.67	1.88
S. Em. ±	0.08		
C.D.	0.20		
C.V %	9.64		

levels of nitrogen realized spectacular improvement in reducing sugar content (4.10). Maximum content of reducing sugar was noted with N₃ (325 kg N/ha), which accounted 19.34 and 6.41 per cent higher reducing sugar content than N₂ (275 kg N/ha) and N₁ (225 kg N/ha), respectively. The score of chips colour index increased significantly as the rate of application of nitrogen increase up to N₂ (275 kg N/ha). Nitrogen N₃ (325 kg N/ha) had higher value of chips colour index, which means more darkness in chips, whereas level N₁ (225 kg N/ha) had lower colour index. This finding is well supported by Swiniarski and Ladenberger (1970).

From the data (Table 1), it appeared that reducing sugar content was linearly increased with increase in potassium level. Potassium level K₃ (325 kg K₂O/ha) and K₂ (275 kg K₂O/ha) had produced tuber having 13.80 and 11.20 per cent higher reducing sugar content than that of produced by K₁ (225 kg K₂O/ha), respectively. These finding corroborate the reports of Ackarya and Mondal (2007). Potassium levels brought significant difference in chips colour index (Table 2). The maximum and minimum score values of chips colour index were noted with K₃ (325 kg K₂O/ha) and K₁ (225 kg K₂O/ha), respectively. Potassium levels K₃ and K₂ did not differ each other and were significantly higher than K₁. These finding are well supported by Khan *et al.*, (2012).

Interaction between nitrogen and potassium levels (N×K) was found to be significant in respect of chips colour index of potato (Table 2). Chips colour index score increased with increase in N levels with correspondence increase in K₂O level. Treatment combination N₃K₃ (325 kg N/ha with 325 kg K₂O/ha) recorded significantly the highest value of chips colour index (1.88) followed by treatment N₂K₂ (1.72). These results are in accordance with those reported by Ishwori *et al.*, (2011).

CONCLUSION

Based on the results from one year experimentation it is concluded that to get higher production of processing grade tuber yield with maximum chips color index and reducing sugar content as well as net realization, potato cv., Kufri Chipsona-3 should be fertilized with 275 kg N/ha and 275 kg K₂O/ha.

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Effect of sowing dates and spacings on summer groundnut (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was conducted during summer, 2012 at Instructional Farm, Department of Agronomy, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, to study the "Effect of sowing dates and spacings on summer groundnut (*Arachis hypogaea* L.). The soil of the experimental field was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorus and potash with 7.85 soil pH. Twelve treatment combinations comprising of four levels of dates of sowing viz., 31st January, 10th February, 20th February and 1st March as a main plot treatment and three levels of spacings viz., 22.5 cm, 30.0 cm and 45.0 cm were relegated in sub plot treatment tested under split plot design with four replications. Higher plant height, number of filled pods per plants, total pods per plants and pods weight per plant as well as pod yield (2431 kg/ha) and haulm (3006 kg/ha) yield were recorded with crop sown on 20th February. With regard to spacing, crop sown with 22.5 cm spacing recorded maximum number of filled pods per plants, total pods per plants and pods weight per plant which resulted in produced significantly higher pods (2482 kg/ha) and haulm (3061 kg/ha) yield.

Key words : Sowing dates, spacing, yield, groundnut

Among oilseed crops, groundnut (*Arachis hypogaea* L.) is known as king of oilseed crops and important food legume of tropical as well as sub-tropical part of the world. In India, groundnut is principal oil seed crop, have a vital role in Indian agricultural industries and export trade with the economy of country. The proper time of sowing exerts a distinguished effect on growth and eventually on the yield of summer groundnut. Very early sowing in last week of January and delayed sowing in second week of March resulted in average yield reducing of 16.7 and 31.8 per cent, respectively, then the sowing on second week of February (Patil and Radder, 1978). Spacing related to plant density and is generally dependent upon crop variety, climate and soil fertility status. An optimum plant density is one of the important factor for increasing crop yield per hectare of groundnut. Higher plant population can be achieved by reducing the distance between two rows and also spacing provides better condition for plant growth which resulted in timely commencement

of reproductive phase and formation of more pods. Suitable plant geometry can be obtained by planting the crop at proper row spacing. Therefore, the use of proper row spacing to get appropriate plant stand is a pre-requisite for higher crop yield per unit area. In order to economize and popularize summer groundnut cultivation for such a large community, research on low cost production technology carries great importance.

MATERIALS AND METHODS

A field experiment was conducted during summer, 2012 at Department of Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, to study the "Effect of sowing dates and spacings on summer groundnut (*Arachis hypogaea* L.). The soil of the experimental field was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorus and available potash with soil pH of 7.85. Twelve treatment combinations comprising of four levels of dates of sowing viz., 31st January, 10th February, 20th February and 1st March as a main plot

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treatment and three levels of spacings viz., 22.5 cm, 30.0 cm and 45.0 cm were relegated in sub plot treatment tested under split plot design with four replications. Groundnut cultivar GG 2 were treated with biofertilizer rhizobium @ 300 g culture per 10 kg seed and sown manually.

RESULTS AND DISCUSSION

Significantly higher plant height was recorded at harvest (39.83 cm) under 20th February (D₃). The effect of dates of sowing was significant on number of filled pods per plants (16.74), total pods per plants (20.15) and pods weight per plant (9.48 g) of groundnut when crop was sown on 20th February (D₃) but number of unfilled pods per plants (3.41) was decreases at 20th February (D₃) dates of sowing (Table 1). This results are in occurrence with those reported by Rinjumoni (2000). Day to maturity (118) was significantly more due to crop sown at 31st January (D₁). Crop sown on 20th February (D₃) producing significantly higher pods (2431 kg/ha) and haulm (3006 kg/ha) yield followed by 10th February (D₂) sowing. Sowing on 20th February (D₃) produced 3.43, 7.20 and 16.02 per cent higher pod yield over D₂ (10th February), D₁ (31st January) and D₄ (1st March), respectively. Like pod yield, haulm yield was also higher with D₃ (20th February) and produced

1.88, 9.98 and 14.36 per cent higher over D₂, D₁ and D₄, respectively (Table 1). This may be due to favorable climatic condition. This is evidently due to cumulative effect of improvement in growth and yield attributes such as plant height, number of filled pods per plant and total number of pods, pods weight per plant and test weight. Similar finding were also reported by Sardana (2009), Ravisankar *et al.* (2010), Mane *et al.* (2010) and Parmar *et al.* (2011). Different dates of sowing did not showed significant effect on number of nodules per plant, weight of nodules per plant, shelling per cent, oil and protein content (Table 2). These finding are in agreement with those obtained by Patel *et al.* (1998).

The number of filled pods per plants (16.37), total pods per plants (20.01) and pods weight per plant (9.41 g) was significantly higher when crop was sown with 22.5 cm (S₁) spacing (Table 1). The increase in row spacing significantly decreases the pods yield of summer groundnut. Among the treatments, S₁ (22.5 cm) recorded higher pods yield (2482 kg/ha), which accounted 10.53 and 16.52 per cent higher over treatments S₂ (30 cm) and S₃ (45 cm), respectively (Table 1). The increase in pods yield might be due to increased sink capacity and better

Table 1 Growth, yield attributes and yield of summer groundnut as influenced by sowing dates and spacings.

Treatments	Plant height (cm)	Number of branches per plant	No. of filled pods per plant	No. of unfilled pods per plant	Total pods per plant	Pods weight per plant (g)	Days to maturity	Pods yield (kg/ha)	Haulm yield (kg/ha)
Dates of sowing									
31 st January	35.12	3.73	15.49	3.53	19.02	8.75	118	2268	2733
10 th February	38.63	3.76	16.36	3.42	19.78	8.89	115	2351	2950
20 th February	39.83	3.90	16.74	3.41	20.15	9.48	112	2431	3006
1 st March	35.98	3.64	14.32	3.95	18.27	8.30	110	2095	2628
S. Em. ±	1.08	0.11	0.40	0.07	0.41	0.22	1.4	65	83
C.D. at 5%	3.47	NS	1.29	0.22	1.30	0.69	4.4	209	267
C.V. %	10.05	9.70	8.86	6.73	7.29	8.43	4.2	9.88	10.0
Spacings									
22.5 cm	38.14	3.86	16.37	3.64	20.01	9.41	115	2482	3061
30.0 cm	37.58	3.79	15.84	3.56	19.40	8.83	113	2246	2789
45.0 cm	36.45	3.63	14.98	3.54	18.52	8.33	113	2130	2638
S. Em. ±	0.76	0.08	0.24	0.05	0.25	0.13	0.8	51.7	51.8
C.D. at 5%	NS	NS	0.69	NS	0.73	0.39	NS	139	151
Intreccion(DxS)	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	8.16	8.16	5.99	5.33	5.17	6.05	2.9	8.34	7.32

Table 2 Biological study, Quality and Economics of summer groundnut as influenced by sowing dates and spacings.

Treatments	No. of nodules per plant	Weight of nodules per plant (g)	Shelling (%)	Oil content (%)	Protein content (%)	Net realization (₹/ha)	BCR
Dates of sowing							
31 st January	85.67	0.16	65.08	43.57	24.43	75544	3.37
10 th February	87.83	0.17	65.25	43.59	24.47	79703	3.49
20 th February	86.67	0.17	66.33	44.49	23.93	83440	3.61
1 st March	86.42	0.16	65.00	43.91	23.83	67577	3.11
S. Em. ±	2.04	0.005	1.12	0.33	0.30	-	-
C.D. at 5%	NS	NS	NS	NS	NS	-	-
C.V. %	8.15	11.30	5.96	2.61	4.34	-	-
Spacings							
22.5 cm	83.75	0.16	65.55	43.86	23.75	-	-
30.0 cm	86.69	0.17	65.44	44.17	24.23	75252	3.40
45.0 cm	89.50	0.17	65.26	43.64	24.52	71131	3.37
S. Em. ±	1.72	0.003	0.74	0.19	0.21	-	-
C.D. at 5%	NS	NS	NS	NS	NS	-	-
Intreccion (D×S)	NS	NS	NS	NS	NS	-	-
C.V. %	7.95	8.02	4.53	1.76	3.54	-	-



availability of growth factors viz., space, light, moisture and nutrient per plant under narrow row spacing as compare to the wider row to row spacing. Significantly the lowest pods yield (2130 kg/ha) was recorded with treatment S_3 (45 cm). Higher pod yield was associated with filled pods per plant, total pods per plant and pods weight per plant. This might be due to more number of plant per unit area. Das *et al.* (1996) was obtained higher pod yield with row spacing of 20 cm than 30 cm spacing. These finding are in line with the results reported by Gunri *et al.* (2010) and Meena *et al.* (2011). Like pod yield, haulm yield also higher with S_1 (3061 kg/ha). The magnitude of increase in haulm yield under S_1 was to the tune of 9.75 and 16.01 per cent over S_2 and S_3 , respectively. Similarly higher haulm yield was associated with higher plant height and more number of branches per plant. These results are in confirmed with those reported by Das *et al.* (1996). Different spacings did not showed significant effect on number of nodules per plant, weight of nodules per plant, shelling per cent, oil and protein content (Table 2). These finding are in agreement with those obtained by Kavimani *et al.* (2002).

The economics of different factor indicated that groundnut crop when sown at 20th February (D_3)

recorded maximum net realization (Rs. 83440/ha) and BCR of 3.61 followed by 10th February (D_2). Among the different row spacing sowing at 22.5 cm (S_1) recorded maximum net realization (₹ 83315/ha) with BCR of 3.41 followed by 30 cm (S_2) with (Rs. 75252/ha) and BCR of 3.40 (Table 2).

Thus, from the present study, for securing higher pod and haulm yield, net realization and cost benefit ratio from summer groundnut GG 2 raised on loamy sand soils of North Gujarat conditions, it is advisable to sow the crop on 20th February by maintaining 22.5 cm row spacing.

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Impact of different growth regulators, chemical and wax coating on shelf-life of sapota fruits cv. 'Kalipatti'

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ABSTRACT

Studies were conducted to assess the effects of different growth regulators, chemical and wax coating to extend the shelf-life of sapota at ambient temperature. Sapota fruits were dipped in GA₃ @ 100, 200 ppm, NAA @ 100, 200 ppm and AgNO₃ @ 20, 40 ppm and then coated with wax 3 and 6 % under different treatments. Observations on various parameters were recorded at 6th, 9th, 12th and 15th days of storage period. Fruit firmness (Kgcm⁻²) was recorded at the end of the storage period. Results indicated that minimum PLW (2.64%) was recorded with treatment of AgNO₃ 40 ppm. Treatment combination of AgNO₃ 40 ppm treated fruits coated with wax 6 % recorded minimum PLW (3.68 and 6.35 %) on 9th and 12th day of storage period, respectively. Maximum marketable fruits (92.50, 66.67 and 45.83 %) was recorded with GA₃ 100 ppm on 6th, 9th and 12th day of storage periods, respectively. The treatment of GA₃ 100 ppm and NAA 100 ppm could significantly minimized spoilage of the fruits during storage. Minimum spoilage of the fruits (22.08 %) on 6th day of storage and 52.92 and 63.75 % on 9th and 12th day of storage period was recorded with GA₃ 100 ppm and NAA 100 ppm, respectively. Maximum shelf-life (9.17 days) was recorded with GA₃ 200 ppm and coating of fruits with wax 6 % (7.92 %). Maximum fruit firmness (0.53 Kgcm⁻²) was recorded with treatment of NAA 200 ppm.

Key words : Growth regulator, sapota, wax coating

Sapota [(*Manilkara achras* (Mill.) Fosberg] is fifth popular fruit in both production and consumption next to mango, banana, citrus and grapes. In India, it is cultivated under area of 1.56 lakh ha. with a total production of 13.07 lakh M.T. (Anonymous 2008-09). The major sapota growing states are Maharashtra, Gujarat, Tamilnadu, Andhra Pradesh, Karnataka, West Bengal, Uttar Pradesh, Punjab and Haryana. Being climacteric in nature, the fruit needs ripening treatments after full maturity. Storage and ripening of sapota are beset with a number of problems under tropical conditions. Fruits ripen within 2 or 3 days and become overripe and spoiled within 5 days after harvest.

The short post-harvest life of horticultural crops is due to their perishable nature and physiological break

down during handling, transport, storage and these losses are further enhanced by infection of post-harvest disease. Various viable technologies for improving shelf-life and storage of horticultural commodities like use of fungicides, cold storage, controlled atmosphere storage, anti-transparent, wax coating, growth regulators, irradiation and different type of packing materials, etc., were evolved during the past decades. The technology aim to preserve quality, nutritional and economic value and assure food safety and regulated supply of commodities for processing, domestic markets and export.

MATERIALS AND METHODS

The experiment was conducted at Department of Horticulture, B.A.C.A., AAU, Anand during 2007-08 and 2008-09. The handpicked, firm and healthy sapota cv. 'Kalipatti' fruits of uniform size and maturity, free from pest and diseases, injuries,

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bruises and blemishes were plucked from Horticulture Research cum Demonstration Farm, AAU, Anand. Out of these fruits, two kg. fruits were randomly selected and dipped in two growth regulators solution each at two levels i.e., GA₃ 100, 200 ppm, NAA 100, 200 ppm, a chemical at two levels i.e., AgNO₃ 20, 40 ppm solution for ten minutes. Treated fruits then surface dried up to sufficient cool and coated with wax (58-60 °C) 3 and 6 % for a minute. The experiment was laid out in Factorial Completely Randomized Block Design comprising thirteen treatment combinations, i.e. GA₃ 100 ppm + Wax 3 % (T₁), GA₃ 200 ppm + Wax 3 % (T₂), NAA 100 ppm + Wax 3 % (T₃), NAA 200 ppm + Wax 3 % (T₄), AgNO₃ 20 ppm + Wax 3 % (T₅), AgNO₃ 40 ppm + Wax 3 % (T₆), GA₃ 100 ppm + Wax 6 % (T₇), GA₃ 200 ppm + Wax 6 % (T₈), NAA 100 ppm + Wax 6 % (T₉), NAA 200 ppm + Wax 6 % (T₁₀), AgNO₃ 20 ppm + Wax 6 % (T₁₁), AgNO₃ 40 ppm + Wax 6 % (T₁₂) and control (T₁₃). The treated fruits then surface dried up to sufficient cool and then packed in card board carton of 30 x 30 x 30 cm size with 6 vents of 3 cm diameter, 3 each on opposite sides and stored in the laboratory at ambient temperature. The mean temperature and relative humidity prevailed during storage at both the season ranges from 25.7 to 31.2 °C, 39-72 % and 28.4 to 32.5 °C, 17-55 %, respectively. Observations on PLW (%), marketable fruits (%), spoilage of fruits (%), number of days taken to ripening, fruit firmness (Kg cm⁻²). Firmness of fruit was measured by means of pocket penetrometer in terms of pressure required for piercing through the fruits and expressed in kg cm⁻². For recording all these parameters, five fruits were randomly selected from a single lot and replicated thrice. The data obtained were statistically analyzed.

RESULTS AND DISCUSSION

The data presented in Table 1 showed increasing trend in PLW during the storage periods. All the treatments significantly exerted for PLW of fruits during the storage periods. On 6th 9th and 12th day of storage, minimum PLW (2.64, 3.73 and 6.55 % respectively) was recorded with AgNO₃ 40 ppm. On 9th and 12th day of storage, various treatments and their interaction also influenced PLW of sapota fruits. On 9th and 12th day of storage, minimum PLW

(3.68 and 6.35 %) was recorded with AgNO₃ 40 ppm + wax 6 %), followed by AgNO₃ 20 ppm + wax 6 %, respectively. This reduction in PLW by AgNO₃ 40 ppm and their combinations with wax 6 %, could be due to reduced metabolism and reduced rate of transpiration that resulted in slow release of free water. Silver nitrate (AgNO₃) is known to be the anti-ethylene compound, as the silver ion plays a vital role in the regulation of ethylene bio-synthesis showing a pronounced effect on the ethylene release during climacteric fruit ripening. The results are in conformity with the findings as reported by Gautam and Chundawat (1990) in sapota cv. 'Kalipatti', Gautam *et al.* (1990) in sapota cvs. 'Kalipatti' and 'Cricket Ball'. Attri and Singh (1996) in sapota cv. 'Cricket Ball', Bairwa and Dashora (1999) in banana and Kahlon and Uppal (2005) in mango cv. 'Chausa'.

Various growth regulators and chemical treatment significantly influenced marketable fruits of sapota during all the day of storage (Table 2). On 6th and 9th day of storage, maximum marketable fruits (92.50 and 66.67% respectively) were recorded with GA₃ 100 ppm. On 12th and 15th day of storage, maximum marketable fruits were recorded with GA₃ 100, 200 ppm (45.83 %) and GA₃ 200 ppm (15 %), respectively. The increase in marketable fruits might be due to gibberellic acid which controlled the ethylene production as well as enzymatic activity. The results are in conformity with findings as reported by Kumar and Nagpal (1996) in mango cv. 'Dashehari'.

Different growth regulators and chemical exerted significant effects on spoilage of fruits during 6th, 9th and 12th day of storage periods (Table 3). On 6th day of storage, minimum (22.08 %) spoilage of fruits was recorded with GA₃ 100 ppm. On 9th and 12th day of storage, minimum (52.92 and 63.75 % respectively) spoilage of fruits was recorded with NAA 100 ppm. GA₃ and NAA dipped fruits showed the least spoilage percentage during the storage period. This might be due to GA₃ treated fruits having thick skin, which prevented the entry of microbes and maintained low rate of various metabolic processes which in turn increased the resistance to microbial entry. The results are in conformity with the findings as reported

Table 1 Effects of different growth regulators, chemical and wax coating on PLW(%) of sapota cv. 'Kalipatti' during different storage periods.

Growth regulators & Chemical(GC)	Physiological Loss in Weight (%)								
	6 th day			9 th day			12 th day		
	Wax 3 %	Wax 6 %	Mean (GC)	Wax 3 %	Wax 6 %	Mean (GC)	Wax 3 %	Wax 6 %	Mean (GC)
Control			6.33			9.78			12.97
GA ₃ 100 ppm	4.49	3.93	4.21	8.82	8.12	8.47	13.35	12.33	12.84
GA ₃ 200 ppm	4.48	3.80	4.15	8.48	7.50	7.99	13.98	13.05	13.52
NAA 100 ppm	4.49	4.22	4.36	7.55	6.93	7.24	8.98	8.00	8.49
NAA 200 ppm	4.40	3.90	4.16	6.55	6.11	6.33	8.48	8.18	8.33
AgNO ₃ 20 ppm	2.87	2.52	2.69	4.50	4.20	4.35	6.92	6.38	6.65
AgNO ₃ 40 ppm	2.90	2.37	2.64	3.78	3.68	3.73	6.76	6.35	6.55
Mean(W)	3.94	3.46	3.70	6.61	6.09	6.35	9.75	9.05	9.40
F-test CD at 5 %									
Grs. & Chemical(GC)			0.42			0.41			0.60
Wax (W)			0.24			0.24			0.35
Interaction (GC x W)			NS			0.268			0.339
									NS

Table 2 Effects of different growth regulators, chemical and wax coating on marketable fruits(%) of sapota cv. 'Kalipatti' during different storage periods.

Growth regulators & Chemical(GC)	Marketable fruits (%)								
	6 th day			9 th day			12 th day		
	Wax 3 %	Wax 6 %	Mean (GC)	Wax 3 %	Wax 6 %	Mean (GC)	Wax 3 %	Wax 6 %	Mean (GC)
Control			74.17			50.83			31.67
GA ₃ 100 ppm	94.17	90.83	92.50	66.67	66.67	66.67	45.00	46.67	45.83
GA ₃ 200 ppm	93.33	93.33	93.33	60.00	65.00	62.50	45.83	45.83	45.83
NAA 100 ppm	80.83	82.50	81.67	59.17	60.00	59.58	40.83	41.67	41.25
NAA 200 ppm	81.67	83.33	82.50	60.00	58.33	59.17	42.50	40.83	41.67
AgNO ₃ 20 ppm	79.16	79.17	79.17	56.67	56.67	57.08	37.50	38.33	37.92
AgNO ₃ 40 ppm	81.67	80.00	80.83	55.83	53.33	55.83	37.50	38.33	37.92
Mean (W)	85.14	84.86	85.00	59.72	60.56	60.14	41.53	41.94	41.74
F-test CD at 5 %									
Grs. & Chemical(GC)			7.24			7.36			6.30
Wax (W)			NS			NS			NS
Interaction (GC x W)			NS			NS			NS
									NS

Table 3 Effects of different growth regulators, chemical and wax coating on spoilage of sapota cv. 'Kalipatti' fruits during different storage periods.

Growth regulators & Chemical (GC)	Spoilage of fruits (%)											
	6 th day			9 th day			12 th day			15 th day		
	Wax 3 %	Wax 6 %	Mean (GC)	Wax 3 %	Wax 6 %	Mean (GC)	Wax 3 %	Wax 6 %	Mean (GC)	Wax 3 %	Wax 6 %	Mean (GC)
Control			37.50			72.50			94.17			95.83
GA ₃ 100 ppm	25.00	19.17	22.08	65.00	64.17	64.58	81.67	78.33	80.00	90.00	86.67	88.33
GA ₃ 200 ppm	29.17	22.50	25.83	62.50	62.50	62.50	90.83	81.67	86.25	95.00	89.16	92.08
NAA 100 ppm	29.17	26.67	27.92	55.00	50.83	52.92	65.83	61.67	63.75	91.67	90.00	90.83
NAA 200 ppm	25.83	21.67	23.75	61.67	51.67	56.67	72.50	58.33	65.42	91.67	89.17	90.42
AgNO ₃ 20 ppm	35.00	28.33	31.67	77.50	75.00	76.25	90.00	90.00	90.00	92.50	91.67	92.08
AgNO ₃ 40 ppm	37.50	31.67	34.58	78.33	76.67	77.50	90.83	89.17	90.00	93.33	91.67	92.50
Mean(W)	30.28	25.00	27.64	66.67	63.47	65.07	81.94	76.53	79.24	92.36	89.72	91.04
F-test CD at 5 %												
Grs. & Chemical(GC)			7.11			9.92			8.76			NS
Wax (W)			4.11			NS			5.06			3.29
Interaction (GC x W)			NS			NS			6.116			NS

Table 4 Effects of different growth regulators, chemical and wax coating on number of days taken for ripening of sapota cv. 'Kalipatti' fruits during different storage periods.

Growth regulators & Chemical (GC)	Number of days taken for ripening		
	Wax 3%	Wax 6%	Mean (GC)
Control			4.67
GA ₃ 100 ppm	7.50	7.83	7.67
GA ₃ 200 ppm	8.83	9.50	9.17
NAA 100 ppm	6.83	7.33	7.08
NAA 200 ppm	6.67	7.00	6.83
AgNO ₃ 20 ppm	7.33	7.67	7.50
AgNO ₃ 40 ppm	7.50	8.16	7.83
Mean(W)	7.44	7.92	7.68
F-test CD at 5 %			
Grs. & Chemical(GC)			0.93
Wax (W)			0.54
Interaction (GC x W)			NS

Table 5 Effects of different growth regulators, chemical and wax coating on fruit firmness of sapota cv. 'Kalipatti'.

Growth regulators & Chemical (GC)	Fruit firmness (Kg cm ⁻²)		
	Wax 3%	Wax 6%	Mean (GC)
Control			0.48
GA ₃ 100 ppm	0.37	0.38	0.38
GA ₃ 200 ppm	0.46	0.51	0.49
NAA 100 ppm	0.50	0.49	0.50
NAA 200 ppm	0.50	0.55	0.50
AgNO ₃ 20 ppm	0.45	0.46	0.46
AgNO ₃ 40 ppm	0.50	0.51	0.51
Mean (W)	0.47	0.49	0.48
F-test CD at 5 %			
Grs. & Chemical(GC)			0.11
Wax (W)			NS
Interaction (GC x W)			NS

by Avaiya and Singh (1989) in sapota cvs. 'Kalipatti', 'Cricket ball', Choudhary and Dhaka (2005) in Kinnow mandarin fruits, Kahlon and Uppal (2005) in mango

cv. 'Chausa', Rajkumar *et al.* (2005) in papaya cv. 'CO-2' and Sudha *et al.* (2007) in sapota cvs. 'PKM-1', 'Zumakhia', 'Calcutta special', 'Mohargootee' and 'Pilipatti'. Application of NAA helped to delay the ripening process and thus reduced spoilage. The results are in conformity with the finding as reported by Banik *et al.* (1988) in sapota, Gautam *et al.* (2003) in mango cv. 'Banganapalli'.

Various treatments significantly influenced number of days to reach ripening of sapota fruits (Table 4). Maximum number of days (9.17) for ripening of the fruits were recorded with GA₃ 200 ppm followed by AgNO₃ 40 ppm (7.83). Wax 6 % treatment showed maximum number of days (7.92) to reach ripening of sapota fruits. This delay in ripening of the fruits was due to the fact that GA₃ slowed down the process of ripening by reducing the respiration rate and ethylene production and through postponement of their climacteric peak *a vis a vis* control. These changes to reduced degradative metabolism in terms of catalase and PME activities and thus are helpful in extending shelf-life of the fruits. The results are in accordance with the findings of Gautam and Chundawat (1989) in sapota cv. 'Kalipatti', Attri and Singh (1996) in sapota cv. 'Cricket Ball', Damodaran *et al.* (2001) in sapota cv. 'Cricket Ball' and Sudha *et al.* (2007) in sapota cvs. 'PKM-1' and 'CO-2'.

Various growth regulators and chemical significantly influenced firmness of sapota fruits (Table 5). Maximum firmness (0.53 Kg cm⁻²) was recorded with NAA 200 ppm. Fruit firmness during the storage period is associated with the activity of acceleration of hydrolytic enzymes. Post-harvest treatments assisted sapota fruits to maintain firmness up to the end of storage period. Fruits treated with NAA showed the highest firmness. All other growth regulators also recorded higher fruit firmness than untreated. GA₃ that reduced the activities of softening enzymes i.e. polygalactouronase and pectin methyl esterase by protecting stiff pectin micro-molecules against demethylation or reduced depolymerization of polygalactouronase. The results of present investigation is in accordance with the results reported by Singh and Narayana (1999) in mango, Rajkumar *et al.* (2005) in papaya cv. 'CO-2' and Sudha *et al.* (2007) in sapota cv. 'PKM-1'.

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Estimation of heterosis in Fieldpea (*Pisum sativum* L. var *arvense*) for yield attributes

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ABSTRACT

Twenty eight cross combinations were developed by 8 x 8 diallel analysis during *rabi* 2012-13. 28 F₁'s and 8 parents were evaluated during *rabi* 2013-14. Thirteen and fifteen crosses manifested significant and positive heterobeltiosis and standard heterosis, respectively, for seed yield per plant. The range of heterobeltiosis and standard heterosis for seed yield was varied from -71.02 % (KPMR 400 x NDP-1) to 153.44 % (PRAKASH x IPFD 10-13) and -61.58 % (KPMR 400 x NDP-1) to 71.31 % (ADARSH x APARNA), respectively. The hybrid PRAKASH x IPFD 10-13 expressed the highest heterobeltiosis (153.44 %) for seed yield. The cross combination (PRAKASH x IPFD 10-13) expressed highest level of heterosis over better parent (18.09 %) for test weight (%). The crosses viz, ADARSH x APARNA (71.31 %) and PRAKASH x IPFD 10-13 (67.01 %) expressed the highest level of heterosis over standard check (DF 1) for seed yield and undesired direction for its contributing characters.

Key words : Diallel, heterobeltiosis, standard heterosis, fieldpea

Heterosis has been successfully exploited both in cross-pollinated and self-pollinated crops. Exploitation of hybrid vigour has been recognized as an important tool for genetic improvement of yield and may serve as a major fruitful technique to break existing yield barriers, to get better transgressive segregants. East (1908) and Shull (1908) studied the effects of cross and self fertilization in maize and finally Shull (1910) summarized the effects of inbreeding and cross breeding in it. The aim of heterosis in the present study was to spot out the best combination of parents giving high degree of useful heterosis. Information about heterosis for the identification of potential crosses, which can offer maximum chances of isolating transgressive segregants, is crucial in self-pollinated crops.

Economic heterosis has the most practical utility, which would be compared with a standard variety as check (Meredith and Bridge, 1972) while heterosis has relatively limited importance and is of more academic interest than that of practical utility. In practical plant breeding, the heterosis measured over better parent and popular cultivar is more realistic and is of more practical importance.

MATERIALS AND METHODS

The eight diverse parental genotypes of Fieldpea and their twenty-eight F₁'s (excluding reciprocals). The parental genotypes viz., DF-1, KPMR 400, VIKAS, PRAKASH, ADARSH, IPFD 10-13, NDP-1, APARNA were selected from germplasm maintained at Centre of Excellence for Research on pulses, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Dist. Banaskantha, during *rabi*, 2012-13 to create a diallel set. The complete set of 36 genotypes (eight parents + 28

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hybrids) were evaluated in Randomized Block Design (RBD) with three replication. DF-1 (Dantiwada Fieldpea-1) was used as standard check. The observations were recorded both as visual assessment (Days to 50% flowering and days to maturity) and measurement on randomly selected five competitive individual plants (plant height, number of primary branches per plant, number of pods per plant, number of seeds per pod, seed yield per plant (g), test weight (g), protein content (%) and harvest index (%)). The heterosis over better parent was estimated based on formulae given by Fonseca and Patterson (1968).

RESULTS AND DISCUSSION

The degree of heterosis varied from cross to cross for all the characters. Considerably high heterosis values in certain crosses and low in other crosses revealed that nature of gene action varied with the genetic architecture of parental material. Out of 28 crosses thirteen crosses manifested heterobeltiosis for seed yield per plant. The range of heterobeltiosis for seed yield was varied from -71.02 % to 153.44 %. The best three hybrids which recorded significant and high positive heterosis over better parent for seed yield were, PRAKASH x IPFD 10-13 (153.44%), ADARSH x APARNA (114.98%) and PRAKASH x ADARSH (97.89%). The standard heterosis varied from -61.58 per cent (KPMR 400 x NDP-1) to 71.31 per cent (ADARSH x APARNA). The best three hybrids which recorded highly significant and positive heterosis over standard check were ADARSH x APARNA (71.31%), PRAKASH x IPFD 10-13 (67.01%) and DF-1 x ADARSH (66.56%)(Table 1 and Table 2). Medium to high heterobeltiosis for seed yield in fieldpea has also been reported by Borah (2009), Singh *et al.* (2012) and Punia *et al.* (2013).

For number of pods per plant, twelve crosses showed significant and positive heterobeltiosis ranged from -46.41 per cent (KPMR 400 x NDP-1) to 161.69 per cent (ADARSH x APARNA). Eighteen hybrids showed significant and positive standard heterosis, ranged from -32.88 per cent (KPMR 400 x IPFD 10-13) to 67.58 per cent (ADARSH x APARNA). For number of seeds per pod, fifteen

crosses showed significant and positive heterobeltiosis which ranged from -37.73 per cent (DF-1 x NDP-1) to 43.11 per cent (ADARSH x APARNA). Thirteen hybrids showed significant and positive standard heterosis. It ranged from -37.73 per cent (DF-1 x NDP-1) to 38.28 per cent (ADARSH x APARNA). These findings are in agreement with the earlier report of Borah (2009), Punia *et al.* (2013), Kosev *et al.* (2012).

For test weight (%), eight hybrids manifested significant and positive heterobeltiosis. The spectrum of variation of heterosis over better parent ranged from -20.78 per cent (KPMR 400 x VIKAS) to 18.09 per cent (PRAKASH x IPFD 10-13). Fifteen hybrids showed significant and positive standard heterosis. The standard heterosis varied from -8.21 per cent (IPFD 10-13 x APARNA) to 23.23 per cent (ADARSH x APARNA). For protein content (%), only one hybrid showed significant and positive standard heterosis. The standard heterosis varied from -12.77 per cent (KPMR 400 x IPFD 10-13) to 4.42 per cent (IPFD 10-13 x APARNA). For harvest index (%), eight hybrids manifested significant and positive heterobeltiosis. The spectrum of variation of heterosis over better parent was observed ranged from -44.21 per cent (IPFD 10-13 x APARNA) to 77.53 per cent (PRAKASH x IPFD 10-13). Four hybrids showed significant and positive standard heterosis. The standard heterosis varied from -65.58 per cent (IPFD 10-13 x APARNA) to 29.67 per cent (ADARSH x APARNA). Similar results were obtained by Singh *et al.* (2010), Punia *et al.* (2013) and Singh *et al.* (2012).

The crosses viz., PRAKASH X IPFD 10-13 and ADARSH X APARNA exhibited significant and desirable heterosis for seed yield and its contributing traits Viz., number of pods per plant, test weight and harvest index.

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Table 1 Heterosis in percentage in F_1 hybrid over better parent [BP] and standard check (DF-1) [SC] for Yield and its components in Field pea.

Sr No.	Hybrids	Seed yield		Number of pods		Number of seeds		Test weight (g)		Protein content (%)		Harvest index (%)	
		BP	SC	BP	SC	BP	SC	BP	SC	BP	SC	BP	SC
1.	DF 1 x KPMR 400	45.79**	45.80**	41.28**	41.28**	26.20**	26.20**	1.79	12.92**	-4.46**	-4.00*	2.29	2.30
2.	DF 1 x VIKAS	1.3	1.30	-34.62**	-22.94**	3.07	3.07	-16.34**	2.12	1.31	1.80	-16.41**	-16.41**
3.	DF 1 x PRAKASH	58.05**	58.04**	39.72**	58.94**	27.06**	27.06**	10.71**	10.71**	-9.37**	-8.93**	6.32	6.32
4.	DF 1 x ADARSH	66.56**	66.56**	62.32**	62.32**	31.17**	31.17**	0.13	10.68**	-10.30**	-9.87**	24.39**	24.39**
5.	DF 1 x IPFD 10-13	11.75	11.75	-10.78	-10.78	19.02**	19.02**	4.34	4.34	-5.80**	-1.54	-21.14**	-21.13**
6.	DF 1 x NDP-1	9.39	45.01**	9.65	48.49**	-37.73**	-37.73**	15.98**	15.98**	-3.32*	-2.85	0.99	0.99
7.	DF 1 x APARNA	43.93**	43.94**	47.57**	47.57**	-9.51	-9.51	15.37**	15.37**	-1.36	-0.88	-4.04	-4.04
8.	KPMR 400 x VIKAS	-17.72	-23.49**	-35.63**	-24.13**	-14.47*	-20.25**	-20.78**	-3.29	-6.78**	-6.62**	-14.78**	-27.39**
9.	KPMR 400 x PRAKASH	55.53**	38.37**	24.80**	41.97**	32.69**	26.99**	5.24	16.75**	-7.49**	-8.25**	22.10**	-14.09**
10.	KPMR 400 x ADARSH	61.77**	43.92**	68.40**	47.39**	-15.87*	-18.71**	8.61**	20.49**	0.88	0.05	17.01**	-14.12**
11.	KPMR 400 x IPFD 10-13	-55.34**	-60.27**	-23.31**	-32.88**	-33.66**	-37.73**	-16.67**	-7.56*	-16.55**	-12.77**	13.72	-31.27**
12.	KPMR 400 x NDP 1	-71.02**	-61.58**	-46.41**	-27.43**	-32.89**	-37.42**	-12.28**	-2.69	-0.53	-1.35	-3.65	-27.95**
13.	KPMR 400 x APARNA	-1.48	-12.35	-6.03	-17.75**	-16.45*	-22.09**	-11.50**	-1.82	-10.28**	-11.01**	17.55*	-27.49**
14.	Vikas x PRAKASH	50.67**	40.10**	22.20**	44.04**	-13.46	-17.18**	-10.69**	9.02**	-8.22**	-8.07**	0.61	-14.28**
15.	Vikas x ADARSH	65.84**	54.20**	36.09**	60.41**	17.84**	13.87*	-6.71*	13.88**	-3.69*	-3.52*	34.84**	14.88**
16.	Vikas x IPFD 10-13	44.12**	34.02**	14.69*	35.18**	19.93**	12.58*	-3.77	17.47**	-10.18**	-6.11**	7.53	-8.38
17.	Vikas x NDP 1	-32.47**	-10.47	-36.25**	-13.67	16.91*	-2.45	-10.78**	8.91**	-1.98	-1.81	-18.73**	-30.76**
18.	Vikas x APARNA	-46.37**	-50.13**	-36.18**	-24.77**	-24.29**	-34.97**	-20.34**	-2.76	-9.62**	-9.46**	-37.31**	-46.59**
19.	Prakash x ADARSH	97.89**	57.70**	37.54**	56.47**	-31.11**	-33.44**	-2.26	8.03*	-6.80**	-9.45**	-0.97	-27.31**
20.	Prakash x IPFD 10-13	153.44**	67.01**	42.74**	62.39**	18.27**	13.19*	18.09**	17.73**	-13.77**	-9.87**	77.53**	24.91**
21.	Prakash x NDP 1	-24.94**	-0.49	-9.65	22.36**	20.77**	15.58*	0.36	-1.14	-4.82**	-7.40**	7.82	-19.38**
22.	Prakash x APARNA	53.69**	1.28	5.52	20.04**	26.92**	21.47**	0.21	-1.29	-3.74*	-6.47**	-6.48	-34.20**
23.	Adarsh x IPFD 10-13	-38.47**	-50.96**	27.48	-29.36**	-21.02**	-23.68**	-14.49**	-5.48	-13.65**	-9.74**	-20.93**	-41.96**
24.	Adarsh x NDP 1	2.64	36.08**	1.69	37.71**	19.37**	15.34*	-5.1	4.90	-1.51	-4.19**	17.17**	-12.38**
25.	Adarsh x APARNA	114.98**	71.31**	161.69**	67.58**	43.11**	38.28**	11.49**	23.23**	-1.71	-4.73**	76.66**	29.67**
26.	IPFD 10-13 x NDP 1	-1.71	30.31**	0.26	35.78**	18.95**	11.66	7.94*	7.60*	-8.13**	-3.97*	-15.25*	-36.63**
27.	IPFD 10-13 x APARNA	11.11	-58.86**	10.32	-29.36**	-18.95**	-23.93**	-7.92*	-8.21*	-0.1	4.42**	-44.21**	-65.58**
28.	NDP 1 x APARNA	-28.19**	-4.82	-12.64*	18.30*	33.57**	14.72*	6.96*	4.97	-1.05	-3.74*	12.23	-16.07**
Range of heterosis		-71.02 to 153.44	-61.58 to 71.31	-46.41 to 161.69	-32.88 to 67.58	-37.73 to 43.11	-37.73 to 38.28	-20.78 to 18.09	-8.21 to 23.23	-3.32 to -16.55	-12.77 to 4.42	-44.21 to 77.53	-65.58 to 29.67

BP=Better Parent; SC= Standard Check(DF-1)

** and * indicates significant at P=0.05 and P= 0.01 levels, respectively.

Table 2 Top three of the parents and hybrids for heterosis estimates

Characters	Magnitude of heterosis over	
	Better parents	Standard check
Seed yield per plant (g)	PRAKASH x IPFD 10-13	ADARSH x APARNA
	ADARSH x APARNA	PRAKASH x IPFD 10-13
	PRAKASH x ADARSH	DF- 1 x ADARSH
Number of pods per plant	ADARSH x APARNA	ADARSH x APARNA
	KPMR 400 x ADARSH	PRAKASH x IPFD 10-13
	DF- 1 x ADARSH	DF- 1 x ADARSH
Number of seeds per pod	ADARSH x APARNA	ADARSH x APARNA
	NDP-1 x APARNA	DF- 1 x ADARSH
	KPMR 400 x PRAKASH	DF- 1 x PRAKASH
Test weight (g)	PRAKASH x IPFD 10-13	ADARSH x NDP-1
	DF-1 x NDP-1	PRAKASH x IPFD 10-13
	ADARSH x APARNA	DF-1 x NDP-1
Protein content (%)	DF-1 x NDP-1	IPFD 10-13 x APARNA
	-	-
	-	-
Harvest index (%)	PRAKASH x IPFD 10-13	ADARSH x APARNA
	ADARSH x APARNA	PRAKASH x IPFD 10-13
	VIKAS x ADARSH	DF- 1 x ADARSH

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Fertility status of cultivated soils in Patan district of North Gujarat

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ABSTRACT

An investigation was carried out to study the fertility status of cultivated soils in Patan district of north Gujarat. The soils of Patan district are neutral to alkaline in reaction (pH 7.10 to 9.30) having electrical conductivity value varied from 0.103 to 9.230 dSm⁻¹. The data on nutrient status showed that soils are low in organic carbon, medium to high in available phosphorus, high status of potash and adequate amount of sulphur. Among the DTPA extractable micronutrients, high to very high amount of manganese and copper, whereas marginal to adequate amount of iron and zinc supply. The availability of potash, sulphur and DTPA extractable micronutrient cations were significantly and positively correlated with organic carbon content of soils.

Key words : Fertility, soil properties, micronutrients

At present the exploitive agriculture with sustained efforts to increase crop yield has not only depleted our soils of their nutrient serve, but also resulted in the emergence of a number of new nutrient deficiency in the soils. Optimum use of fertilizers contributes significantly in bringing about an increase in agricultural production. Amount of fertilizers required for same crop varies from soil to soil and even from field to field. Maintenance of fertility of soils is immense concern to obtain harness higher yields (Gupta 2000). Now a day, due to change in cropping pattern and diversification of crops, it is necessary to know fertility status of soils. In the current concept of sustainable agriculture, there is need to understand the characteristics and inherent fertility of the soils for enhancing its productivity. Knowledge about the fertility status of the soils is of prime importance for the optimum use of land. Proper understanding of nutrients availability in soils and extent of their deficiencies is prerequisite for efficient management of fertilizers to sustain the crop productivity. Scantly information is available regarding fertility status of soils and their relationship with soil properties of Patan district. Therefore, the attempt was made to study the fertility status in soils of Patan district of north Gujarat

MATERIALS AND METHODS

The study area is located (Patan district) is located in the north region of Gujarat at 23.55° to 24.41° N Latitude and 71.31° to 72.20° E longitude. The district has semi-arid climate and received average rainfall of 550 mm. The main crops grown include castor, cotton, mustard, cumin, wheat etc. Three hundred sixteen (316) surface (0-15 cm) soil samples of farmers' field were collected from seven talukas (Siddhpur, Patan, Chanasma, Harij, Sami, Radhanpur and Santalpur) of Patan district by following the random sampling techniques. The soil samples, after air drying were ground with wooden mortar and pestle and passed through 2.0 mm sieve. The soil reaction (pH) and electrical conductivity (EC) were determined as per the procedure described by Jackson (1973). The soil organic carbon (OC) was estimated by wet digestion method of Walkley and Black (1934). The available P was extracted by employing Olsen extractant (0.5 M NaHCO₃) as described by Olsen *et al.*, (1954) and the available K was extracted by using neutral normal ammonium acetate and the content was determined by aspirating the extract in to flame photometer (Jackson, 1973). The available sulphur in the soil was extracted by 0.15 % CaCl₂ · 2H₂O solution as described by Williams and Steinbergs (1959) and the content of DTPA Extractable micronutrients *viz.*,

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Iron (Fe), Manganese (Mn), Zinc (Zn) and Copper (Cu) in soil was estimated using 1: 2 soil to extractants ratio (Lindsay and Norvell, 1978). Simple correlations were worked among different chemical properties of soil by standard statistical methods (Panse and Sukhatme, 1967). The nutrient index (NI) values for available nutrients were calculated utilizing the formula suggested by Parkar *et al.* (1951).

$$NI = [(N_l \times 1) + (N_m \times 2) + (N_h \times 3)] / N_t$$

Where, N_l , N_m and N_h are the number of soils samples falling in low medium and high categories for nutrient status and are given weightage of 1, 2 and 3, respectively. N_t is the total number of samples,

The nutrient index value are rated in various categories viz., very low (< 1.33), low (1.33-1.66), marginal (1.66 to 2.00), adequate (2.00-2.33), high (2.33-2.66) and very high (> 2.66) as rating given by Stalin *et al.* (2010).

RESULTS AND DISCUSSION

The chemical properties of soil revealed that the soils of Patan district are neutral to alkaline in reaction with the pH ranging from 7.10 to 9.30 (Table 1). The highest value of pH was found in Siddhpur taluka (9.30). As

far as electrical conductivity is concerned, the overall value of EC in soils of Patan district ranged from 0.103 to 9.230 dSm⁻¹ with a mean value of 1.139 dSm⁻¹. The higher EC range was observed in Radhanpur taluka whereas lowest rang was observed in Siddhpur taluka. Similar results were found by Thakor *et al.* (2014a) in North Gujarat.

The organic carbon content of soil ranged from 0.039 to 2.388 with a mean value of 0.366 % which indicates poor fertility of soil in Patan district. This could be ascribed due to rapid decomposition and mineralization organic matter in semi arid climatic conditions. The lowest value of organic carbon content of 0.039 per cent was recorded in soil samples collected from Sami taluka, whereas the highest value of 2.388 per cent was obtained in Chansma taluka (Table 1). The mean value of organic carbon content in soil for Siddhpur, Patan, Chansma, Harij, Sami, Radhanpur and Santalpur talukas were 0.355, 0.360, 0.540, 0.336, 0.300, 0.486 and 0.235 per cent, respectively. The lower value of organic carbon in north Gujarat was also reported by Thakor *et al.* (2014a)

The available P₂O₅ content of soil samples of Patan district varied between 9.99 to 138.82 kg/ha. The overall mean value of available phosphorus (52.42 kg P₂O₅/ha)

Table 1: Chemical characteristics and nutrient status of soils of Patan district

Sr. No.	Taluka	No. of Samples	pH _{2.5}	EC _{2.5} (dSm ⁻¹)	Organic Carbon (%)	Available P ₂ O ₅ (kg/ha)	Available K ₂ O (kg/ha)	Available Sulphur (mg/kg)
1.	Siddhpur	41	7.10-9.30 (8.13)	0.132-1.350 (0.397)	0.117-1.025 (0.355)	9.99-120.85 (55.25)	123.51-616.22 (257.88)	6.30-49.99 (20.51)
2.	Patan	54	7.10-8.70 (7.75)	0.180-3.500 (0.790)	0.117-0.766 (0.360)	15.98-101.87 (37.53)	105.91-678.05 (300.21)	5.18-79.60 (24.69)
3.	Chansma	42	7.20-8.80 (7.86)	0.103-2.500 (0.617)	0.182-2.388 (0.540)	11.99-126.94 (45.89)	213.70-873.60 (460.33)	4.81-57.76 (26.40)
4.	Harij	42	7.20-8.60 (7.94)	0.241-4.480 (1.213)	0.065-0.779 (0.336)	21.97-138.82 (66.92)	170.69-744.71 (431.73)	5.92-74.79 (25.34)
5.	Sami	56	7.40-8.75 (8.04)	0.167-7.310 (1.287)	0.039-0.948 (0.300)	17.98-103.87 (53.79)	177.41-940.80 (523.79)	2.22-70.32 (36.85)
6.	Radhanpur	36	7.15-8.80 (8.18)	0.332-9.230 (2.782)	0.182-1.181 (0.486)	19.98-106.86 (56.87)	185.88-825.22 (468.80)	4.81-94.78 (38.47)
7.	Santalpur	45	7.10-8.85 (7.88)	0.209-7.410 (1.153)	0.117-0.584 (0.235)	20.97-95.88 (55.04)	124.99-768.77 (369.73)	7.41-98.12 (30.51)
	District	316	7.10-9.30 (7.96)	0.103-9.230 (1.139)	0.039-2.388 (0.366)	9.99-138.82 (52.42)	105.91-940.80 (402.21)	2.22-170.32 (29.03)

Note: Value in parenthesis shows mean

Table 2 Micronutrient status of soils of Patan district

Sr. No.	Taluka	No. of Samples	DTPA - extractable micronutrients (mg/kg)			
			Fe	Mn	Zn	Cu
1.	Siddhpur	41	4.22-14.22 (6.61)	5.20-28.76 (13.17)	0.22-1.28 (0.73)	0.34-1.70 (0.70)
2.	Patan	54	4.26-12.86 (6.23)	3.60-25.48 (11.71)	0.14-1.48 (0.60)	0.22-2.14 (0.71)
3.	Chanasma	42	3.48-8.84 (6.29)	6.38-38.08 (15.66)	0.46-1.86 (0.90)	0.22-1.16 (0.68)
4.	Harij	42	4.84-16.04 (7.13)	4.36-24.14 (14.69)	0.40-1.38 (0.82)	0.34-1.90 (0.85)
5.	Sami	56	4.12-23.92 (6.99)	4.18-24.36 (10.19)	0.30-2.10 (0.71)	0.28-2.76 (0.88)
6.	Radhanpur	36	3.54 -13.60 (7.52)	4.94-20.58 (13.03)	0.34-1.40 (0.69)	0.16-2.58 (0.95)
7.	Santalpur	45	3.66 -14.80 (7.39)	3.92-17.94 (10.85)	0.38-1.32 (0.64)	0.18-2.18 (0.84)
	District	316	3.48-23.92 (6.77)	3.60-38.08 (12.51)	0.14-2.10 (0.71)	0.10-2.76 (0.86)

Note: Value in parenthesis shows mean

Table 3 Correlation coefficient (r) between different chemical properties of soil

Soil Properties	EC _{2.5}	pH _{2.5}	Org. Carbon (%)	Ava. P ₂ O ₅ (kg/ha)	Ava. K ₂ O (kg/ha)	Ava. S (mg/kg)	DTPA -extractable micronutrients (mg/kg)		
							Fe	Mn	Zn
pH _{2.5}	-0.101								
Org. Carbon(%)	0.185**	-0.045							
Avail. P ₂ O ₅ (kg/ha)	0.98**	0.011	0.053						
Avail. K ₂ O (kg/ha)	0.226**	0.016	0.209**	0.141*					
Avail. S (mg/kg)	0.580**	-0.137*	0.130*	0.097	0.200**				
Fe (mg/kg)	0.109	-0.075	0.200**	0.173**	0.334**	0.079			
Mn (mg/kg)	0.157**	-0.360**	0.343**	0.218**	0.170**	0.132*	0.110		
Zn (mg/kg)	0.142*	-0.102	0.388**	0.139*	0.279**	0.136*	0.213**	0.326**	
Cu (mg/kg)	0.257**	-0.076	0.288**	0.037	0.586**	0.197**	0.555**	0.182**	0.397**

Table 4 Nutrient index values of available nutrients in soils of Patan district

Taluka	Available P ₂ O ₅	Available K ₂ O	Available S	DTPA Extractable Micronutrients			
				Fe	Mn	Zn	Cu
Siddhpur	2.22	2.27	2.24	1.88	2.68	1.95	2.85
Patan	1.78	2.48	2.19	1.85	2.52	1.80	2.67
Chansama	2.00	2.93	2.29	1.79	2.74	2.17	2.86
Harij	2.43	2.86	2.31	1.90	2.67	1.98	2.74
Sami	2.29	2.84	2.29	1.87	2.37	1.82	2.89
Radhanpur	2.33	2.72	2.31	2.22	2.69	1.86	2.83
Santalpur	2.29	2.62	2.24	2.16	2.62	1.80	2.82
District	2.18	2.67	2.27	1.91	2.58	1.86	2.87

also indicate that the soil of Patan district was medium in available phosphorus status. Similar results were also reported by Thakor *et al.* (2014a) in north Gujarat. The farmers are using only Dia Ammonium Phosphate (DAP) as a source of nutrients in adequate quantity. As a result, available P_2O_5 in medium range. The average available K_2O content of soil varied from 105.91 to 940.80 kg/ha with a mean value of 402.21 kg/ha. (Table 1). Adequate (medium to high) available K in this soil attributed to the prevalence of potassium rich mineral like illite and feldspar. This clearly shows that the soils of Patan district is medium to well supplied with available potassium. These results are conformity with Hasan (2002).

The available sulphur in soils of Patan district ranged from 2.22 to 170.32 mg/kg with a mean value of 29.03 mg/kg (Table 1). Considering the 10 mg/kg as critical limit for available sulphur, the soils of Patan district are adequate in sulphur. The higher concentration of available S in sub tropical region might be attributed to higher amount of soluble salts in these soils. Similar results were reported by Kour and Jalai (2008)

The available Fe content of soil sample varied from 3.48 to 23.92 with a mean value of 6.77 mg/kg (Table 2). The highest mean value was found in Radhanpur taluka (7.52 mg/kg) and lowest mean value was found in Patan taluka (6.23 mg/kg). The DTPA-extractable Zn content in soil ranged from 0.14 to 2.10 mg/kg with a mean value of 0.71 mg/kg (Table 2). Similar Results are also reported by Patel *et al.* (1998) and Thakor *et al.* (2014b). The medium status of Fe and Zn might be due precipitation of this nutrients under alkaline condition of soil. The average available Mn content of soil ranged from 3.60 to 38.08 mg/kg with a mean value of 12.51 mg/kg. The average available Cu content of soil ranged from 0.10 to 2.76 with a mean value of 0.86 mg/kg. The higher overall mean values of available Mn and Cu indicates sufficient availability of Mn and Cu in the soils of Patan district. Similar Results are also reported by Patel *et al.* (1998) and Thakor *et al.* (2014b)

Interrelationship among different chemical properties of soil

The correlation coefficient (r) among different chemical properties of soils in Patan district is presented in Table 3. The available P_2O_5 , K_2O , S and DTPA extractable micronutrients (Mn, Zn, Cu) of the soil were found to be correlated positively and significantly with electrical conductivity. Similar relationship was

also reported by Chatopadhyay *et al.* (1996). With the increasing of soil pH, availability of micronutrient decreased, which probably due to alkaline nature of soils. This confirmed that soil pH had negative correlation with available Fe (-0.075), available Zn (-0.102), available Mn (-0.366") and available Cu (-0.076). Soil available potassium, sulphur and micronutrients (Fe, Mn, Zn, Cu) had significant and positive correlation with organic carbon. The positive correlation between these nutrients and organic carbon content of soil indicate that the availability of nutrients increased with an increase of organic carbon in the soil. Similar relationship was also observed by Dhane and Shukla (1995) and Bhogal *et al.* (1993). Available K had a significant positive correlation with available Fe (0.334"), available Mn (0.170"), available Zn (0.279") and available Cu (0.586"). Sharam *et al.* (2008) also reported similar results in soils of Amritsar district of Punjab. Soil available phosphorus showed significant and positive correlation with available K_2O , available Fe, available Mn and available Zn.

Nutrient Index Values and fertility status

The nutrient index values (Table 4) for all the nutrients were worked out for all the talukas of Patan district. The nutrient index value for available phosphorus was ranged from 1.78 to 2.43 indicating marginal to high status of phosphorus in soil. The nutrient index value for available potassium ranged from 2.27 to 2.93 indicating adequate to very high status of potassium in soils of Patan district. The nutrient index value for available sulphur was ranged from 2.19 to 2.31 indicating adequate status of sulphur in soil. The nutrient index for Fe and Zn ranged from 1.79 to 2.22 and 1.80 to 2.17, respectively indicating marginal to adequate status of these nutrient in soils. The higher nutrient index was noticed in all the talukas for Mn (2.37 to 2.74) and Cu (2.67 to 2.85) indicating high to very high status of Mn and Cu in soils of Patan district.

CONCLUSION

The results of study indicate that soils of Patan district are neutral to alkaline in reaction with low in organic carbon. The soils of Patan district are low to medium in available P_2O_5 and sulphur whereas high in available K_2O content. With respect to DTPA Mn and Cu, the soils of Patan district were found to be sufficient but for DTPA Zn and Fe, it was medium in status. This information can be useful for the cultivated soils of Patan district.

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Effect of calcium application on yield and post harvest qualities of potato

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ABSTRACT

Three years studies were conducted at Potato Research Station, SDAU, Deesa to study the effect of calcium application in the form of gypsum on yield and post harvest qualities of potato cv. Kufri Badshah. Results revealed that calcium application did not have significant influence on growth and yield of potato. However, application of 80 kg/ha calcium at the time of planting in the form of gypsum enhanced net returns, benefit-cost ratio and % dry matter of tubers over rest of treatments. Post harvest studies indicated that split application of 40 kg/ha calcium during planting and 40 kg/ha calcium at earthing up reduced tuber weight loss, number of sprouts and rotting of tubers during 90 days storage.

Key words : Calcium, gypsum, potato tuber

Calcium is of utmost importance in plant for maintaining cell membrane stability and wall structure and assists as a secondary messenger in various plant functions from nutrient uptake to changes in cell status to help the plant react to the impact of environmental and disease stresses (Allen and Schroeder, 2001). Deficiency of calcium in potato has been related with many disorders such as Brown Center, Internal Brown Spot, hollow heart, susceptibility to bacterial rot caused by *Erwinia caratovora* and internal defects of tubers (Karlsson *et al.*, 2001). Adequate calcium supply strengthens tuber skin imparting better resistance to many diseases and improving skin finish of tuber, leading to a brighter and more marketable product. Calcium plays an important role in tuberization *in vitro*. Balamani *et al.* (1986) observed inhibition of calcium uptake by potato plantlets *in vitro* experiment that resulted in the inhibition of tuberization, which was restored by adding Ca to the medium. Little information has been available regarding response of dose and timing of calcium application on potato. So, an experiment was planned to evaluate the effect of calcium application on tuber yield of potato and its post harvest qualities

like tuber weight loss, sprouting, healthy and rotting tuber during storage period.

MATERIALS AND METHODS

Field experiment was conducted at Potato Research Station, SDAU, Deesa (Gujarat) during *rabi* seasons of 2009-10, 2010-11 and 2011-12 to study the effect of calcium application on yield and post harvest qualities of potato variety Kufri Badshah. The soil was loamy sand in texture, low in organic carbon (0.33%), available nitrogen (178.12 kg/ha), medium in available phosphorus (15.20 kg P/ha) and available potassium (235.11 kg K₂O/ha). Source of calcium was gypsum. Seven treatments viz; 0 kg Ca/ha, 40 kg Ca/ha at planting, 20 kg Ca/ha at planting and 20 kg Ca/ha at earthing up, 80 kg Ca/ha at planting, 40 kg Ca/ha at planting and 40 kg Ca/ha at earthing up, 120 kg Ca/ha at planting, 60 kg Ca/ha at planting and 60 kg Ca/ha at earthing up were laid out in randomized block design and replicated four times. Biomertic observations viz., plant emergence at 30 days after planting (DAP), plant height, number of shoots and leaves/hill at 45 DAP were recorded. Total tuber yield was harvest from each net plot of size 3.0 m x 3.6 m, which was further grouped into marketable (more than 25 g tuber weight) and non-marketable tuber (0-25 g tuber weight) grades and then expressed in

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tonne/ha. Dry matter content was determined by chopping and mixing of tubers in to small pieces and drying of 100 gram sample in hot air oven at 80° C for first six hours and then at 65° C till constant weight was obtained (Kumar *et al.*, 2006). Net returns and benefit: cost ratio were estimated by using formulae

Net return (₹/ha) = Gross return (/ha) – Total cost of cultivation (/ha)

Benefit cost ratio (BCR) = Net return (/ha) / Total cost of cultivation (/ha)

Post harvest studies included storage studies at room temperature by keeping 5 kg potatoes from each plot in hessian bags for 90 days and recording tuber weight loss (g) at 30, 60 and 90 days during storage period. Number of sprouted tubers, weight of sprouts, healthy tubers and rotted tubers were recorded at 90 days of storage.

RESULTS AND DISCUSSION

Growth, yield and economics

Perusal of the data (Table 1) revealed that calcium application did not influence all the growth attributes (plant emergence at 30 DAP, plant height, number of shoots and number of leaves/hill at 45 DAP. Modisane (2007) also observed that there was no correlation between growth attributes of potato with calcium

application. Similarly, tuber yields of potato i.e; marketable, non-marketable and total yield were statistically unaffected by calcium application (Table 2). Sterrett and Henninger (1991) also reported that tuber yield was unaffected by increasing levels of gypsum application. On the contrary, El- Beltagy *et al.* (2002) found that increase the calcium dose upto medium level increased tuber yield. However, numerically lower non-marketable yield with higher marketable tuber yield and highest total tuber yield were registered under 80 kg Ca/ha at planting.

Application of calcium significantly improved % dry matter of tuber over the control (Table 2). Highest value of % dry matter (18.11%) was recorded under application of 40 kg Ca/ha at planting + 40 kg Ca/ha at earthing up. Steyn *et al.* (1992) reported increase in tuber dry mass with increasing level of calcium application. Modisane (2007) had similar observations but the result was non-significant. Highest net return (₹ 137577/ha) and BCR (1.64) were recorded under 80 kg Ca/ha at planting which was followed by application of 120 kg Ca/ha at planting. Higher tuber yield under 80 kg Ca/ha at planting might have resulted in higher net return and BCR.

Post harvest studies

It was evident from Table 3 that application of calcium reduced tuber weight loss, number of sprouted tubers and rotted tuber over no application of calcium. This

Table 1 Effect of calcium application on growth attributes of potato (pooled data of three years)

Treatments	Plant emergence (%) at 30 DAP	Plant height (cm) at 45 DAP	Number of shoots/plant at 45 DAP	Number of leaves/plant at 45 DAP
No application of calcium	97.39	52.50	2.78	32.85
40 kg Ca/ha (planting)	97.13	53.92	2.80	32.05
20 kg Ca/ha (planting) + 20 kg Ca/ha (earthing up)	97.25	54.77	3.00	34.93
80 kg Ca/ha (planting)	97.83	55.02	2.95	34.70
40 kg Ca/ha (planting) + 40 kg Ca/ha (earthing up)	97.47	52.37	2.98	33.15
120 kg Ca/ha (planting)	97.36	53.33	2.87	32.63
60 kg Ca/ha (planting) + 60 kg Ca/ha (earthing up)	96.88	53.55	2.82	32.28
SEm ±	0.42	0.89	0.11	0.87
CD (P = 0.05)	NS	NS	NS	NS
CV (%)	0.74	2.86	6.80	4.56

Table 2 Effect of calcium application on tuber yield, % dry matter, net return and BCR of potato (pooled data of three years)

Treatments	Non-marketable tuber yield (t/ha)	Marketable tuber yield (t/ha)	Total tuber yield (t/ha)	% dry matter	Net returns (₹/ha)	BCR
No application of calcium	1.17	41.73	42.90	17.52	131294	1.58
40 kg Ca/ha (planting)	1.09	40.51	41.60	17.98	124534	1.49
20 kg Ca/ha (planting) + 20 kg Ca/ha (earthing up)	1.06	42.72	43.78	18.05	135430	1.62
80 kg Ca/ha (planting)	0.94	43.32	44.26	18.06	137577	1.64
40 kg Ca/ha (planting) + 40 kg Ca/ha (earthing up)	1.08	40.46	41.53	18.11	123930	1.48
120 kg Ca/ha (planting)	1.08	43.13	44.21	18.04	137056	1.63
60 kg Ca/ha (planting) + 60 kg Ca/ha (earthing up)	0.96	42.94	43.90	18.10	135489	1.61
SEm $\pm$	0.07	1.57	1.56	0.05	-	-
CD (P = 0.05)	NS	NS	NS	0.15	-	-
CV (%)	11.63	7.15	7.09	0.51	-	-

Table 3 Effect of calcium application on post harvest attributes of potato (Mean data of three years)

Treatments	Tuber weight loss (kg)			No. of sprouted tubers at 90 days of storage	Weight (kg) of at 90 days of storage		
	30 days	60 days	90 days		Sprouts	Healthy tubers	Rotted tubers
No application of calcium	0.71	1.27	2.06	6.67	0.00	2.86	0.85
40 kg Ca/ha (planting)	0.73	1.08	1.89	5.00	0.00	3.00	0.99
20 kg Ca/ha (planting) + 20 kg/ha (earthing up)	0.67	1.05	1.91	4.67	0.00	2.90	0.97
80 kg Ca/ha (planting)	0.71	1.06	1.96	6.00	0.00	3.01	0.69
40 kg Ca/ha (planting) + 40 kg/ha (earthing up)	0.31	0.93	1.69	4.33	0.00	3.22	0.78
120 kg Ca/ha (planting)	0.73	1.06	1.77	5.00	0.00	3.18	0.71
60 kg Ca/ha (planting) + 60 kg/ha (earthing up)	0.55	0.99	1.58	5.00	0.00	3.26	0.63

could be attributed to increased calcium uptake by tuber which strengthens cell wall and imparts resistance to stresses, which was supported by the findings of Kleinhenz and Palta (2002). Split application of calcium i.e; 40 kg Ca/ha at planting + 40 kg Ca/ha at earthing up minimized reduction in tuber weight and lesser number of sprouted tuber during the 90 days storage period. This resulted in higher weight of healthy tuber with lower rotted tubers than lower doses of calcium application.

CONCLUSION

From above findings it can be concluded that application of calcium @ 80 kg/ha in the form of gypsum at planting could achieve higher yield, % dry matter of tuber and economic returns with reduced losses during storage. However, for drawing a more concrete conclusion, we need to conduct more elaborate post harvest studies further.

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Constraints faced by the dairy farm women in animal husbandry practices and solutions to overcome those constraints

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ABSTRACT

The study was conducted in Vijapur and Mehsana talukas of Mehsana district, where production of milk was highest as compared to other talukas. Ten villages having the larger number of female in milk producer' co- operative societies were selected purposively. The sample consisted of 120 respondents for the study. The major economical constraints faced by dairy farm women in sequential order were: high cost of concentrate feed, high rates of interest on loans, high cost of milch animal, high cost of construction of cattle shed and lack of loan facilities. The important technological constraints were, lack of knowledge about recommended practices of animal husbandry, lack of technical know-how about feed, fodder and health management aspects, inadequate knowledge of vaccination schedule and lack of knowledge about latest technological related to milk and milk processing. The most important input-supply constraints were, non-availability of roughages, lack of supply of crossbred and non-availability of medical aids for animal treatments. The important marketing constraints were, non-availability of remunerative prices of milk and milk products, high cost of preparation of milk product and irregular collection of milk. The major administrative constraints where, lack of proper training on animal husbandry, lack of artificial insemination facility in villages and lack of veterinary services in time. The major suggestion offered by dairy farm women to overcome the constraints in animal husbandry practices were; supply of roughages and concentrate feed should be made available for construction of cattle shed and purchase of dairy animals, loan/subsidy facilities should be provided for purchase of dairy animals, supply of good quality of crossbred cows should be regular, provisions should be made for regular training of dairy farm women, veterinary health care and cattle camp should be organized time to time, at least five member of dairy co-operative society should be trained to solve the problems in animal husbandry and technical guidance regarding latest technology related to milk and milk processing should be provided to dairy farm women.

Key words : Feeding, breeding, animal husbandry practices and constraints

Women's contribution to national development is crucial. Emancipation of women is an essential pre-requisite for economic development and social progress of the nation. Women play an important and vital role in animal husbandry practices as manager, decision makers and skilled workers. The contribution of dairy farm women in terms of time and effort is more important as compared to man. India ranks first in buffalo populations and second in cattle populations

(Anonymous, 2008). The total livestock populations of Gujarat state is 237.94 lakhs. There was about 87.74 lakhs buffalo population, followed by 79.76 lakhs cattle populations (indigenous and crossbred) in Gujarat state in year 2007. The contribution of this sector in total Gross Domestic Production (GDP) is 05.00 per cent and share in GDP of agriculture and allied sector is 22.89 per cent. Out of 84.00 per cent of livestock population is being reared by 75.00 per cent rural households. Animal husbandry contributes average 30.00 per cent to 50.00 per cent share in total family income in rural area. Further, out of total

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101.94 lakhs households of Gujarat, 42.66 lakhs households (42.00 per cent) adopted animal husbandry as a primary or secondary source of income, which shows the potentiality of animal husbandry as a sustainable source of rural livelihood (Anonymous, 2007a). In India, women's involvement in livestock management is a long standing tradition and livestock rearing has been as integral part of homestead farming system. Animal husbandry practices is in important tasks in animal husbandry activities are performed by dairy farm women besides fulfilling their responsibilities as home makers. Moreover, the knowledge and skill of the dairy farm women and their participation in decision-making certainly affects effectively in their work. Looking to these facts, the present investigation was planned to study the constraints faced by dairy farm women in animal husbandry practices. to seek suggestions from dairy farm women to overcome the constraints in animal husbandry practices.

METHODOLOGY

The present investigation was purposively carried out in Vijapur and Mehsana taluka of Mehsana district, where production of milk is highest as compared to other talukas. Ten villages having the larger number of female in milk producers' co-operative societies were selected purposively. The dairy farm women were selected by single stage random sampling technique. Thus, the sample consisted of 120 respondents for the study.

The independent variables undertaken in this study were: age, education and experience in animal husbandry practices. Size of family, social participation, size of land holding, time spent in dairy activities, herd size, expenditure on dairy animal, occupation, annual income, mass media exposure, extension contact, scientific orientation, risk orientation, knowledge level regarding recommended animal husbandry practices and participation in decision-making. The dependent variable chosen for the purpose of the study was extent of participation of dairy farm women in animal husbandry practices.

Constraints were measured by asking to the dairy farm women to state the constraints faced in animal husbandry practices. The frequency and percentage for all the constraints were calculated and then ranked accordingly. At the same time, the suggestions were collected from the dairy farm women to overcome the constraints they faced in animal husbandry practices. Information collected was tabulated based on frequency and percentage and ranks were assigned to them.

The independent and dependent variable were measured by using suitable scale and procedures adopted by various researchers. The interview schedule was prepared keeping in view the objective of the study. Before its actual use, it was pre-tested and translated into Gujarati. The data of this study were collected by arranging personal interview with 120 respondents of the 10 selected villages. The data so collected were classified, tabulated and analyzed in order to make the findings meaningful. The statistical measures such as percentage, mean score, standard deviation and coefficient of correlation were used.

RESULT AND DISCUSSION

Constraints faced by dairy farm women in animal husbandry practices

Constraints faced by the dairy farm women are never ended. However, they can be minimized if known to policy makers and planners. During the course of present investigation, the respondents expressed many constraints which were grouped into five category viz., (i) economical, (ii) technological, (iii) input supply, (iv) marketing and (v) administrative constraints. The constraints were ranked on the basis of mean weighed scores. The responses of the respondents with regard to the constraints are presented in Table 1.

The data given in Table 1 reveal that with regard to economical constraints: the respondent had assigned first rank to high cost of concentrate feed, followed by high rates of interest on loans (Rank II), high cost of milch animal, (Rank III), high cost of construction of cattle shed (Rank IV) and lack of loan facilities

Table 1 Distribution of dairy farm women according faced by them in animal husbandry practices.

(n = 120)

Sr. No.	Constraints	Mean weighted score	Rank order
I	Economical constraints		
	1. High cost of milch animals	2.12	III
	2. High rates of interest on loans	2.37	II
	3. High cost of construction of cattle shed	1.92	IV
	4. Lack of loan facilities	1.75	V
	5. High cost of concentrate	2.50	I
II	Technological constraints		
	1. Lack of knowledge about recommended practices of animal husbandry	2.19	I
	2. Lack of technical know-how about feed, fodder and health management aspects	1.96	II
	3. Lack of knowledge about latest technology related to milk and milk processing	1.63	IV
	4. Inadequate knowledge of vaccination	1.58	III
III	Input-supply constraints		
	1. Lack of supply of crossbred cows	1.86	II
	2. Non-availability of roughage	2.47	I
	3. Non-availability of medical aids for animal treatments	1.49	III
IV	Marketing constraints		
	1. Non-availability of remunerative prices of milk and milk products	2.35	I
	2. Irregular collection of milk	1.42	III
	3. High cost of preparation of milk products	2.10	II
V	Administrative constraints		
	1. Lack of veterinary services in time	1.36	III
	2. Lack of proper training on animal husbandry	2.40	I
	3. Lack of artificial insemination facility in village	1.65	II

(Rank V), respectively. As regarding technological constraints, lack of knowledge about recommended practices of animal husbandry ranked I, lack of technical know-how about feed, fodder and health management aspects ranked II, inadequate knowledge of vaccination schedule ranked III and lack of knowledge about latest technology related to milk and milk processing ranked IV were the most important constraints mentioned by dairy farm women, respectively. Among input-supply constraints: the dairy farm women endorsed major constraints were: non-availability of roughages ranked I, lack of supply of crossbred cows ranked II and non-availability of medical aids for animal treatments

ranked III, respectively. In case of marketing constraints non-availability of remunerative prices of milk and milk products was major constraints ranked I, followed by high cost of preparation of milk products ranked II and irregular collection of milk ranked III, respectively. With case to administrative constraints: lack of proper training on animal husbandry was the first major constraints endorsed by dairy farm women, followed by lack of artificial insemination facility in villages ranked II and lack of veterinary services in time ranked III, respectively. These findings has been supported by the findings of Debas *et al.* (2004), Khokhar (2007), and Shirolkar (1993).

Table 2 Suggestion offered by dairy farm women to overcome the Constraints faced by them.

Sr. No.	Suggestions	Frequency	Per cent	Rank
1.	Supply of good quality crossbred cows should be regular.	88	73.34	III
2.	Technical guidance regarding latest technology related to milk and milk processing should be provided.	68	56.67	VII
3.	Supply of roughages and concentrate feed should be made available at cheaper rates.	100	83.34	I
4.	Provisions should be made for regular training of dairy farm women.	82	68.33	IV
5.	Loan/Subsidy facilities should be cattle shed and purchase of dairy animals.	93	77.50	II
6.	At least five member of dairy co-operative society should be trained to solve the problems in animal husbandry.	73	60.83	VI
7.	Veterinary health care and cattle camp should be organized time to time.	80	66.67	V

Suggestions offered by dairy farm women to overcome the constraints in animal husbandry practices.

An attempt was made to ascertain suggestions from dairy farm women to overcome various constraints faced by them in animal husbandry practices. The respondents were requested to offer their valuable suggestions against difficulties faced by them in animal husbandry practices. The suggestions offered by the dairy farm women are presented in Table 2.

The data given in Table 2 reveal that the major suggestions offered by dairy farm women to overcome the constraints in animal husbandry practices in sequential order were: supply of roughages and concentrate feed should be made available at cheaper rates ranked I, followed by loan/subsidy facilities should be made available for construction of cattle shed and purchase of dairy animals ranked II, supply of good quality of crossbred cows should be regular ranked III, provisions should be made for regular training of dairy farm women ranked IV, veterinary health care and cattle camp should be organized time

to time ranked V, at least five members of dairy co-operative society should be trained to solve the problems in animal husbandry ranked VI and technical guidance regarding latest technology related to milk and milk processing technology should be provided to dairy farm women ranked VII. These finding has been supported by the findings of Khokhar (2007) and Rani (2009).

CONCLUSION

Major constrain which was ranked first in economical, technological, input supply, marketing and administrative were, high cost of concentrate, lack of knowledge about recommended practices of animal husbandry, non availability of roughage, non availability of remunerative price of milk and milk products, lack of proper training on animal husbandry respectively. The major suggestions was supply of roughage and concentrate food should be made available at cheaper rates followed by loan and subsidy facilities should be for cattelshed and purchase of animal, supply of good quality of crossbred cows should be regular,

supply of good quality of crossbred cows should be regular, veterinary health care and cattle camp should be organized time to time, at least five members of dairy co-operative society should be trained to solve the problems in animal husbandry, technical guidance regarding latest technology related to milk and milk processing technology should be provided to dairy farm women.

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The behaviour of dairy farmers towards rearing cross bred cows in Banaskantha district of Gujarat

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ABSTRACT

Dairy farming in India is one of the most important means of providing livelihood and nutritional security to vast rural population. Though Gujarat is one of the leading states in dairy sector it has inherent constraints of low yielding non-descript cattle population along with scarcity of balanced resources of feeds and fodder. No previous attempts had been made to study the attitude of dairy farmers towards rearing of Crossbred cows, So taking these considerations the present study was conducted in the Banaskantha district of Gujarat. Majority of the respondents had neutral attitude towards rearing Crossbred cows, followed by favourable and unfavourable attitude. The study highlighted the need of organizing more number of training related with Crossbred cows rearing practices and active participation by dairy farmers which would bring a significant change in the attitude of dairy farmers towards Crossbred cows.

Key words : Attitude, crossbreed cows and dairy farmers

Dairy farming in India is one of the most important means of providing livelihood and nutritional security to vast rural population. India, with its sizeable dairy sector is growing rapidly and moving towards modernization, resulting in prosperity in the years to come. India is home to the world's largest dairy herd, but the country still faces a production shortfall due to massive demand from growing population and also low productivity of Indian cows. In spite of India's position as highest producer of milk, productivity per animal is very poor. It is only about 987 kg / lactation as against world average of 2,038 kg / lactation. This low productivity is due to the gradual genetic deterioration and rises in the population of non-descript cows (80 per cent) and buffaloes (50 per cent) (Anonymous, 2010-11). Cross breeding, scientifically speaking is the mating of animals belonging to different breeds. Cross breeding in local cattle with exotic dairy breeds was introduced in the country to improve their genetic potential so as to produce cows having characteristics, like higher lactation yield, early maturity, lower age at first calving and shorter dry

period. The productivity potential of Crossbred cattle in Gujarat is still to be realized. With this perspective an empirical study was carried on the following objectives the attitude of dairy farmers towards rearing Crossbred cows in Banaskantha district of Gujarat.

METHODOLOGY

The present investigation was purposively carried out in Deesa, Palanpur and Vadgam talukas of Banaskantha district, where these talukas having major crossbred cows population of Banaskantha district. The selected taluka from each selected taluka, four villages were selected by random sampling, thus making total of twelve villages. From each selected village 10 respondents were selected randomly. Thus, the sample consisted of 120 respondents for the study. The data were collected by personal contact method with the help of structured interview schedule. The collected data were coded, classified, tabulated and analyzed in order to make the finding meaningful. In light of the objective for drawing meaningful interpretation. The respondents were categorized in to three categories on the basis of mean score. The mean score < 46.95 was unfavourable, the mean score

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in between 46.95 to 51.53 was neutral and the mean score > 51.53 was favourable.

RESULTS AND DISCUSSION

Attitude of respondents towards rearing Crossbred cows

A quick glance at the result in the Table 1 clearly indicated that 56.67, 25.00 and 18.33 per cent respondents exhibited neutral, favourable and unfavourable attitude towards rearing Crossbred cows, respectively. The finding is in line with the finding reported by Kannan (2002), Prakash (2005) and Alam (2012).

Table 1 Attitude of respondents towards rearing Crossbred cows

Attitude	Mean	n=120	
		Frequency	Percentage
Unfavourable (<46.95)	54.92	22	18.33
Neutral (46.95-51.53)		68	56.67
Favourable (>51.53)		30	25.00

The finding in the Table 1 clearly indicated that majority of the dairy farmers were having neutral attitude towards rearing Crossbred cows. This is due to the following main reasons:

- Less price of Crossbred cows milk

- Unavailability of good quality semen
- Need of growing cash crops rather than green fodder cultivation
- High cost of concentrate
- Non-availability of Veterinary doctors at proper time

CONCLUSION

Majority of the dairy farmers were having neutral attitude towards rearing Crossbred cows. The neutral group must be the main focus area for the extension agencies to mobilize their attitude in positive direction to bring dairy farmers maximum into fold of favourable attitude towards rearing Crossbred cows.

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Adoption of vermicompost practices among the tribal beneficiaries of NAIP-III

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ABSTRACT

Vermicomposting is the term given to the process of conversion of biodegradable matter by earthworms into vermicast. Vermicompost supplies a suitable mineral balance, improve nutrient availability could act as complex fertilizer granules. Vermicompost may also bring about a greater decrease in bio available heavy metals than in the composting process and there is evidence that the final product may contain hormone like compounds which accelerate plant growth. This study was undertaken in one district viz., Bansakantha, of North Gujarat state. The district was purposively selected for the study being the more number of vermicompost making framers under NAIP-III. For selection of taluka, villages and respondents, three stage random sampling technique with purposive selection was employed. All beneficiaries' farmers of vermicompost farmers were selected from each village. A total of 120 vermicompost farmers were selected from 6 villages of 2 talukas. Thus final sample constituted of 120 farmers. Majority (57.5 per cent) of the respondents were having medium level of adoption. 21.67 per cent of the respondents fall under the category of low level of adoption and 20.83 per cent respondents were found having high level of adoption.

Key words : Vermicompost, tribal, beneficiaries

Increased usage of chemical fertilizers without adequate organic recycling has not only aggravated multi-nutrient deficiencies in soil plant system but also deteriorated soil health and created environment pollution. Moreover, chemical fertilizers are becoming costlier input in agriculture because of increasing oil prices as well as raw materials prices. Therefore, it is right time to evaluate the feasibility and efficiency of organic manures but also increasing the efficiency of chemical fertilizers. Organic Farming is giving back to the nature what is taken from it. It is not mere non-chemicalism in agriculture, it is a system of farming based on integral relationship. Therefore, one should know the relationship among soil, water, plant and microflora and overall relationship between plant and animal kingdom. It is the totality of these relationships, which is the backbone of the organic Farming (Funtilana 1990).

The NAIP-III is aimed at achieving sustainable livelihood security of the farmers of disadvantaged districts of the Gujarat state namely Banaskantha, Dahod and Dangs. At the initial stage of project implementation, the Participatory Rural Appraisal and individual family survey was conducted. The major observation of participatory rural appraisal and survey were; (1). More than half of the farmers in all the villages were marginal and small. (2). The live stock population is high i.e., 2-3 animals per family but the breed is low milk yielding. (3). The crop productivity was found to be low, no micro irrigation system was observed. The cultivation of high value crops viz., vegetables, soybean, horticulture etc. were not cultivated. Irrigation facility was very limited.

Therefore, it is necessary to conduct impact study of adoption of vermicompost practices among the tribal beneficiaries of NAIP-III. With this ideology in view, an attempt has been made to study the adoption of vermicompost practices among the tribal beneficiaries of NAIP-III in the adopted villages with the following objectives :

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- [1] To assess the extent of adoption of vermicompost practices among the tribal beneficiaries of NAIP-III.
- [2] To assess the association between the personal, social economic, communication and situational attributes of the tribal beneficiaries and their level of the knowledge about the vermicompost practices.

METHODOLOGY

The present study was conducted in two talukas viz., Danta & Amirgadh of Banaskantha district, Gujarat because this district was under jurisdiction of the project NAIP-III. These two talukas were selected purposively. Three villages were selected purposively from each taluka. Total 120 beneficiaries were selected purposively because they have been given vermicompost units by the NAIP-III project. Ex-post- facto reserch design (Funtilana 1990) was used for this study. The data were collected through personal intview with the help of pre-tested structured schedule. The data collected were tabulated and statistical tools like frequency, percentage and correlation coefficient were used for logical conclusion.

RESULTS AND DISCUSSION

Extent of adoption of vermicompost practices among the tribal beneficiaries of NAIP -III

The finding on extent of adoption of recommended vermicompost technologies are presented and discussed in Table1. Majority of the respondents (57.50 per cent) were having medium level of adoption of vermicompost technology followed by 21.67 per cent and 20.83 percent low & high adoption of vermicompost technology, respectively. The probable reason might

Table 1 : Distribution of the respondents according to their extent of adoption of recommended vermicompost technology.

(n=120)

Level of adoption	Farmers	
	Frequency	Per cent
Low (Up to33.00 per cent)	26	21.67
Medium (34.00 to 53.00 per cent)	69	57.50
High (above 54 per cent)	25	20.83
Total	120	100.00

Mean=43.67

S.D.=10.61

be due to medium level of knowledge about the recommended vermicompost technology among the beneficiaries. The present finding are supported by the finding of Patel (2012), Upadhyay and Kaur (2012) and Jaganathan *et al.*, (2009).

Relationship between the personal, social, economic, communication and situational attribute of farmer and their extent of adoption of vermicompost practices

The data presented in Table 2 clearly indicated that education(0.3656**), herd size(0.2801**), source of water(0.3024**), extension contact(0.3342**) had positive and significant relationship with the extent of adoption of recommended vermicompost production technologies. Variables viz., family type(-0.0739^{NS}), family size(-0.0621^{NS}), social participation(0.0352^{NS}), land holding(-0.0085^{NS}) were failed to establish any significant relationship with extent of adoption whereas, age (-0.2554**) and annual income(-0.5443**) was negative and significantly related with extent of adoption of recommended vermicompost production technologies. This findings is similar to the finding reported by Pandya

Table 2 Relationship between the personal socio-economic attribute of farmers and their extent of adoption of vermicompost practices.

(n=120)

Independent Variables	Correlation coefficient (r value)
Personal characteristic	
1 Age	-0.2554**
2 Education	0.3656**
Socio economic characteristic	
1 Family type	-0.0739 ^{NS}
2 Family size	-0.0621 ^{NS}
3 Social participation	0.0352 ^{NS}
Economic characteristic	
1 Land holding	-0.0085 ^{NS}
2 Annual income	-0.5443**
3 Herd size	0.2801**
Communication characteristic	
1 Extension contact	0.3342**
Situational characteristic	
1 Source of water	0.3024**

NS = Non significant

** Significant at 1% level

(2011) and Patel (2006). The probable reasons for this might be the aged farmers had less risk taking capacity and enthusiastic than the younger ones. It can be concluded that education brings the changes in adoption behavior leading to higher education. Education helps in grasping ideas, forming favorable attitude and also in explaining the ideas to other. This may be reasons of higher adoption by educated farmer. This might be due to that in large size family might be the not awareness of family planning among the beneficiary farmers. In large size family, decision for vermicompost practices was taken jointly and took some time. This may be the probable reason for having non- significant relationship between family size and adoption. Social participation of the vermicompost was also limited to one organization. The probable reason for this might be farmers who have already higher income have higher capacity to invest and therefore most likely adopt the new agricultural technologies. The probable reason for positive and highly significant association between extension contact and knowledge level about vermicompost practices may be due to interaction between extension personnel with tribale beneficiaries pertaining to improved vermicompost technologies which can have cleared their doubts improved technology. The probable reason for positive and highly significant association between source of water and extent of adoption about vermicompost practices may be due to more utilization of vermicompost due to intensive farming.

CONCLUSION

Majority (57.5 per cent) of the respondents were having medium level of adoption. 21.67 per cent of the respondents fall under the category of low level of adoption and 20.83 per cent respondents were found having high level of adoption. It was found that education, herd size, source of water, extension contact had positive and significant relationship with the extent of adoption of recommended vermicompost production technologies. Variables viz., family type, family size,

social participation, land holding were failed to establish any significant relationship with extent of adoption whereas, age and annual income was negative and significantly related with extent of adoption of recommended vermicompost production technologies.

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Clinical scoring as a prognostic indicator in canine babesiosis

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ABSTRACT

Babesiosis, a tick borne disease of canine has varying severity and several forms involving nervous, cardiovascular, respiratory and other body systems. The *babesia gibsoni* remained the dominant species in canine population of south Gujarat without manifestation of haemoglobinuria in infected animals. Based on severity of the disease and involvement of various body systems, a clinical score that helps in early prognosis in babesia infection was worked out. Mortality remained significantly higher in dogs with higher clinical score at the time of first presentation in the present study.

Key words : Canine babesiosis, clinical scoring, prognosis

Babesiosis is one of the important diseases of domestic and wild Canidae caused by intraerythrocytic piroplasms of the genus *Babesia*. It is a tick borne disease, has a world-wide distribution and is a well established clinical entity in the tropical and subtropical countries (Soulsby, 1982) including India. The disease is emerging as an important clinical disease in the cosmopolitan cities of the country (Varshney *et al.*, 2008).

MATERIALS AND METHODS

Of the 1986 dogs brought at the Nandini hospital, Surat, Gujarat for treatment of illness, 518 ailing dogs with various systemic signs were examined clinically and were subjected to peripheral blood cytology for confirming babesia infection. Of the ailing 518 dogs, 314 dogs found cytologically positive to *B. gibsoni* infection were included in the study. These dogs were subjected to detailed clinical and specific examinations like electrocardiography and ultrasonography to know the involvement of specific body system. Based on severity of symptoms, Babesiosis was classified as per-acute, acute, chronic or subclinical (Schoeman, 2009; Irwin, 2010) or as

complicated and uncomplicated form. Uncomplicated form was further subdivided into severe, moderate and mild depending upon the degree of anaemia (Jacobson and Clark, 1994).

A clinical score recording proforma was worked out on the basis of severity and involvement of various systems. A clinical score of each dog was calculated on a 20 point scale as per the proforma. The score was primarily based on presence (score-1) or absence (score-0) of 20 clinical signs and investigations carried out at initial presentation. These signs were then clubbed as of general state, gastrointestinal, nervous, cardiac and respiratory forms. (Table 1). Thirty two cases which died during the course of the disease were given an additional score. Clinical score of each individual animal was worked out based on the systematic examination of the animal using signs as given in Table 2.

RESULTS AND DISCUSSION

The clinical picture

The clinical picture in naturally occurring cases of canine babesiosis remained very diverse and a wide variability in clinical signs was recorded. The different clinical symptoms recorded are given in Table 1 with their frequency of occurrence.

¹Professor and ²P.G. Student

Table 1 Frequency distribution of clinical signs among 314 canine babesiosis positive cases.

Sr. No.	Clinical Signs	Total	Percentage
General signs		249	92.22
Temperature			
A	Hyperthermia (> 102.40F)	174	64.44
B	Hypothermia (< 98.0F)	21	7.77
C	Normothermia	75	27.77
Weakness/emaciation		145	53.7
Presence of ticks on body		140	51.85
Dehydration (STT >3 sec)		115	42.59
Gastrointestinal signs		229	84.81
Anorexia		204	75.55
Vomition/nausea/salivation		120	44.44
Constipation/diarrhoea		94	34.81
Ascites/oedema		4	1.48
Splenomegaly		36	13.33
Hepatomegaly		9	3.33
Nervous signs		88	32.59
Ataxia		29	10.74
Tremors/convulsions		20	7.40
Dull/depressed/coma		64	23.70
Cardiac signs		162	60.00
Arrhythmia/cardiomyopathy		147	54.44
Weak thready pulse		48	17.77
Pulse deficit		46	17.03
Anaemia		70	25.92
Respiratory signs		58	21.48
Nasal discharge/ coughing/ epistaxis		35	12.96
Tachypnoea/dyspnoea		48	17.77
Collapse		32	11.85
Mean Clinical Score in cases presented		5.87 ± 0.20 (1-15)	-

Table 2 Relationship of Clinical score and mortality in canine babesiosis

Clinical score	Total cases	No of dogs died	Percentage
1-5	138	2	1.45
6-10	102	12	11.76
11-15	30	18	60.00
Total	270	32	11.85

The cases of babesiosis were further classified as acute, chronic and subclinical. The dogs with subclinical babesiosis showed no overt clinical signs but were cytologically positive. Acute form of the disease was seen in 27.78%, chronic form in 48.52% and subclinical form in 23.70% of the cases.

The signs were categorised as general state, gastrointestinal, nervous, cardiac and respiratory. Majority (92.22%) of the dogs had clinical signs attributable to the general state. Rectal temperature was elevated in 64.44% dogs, hypothermia in 7.77%, (21) while remaining 27.77% of the dogs had normal body temperature. Thus it is apparent that pyrexia is not a concordant sign in canine babesiosis due to *B. gibsoni*, contrary to the common belief. It was interesting to note that severely septicemic dogs had subnormal temperature. The fact that normal rectal temperature was also recorded in 27.77 % cases which indicated that pyrexia should not be taken as a thumb rule in canine babesiosis and the disease can be suspected even when there is no elevation of temperature if other clinical indicators are present.

Weakness, emaciation, dehydration were other general non-specific clinical signs observed, agreeing with earlier workers (Abdullahi *et al.*, 1990; Gupta *et al.*, 2002; Irwin, 2010). The main agent responsible for transmission of the disease is tick. However ticks were found only in 51.85% of the cases at the time of referral. Godara *et al.* (2010) in their study noted that there was a positive correlation between presence of ticks on the body surface of the host and haemoprotozoan infections. The general signs were manifested singly or in various combinations.

Gastrointestinal symptoms were observed in 84.81% of the dogs in the present study. Earlier workers have also recorded gastrointestinal symptoms as the major manifestation (Botros *et al.*, 1975; Irwin and Hutchinson, 1991). However, Malherbe and Parkin (1951) reported that the enterohagic form was a comparatively rare finding in *B. canis* infection.

In the present study 75.55% of the dogs suffered from anorexia. Indeed many dogs were presented with the only complaint of complete or partial anorexia for past few days. Vomiting or excessive salivation observed in 44.44% dogs may be a result of gastritis.

Diarrhoea (34.81%) in the present study was manifested in different forms ranging from merely increased frequency or semi-solid stools to haemorrhagic diarrhoea. Many dogs showed classical signs of haemorrhagic gastroenteritis (HGE). It seems probable that in many cases HGE might have accentuated babesia infection. Many of the dogs suffering from babesiosis subsequently or concurrently also suffered from severe HGE. Babesiosis by lowering the immune defence of the host could possibly make the dog more susceptible to other pathogens resulting in HGE. The reverse could also be true. Such complications were common in young pups (< 4 months) and dogs with no history of vaccination. The mortality in such cases was also higher.

Splenomegaly a relatively common sign in canine babesiosis (Conrad *et al.*, 1991; Varshney *et al.*, 2003; Vial and Gorenflot, 2006) was seen in 13.33% of the cases in the present study. Varshney *et al.* (2008) reported 20% incidence of splenomegaly. Seneviratna (1965) found on post-mortem examination that spleens of dogs infected with *B. gibsoni* were 3-6 times the normal size. Splenomegaly in babesiosis could be a result of chronic inflammation (Varshney *et al.*, 2008). The lower incidence in the present study might be due to increased awareness of the owners about the disease and their overwhelming concern for their pets. As such most dogs were usually brought to the Hospital immediately when they showed the slightest abnormal activity. Therefore chronic symptoms were not seen in such cases.

Hepatomegaly was seen in very few cases (3.33%). Ultrasonography also revealed hepatomegaly and hypoechoic texture of liver in one case which was suggestive of inflammation. (Sakuma *et al.*, 1987; Varshney *et al.*, 2003). Two dogs showed hyperechoic texture which could be due to hepatic fibrosis/ cirrhosis. Varshney *et al.* (2003) also documented hepatomegaly in clinical cases of babesiosis. Mathe *et al.* (2006) reported hepatomegaly and increased echogenicity of the liver in dogs with babesiosis. In canine babesiosis, hepatomegaly has been observed at necropsy (Irwin and Hutchinson, 1991).

Biurate crystals in urine were observed on microscopic examination in one dog with babesiosis which had protracted illness for more than a month and revealed splenomegaly and hepatomegaly with hyperechoic liver on ultrasonography. Biurate crystals are indicative

of chronic liver disease (Rothuizen, 2009) which in this case was probably secondary to babesiosis. Hypoxia can cause diffuse hepatocellular swelling (LeMasters, 2001) and therefore the hypoxia in babesiosis may be sufficient to cause transient hepatopathy. Thus the present findings indicate that the hepatic insult does occur in cases of babesiosis and the severity will increase if proper treatment is not instituted at an early juncture.

Ascites was seen in a small percentage of the cases (1.48%). Limb oedema was also seen in three dogs. Two dogs showed bilateral limb oedema (one also had ascites) while one showed oedema of all four limbs. Wadhwa *et al.* (2011) reported bilateral limb oedema in canine babesiosis. However oedema of all four limbs has not yet been reported. The oedema could be due to disturbances in peripheral circulation due to vascular stasis resulting from sludging of parasitized erythrocytes in the capillary beds (Birkenheuer, 2012). This may lead to escape of fluid into interstitial spaces resulting in oedema.

Symptoms of nervous system involvement were seen in 32.59% dogs with babesiosis. The main nervous signs were dullness and depression (23.70%) with coma in severe cases, ataxia (10.74%) and tremors or convulsions (7.4%). Cerebral babesiosis has been reported in *B. canis* infections (Jacobson, 1994; Collett, 2000; Sriram and Gomathinayagan, 2004). Recent publications have also described similar nervous signs in *B. gibsoni* infection (Varshney *et al.*, 2008; Chaudhari *et al.*, 2009). Cerebral babesiosis though less common, is characterised by nervous symptoms such as limb weakness, rheumatoid muscular pain, paresis and sudden death (Soulsby, 1982). Sludging of parasitized erythrocytes in small capillaries of CNS may lead to the development of CNS signs (Birkenheuer, 2012). Moore and Williams (1979) observed that microvascular damage secondary to hypoxia due to haemolysis contributed to the development of disseminated intravascular coagulation (DIC) which may be responsible for the atypical manifestations of babesiosis such as the nervous form. In the present study, 29 dogs showed ataxia and hind limb weakness. Epileptic convulsions with foaming at the mouth commensures were seen in five dogs. Myoclonus was seen in four dogs, one dog with myoclonus also had concurrent canine distemper (distemper inclusion in blood film) and head tilt was seen in one dog. The nervous signs in the present

cases were similar to those reported in cerebral malaria in humans. The nervous form had greater severity and was potentially more fatal.

Cardiac signs were observed in 60% cases in the present study. Arrhythmias were seen in 54.44% cases. Pulse deficit observed in 17.03% cases could be due to tachycardia. Pale mucous membranes (25.92%) could be due to the profound anaemia seen in babesiosis. However congested mucous membranes may also be seen in babesiosis (Varshney *et al.*, 2008). This may be due to the paradoxical phenomenon of severe intravascular haemolysis and haemoconcentration (Jacobson and Clark, 1994).

Respiratory manifestations were noticed in 21.48% dogs. Of respiratory signs, nasal discharge, epistaxis and coughing were seen in 12.96% and dyspnoea or tachypnoea in 17.77 % of the dogs with babesiosis. Deshmukh *et al.* (2008) also reported respiratory syndrome in a Great Dane pup with a mixed infection of *B. gibsoni*, *B. canis* and *E. canis* which was manifested by coughing, dyspnoea, tachypnoea and tachycardia. Increased vesicular tone auscultated in these cases was probably due to pneumonic changes or concurrent cardio-pulmonary involvement.

Higher frequency of tachypnoea in babesiosis (Chou, 1995) seems to be due to marked anaemia and stress (Varshney *et al.*, 2008). Hyperventilation which results in respiratory alkalosis is probably due to the body's attempt to compensate metabolic acidosis owing to hypoxemia (Birkenheuer, 2012). Epistaxis though not common in babesiosis can be due to marked thrombocytopaenia.

Clinical scoring

The individual dogs' total clinical score varied from 1 to 15 with a mean of 5.87 ± 0.20 in the present study. The present investigation showed a wide variability in clinical signs ranging from fever, anorexia, lethargy, weight loss, dehydration, diarrhoea/ constipation, vomition, pale mucous membranes to splenomegaly, hepatomegaly, ascites, arrhythmia, dyspnoea, ataxia and convulsions which is in accordance with the observations of earlier workers (Botros *et al.*, 1975; Irwin and Hutchinson, 1991; Gupta *et al.*, 2002; Varshney *et al.*, 2003; Varshney *et al.*, 2008; Selvaraj *et al.*, 2010; Wadhwa *et al.*, (2011). Haemoglobinuria which has been reported in *B. canis* infection was not seen in any case of *B. gibsoni* infection in the

present study and concurred with Groves and Dennis (1972) and Chou (1995). The large variation in clinical signs could be due to differences between breeds, age of the dogs, concurrent infections, nutritional and immune status of the dog.

Canine babesiosis is manifested in a myriad of forms. However clinical symptoms such as fever, anorexia, anaemia, presence of ticks, vomiting and diarrhoea, splenomegaly either singly or in combination should raise the suspicion of babesiosis.

Role of age and sex

Conrad *et al.* (1991) reported that the acute form is more common in *B. gibsoni* infection. There was no difference in the proportion of the disease severity between sexes and between breeds of dogs. However significantly ($P < 0.05$) higher number (50.00%) of dogs in > 72 months age group suffered from the acute form of the disease in the present study. This could probably be due to lowering of defence mechanisms in older dogs (Kearns *et al.*, 1999) thus making them more susceptible. Irwin (2005) stated that the age and immune status of the host play an important role in determining the pathogenesis of the disease.

Mortality

Death in 32 (11.85%) of the cases was attributed to respiratory failure. Fatality was significantly higher ($P < 0.01$) in dogs with hypothermia than in dogs with hyperthermia. Thus it is clear that dogs with subnormal temperature require more critical care. Mortality was also significantly related ($P < 0.01$) to the clinical score (Table 2). Increasing mortality with increase in clinical score observed in the study could be due to multisystemic complications in such cases. Therefore computation of clinical score at the time of admission could lead to a correct prognosis and better management of critical cases keeping all aspects in mind. Collapse was also significantly correlated with nervous signs, cardiac signs and respiratory signs. Chaudhari (2006) and Jacobson (1994) reported that the nervous form of babesiosis is potentially more fatal.

CONCLUSION

Babesiosis shows wide variability in clinical signs in canines. Working out clinical score of the case at the time of first presentation, help early prognosis and thereby better management of case.

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Heavy metal residues in plasma of broiler birds and goats from automobile industry rich area of northern Gujarat

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ABSTRACT

The present work was carried out to study plasma profile of five heavy metals viz., lead (Pb), chromium (Cr), cadmium (Cd), zinc (Zn) and cobalt (Co) from broiler (poultry) birds and goats reared in vicinity of automobile industry rich area of Palanpur, Banaskantha district of Gujarat. Plasma samples of fourteen birds and nine goats were analysed by atomic absorption spectrometry (AAS) for estimation of heavy metals. The mean $\pm$ S.E. value of lead, chromium, zinc and cobalt in broiler birds' plasma were found to be 4.389 ± 0.676 , 0.149 ± 0.067 , 0.963 ± 0.103 and 1.332 ± 0.135 ppm, respectively. In goat plasma, the mean $\pm$ S.E. value of lead, chromium, zinc and cobalt were found to be 3.321 ± 0.690 , 0.018 ± 0.017 , 1.343 ± 0.171 and 1.462 ± 0.171 ppm, respectively. Cadmium was not found in any goat or broiler bird's sample.

Key words : Heavy metals, blood plasma, broiler birds, goat

Heavy metals are persistent environmental contaminants that can cause serious health hazards to man and animals. Anthropogenic activities (mostly industrial growth) and geological background are two main origins for the wide release of the heavy metals in the environment (Baize and Sterckeman, 2001). Heavy metals can readily transfer through food chains and cause adverse effects on human health (Rahimi, 2013). Palanpur is the headquarter city of Banaskantha district of Gujarat State, having automobile and ancillary industries like manufacturing and recycling of automobile batteries, recycling of engine oils and rubber tyres. Additionally, this city is located on linking of state and national highways, so, exposure to vehicular emissions is common. There is trend of goat and poultry rearing in the area for the purpose of trading chevon and chicken meat; respectively. Thus, there is need to assess the

selected heavy metal levels in poultry and goats to safeguard the local public health. Also, knowledge of heavy metal concentration in livestock reared in polluted environment is essential to assess their deleterious effects on animal health and humans (Lopez-Alonso *et al.*, 2000; Miranda *et al.*, 2005). Plasma heavy metal level reflects the potential of metals for biotransfer and bioaccumulation in meat beyond legal limits and help to determine the potential risks from the toxic effects of heavy metals. Moreover, concentration of heavy metals in blood samples could be considered as bio-indicators of heavy metal pollution in an environment (Somasundaram *et al.*, 2005). Thus, the present study was undertaken to acquire the plasma heavy metal profile of broiler birds and goats reared in Palanpur area of Banaskantha district of Gujarat state having above mentioned predispositions.

MATERIALS AND METHODS

Blood samples from nine goats and fourteen broiler birds (poultry) from slaughter houses located in

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Palanpur, Banaskantha district, North Gujarat, were collected. Analysis of metals included lead (Pb), chromium (Cr), cadmium (Cd), zinc (Zn) and cobalt (Co). The metals were selected based on their toxic potential of exposure to domestic animals and birds, and on the nature of industries located in the vicinity of area under investigation. About 2 ml of blood was collected from jugular vein of goats whereas about 1 ml of blood was collected from wing vein from poultry in a clean, sterile heparinized tube, prior to slaughter. All the blood samples were centrifuged (4000 RPM for 10 minutes) and plasma was separated and stored in deep freeze (-20°C) until analysed by atomic absorption spectrometry (AAS; Model AAS-4141, ECIL, New Delhi). Sample digestion was performed by method as described by Kolmer *et al.* (1951) with some modifications. For sample processing, 0.2 ml of plasma was digested with 1.8 ml of triple acid mixture (Nitric acid: sulfuric acid: perchloric acid; 1:2:1). The digestion procedure was continued until the solution became clear. Then sample was transferred into volumetric flask and diluted to 10 ml with deionizer water. Lead, copper, cadmium, chromium and zinc were excited using oxygen

acetylene flame. The absorbance of elements was compared with absorption values of standards.

RESULTS AND DISCUSSION

The levels of heavy metals in plasma of broiler birds and goats are presented in Tables 1 and 2, respectively. Present investigation revealed that mean level of Pb, Cr, Zn and Co in broilers plasma were 4.389, 0.149, 0.963 and 1.332 ppm, respectively, where as these values in goat plasma were 3.321, 0.018, 1.343 and 1.462 ppm, respectively. High blood lead levels were noticed in both broilers and goats with the range of 1.522 to 7.997 ppm and 0.102 to 6.361 ppm, respectively. In goats, blood lead levels less than 0.20 ppm are considered normal and levels more than that may be indicative of lead intoxication (Smith and Sherman, 2009), but in the present report all the goats were apparently healthy and exhibit no clinical signs. Nigam *et al.* (2014) reported much higher values of blood lead level in the range of 7.35 ppm to 14.91 ppm in buffaloes without any apparent toxic symptoms which is in close agreement to our findings.

Table 1 Levels of heavy metals (ppm) in plasma of broilers

Sample No.	Lead (Pb)	Chromium (Cr)	Cadmium (Cd)	Zinc (Zn)	Cobalt (Co)
1	3.680	0.684	0.000	0.170	0.037
2	2.995	0.000	0.000	1.247	1.560
3	2.626	0.684	0.000	0.264	1.367
4	1.522	0.000	0.000	0.947	1.633
5	6.729	0.387	0.000	1.009	1.657
6	6.571	0.212	0.000	1.004	1.464
7	7.512	0.000	0.000	0.926	1.343
8	7.997	0.000	0.000	1.029	1.560
9	7.307	0.000	0.000	0.910	1.488
10	1.789	0.000	0.000	0.893	1.876
11	1.953	0.000	0.000	0.976	1.234
12	6.543	0.122	0.000	1.672	1.87
13	2.456	0.000	0.000	0.978	0.987
14	1.765	0.000	0.000	1.453	0.578
Mean ± SE	4.389 ± 0.676	0.149 ± 0.068	0.000 ± 0.000	0.963 ± 0.104	1.332 ± 0.135

Table 2 Levels of heavy metals (ppm) in plasma of goats.

Sample No.	Lead (Pb)	Chromium (Cr)	Cadmium (Cd)	Zinc (Zn)	Cobalt (Co)
1	5.624	0.000	0.000	0.926	1.343
2	6.361	0.000	0.000	1.029	1.560
3	0.102	0.000	0.000	0.910	1.488
4	4.234	0.000	0.000	1.629	1.273
5	2.323	0.000	0.000	1.982	1.856
6	2.822	0.000	0.000	0.899	2.007
7	1.892	0.161	0.000	1.728	1.899
8	1.652	0.000	0.000	2.112	1.456
9	4.876	0.000	0.000	0.872	0.275
Mean±SE	3.321 ± 0.690	0.018 ± 0.017	0.000 ± 0.000	1.343 ± 0.171	1.462 ± 0.171

In present study, cadmium was not detectable in any goat or broiler birds' sample. Lead along with cadmium is most abundant heavy metal in the industrial polluted environment and they have no detectable beneficial roles in the body. Increased level of blood lead concentration also affects bioaccumulation of other heavy metals including cadmium (Patra *et al.*, 2006). In this study too, there are high blood lead levels found with no detectable cadmium in broilers as well as goat. However, Oluokun *et al.* (2007) reported lower blood lead level (0.511 ± 0.126 ppm) and detectable blood cadmium level (0.024 ± 0.004 ppm) from goats raised in environment polluted with cement kiln dust. Mean level of zinc and cobalt in goat plasma were observed to be 1.343 ± 0.17 and 1.462 ± 0.171 ppm, respectively in the present study whereas Swarup *et al.* (2006) found blood Zn and Co values as 2.709 ± 0.163 and 0.102 ± 0.012 , respectively in goats from lead polluted smelter area. These dissimilarities may be attributable to the difference in nature of pollutants. Chromium was detected only in five broilers and one goat plasma sample indicating that variation in the pattern of bioaccumulation of chromium in broilers where as goats were more tolerable to the bio-transfer of chromium.

CONCLUSION

In heavy metal analysis from 14 broiler bird's plasma and 9 goat plasma, lead, zinc and cobalt were detectable in all samples whereas chromium was detected in five broilers and one goat plasma samples.

Cadmium was not found in any of plasma sample from either species. Blood lead levels were high in both broiler birds and goats. On the basis of this preliminary model study, it is necessary to study periodically the level of heavy metals in the edible tissues of meat animals from the same area rich in automobile industry. Further expansion of study over large area involving more number of samples would clarify the heavy metal profile, its relation with health status and quality of livestock origin foods.

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Residue analysis of ciprofloxacin in milk of dairy animals by LC-FD method

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ABSTRACT

Increasing use of antimicrobials to combat bacterial diseases among dairy animals has imposed the threat of antimicrobial drug residues in milk of dairy animals. Monitoring of drug residues in foods of livestock animal is essential to establish benchmark for quality of livestock food including milk. The MRL (maximum residue limit) of ciprofloxacin in bovine milk is 0.1 ppm as recommended by European Commission regulations. The present study was executed to establish the residual concentration of ciprofloxacin, an antimicrobial drug of fluoroquinolone group, in milk samples collected from different area of Northern Gujarat. Milk samples were collected from 49 dairy animals from unorganized dairy farms and farmers' door steps located at two districts of North Gujarat namely, Banaskantha and Aravalli. The concentration of ciprofloxacin in milk was analysed using validated high performance liquid chromatography (HPLC) with fluorescent detector (LC-FD). Mobile phase contained mixture of acetonitrile and buffer (50:50) and kept at the flow rate of 2.0 ml/min. Excitation and emission wave length were 295 and 500 nm, respectively. Limit of quantification (LOQ) and limit of detection (LOD) were 0.01 µg/ml and 0.003 µg/ml, respectively. Out of 49 milk samples, none was found to contain the detectable concentrations of ciprofloxacin.

Key words : Ciprofloxacin, milk residue, dairy animals

Dairy production system should be planned and managed in a way that the exposure of milk producing animals to veterinary drugs should not pose a risk to human health through consumption of such milk. Residue level of any veterinary drug above its MRL (Maximum Residue Level), as established by the concerned regulatory authorities of respective countries, is likely to cause adverse effects in consumers. Globally, various regulatory agencies like Codex alimentarius, US-FDA (Food and Drug Administration), European Commission (EC) and FSSAI (Food Safety and Standard Authority of India) recommend legal MRL for veterinary drug residues in foods of animal origin like milk and meat. Indiscriminate use of antimicrobials with overdosing

and non-compliance of withdrawal periods for milking, are the main reasons responsible for causing drug residual concentration in milk above established MRL. Antimicrobial milk residues may exert an adverse effect on consumers in a number of ways, such as toxicological adverse effects (intrinsic nature of antimicrobial), adverse effects on beneficial microflora of the gastrointestinal tract of consumers and drug allergic reactions.

Ciprofloxacin is a second generation fluoroquinolone antimicrobial having broad spectrum activity against many veterinary pathogens. Additionally, it is major metabolite of enrofloxacin, a veterinary fluoroquinolone, and thus, can be present as residues in milk (Choma, 2006). Ciprofloxacin act on pathogens by blocking their DNA synthesis through inhibition of DNA gyrase and topoisomerase IV enzymes. Ciprofloxacin is used commonly for the treatment of pneumonia, metritis, mastitis and other infections

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caused by susceptible bacteria in dairy animals. Such a wide spread use is likely associated with presence of residual concentration in milk of dairy animal at field level. In a pharmacokinetic study, ciprofloxacin was found above therapeutic concentration in milk of lactating goats for more than 10 hours following single intramuscular administration at dose rate of 5 mg/kg body weight and showed a cumulative behaviour in milk after repeated administrations (El-Banna, and Abo, 1998). European Union has set Maximum Residue Limits (MRLs) for quinolones like ciprofloxacin and enrofloxacin in animal products such as milk, with the aim of minimizing the risk to human health associated with their residue consumption. Common toxic reactions of ciprofloxacin in humans involve gastro-intestinal tract, central nervous system and haematological system. It is also reported as cardiotoxic and hepatotoxic (Adikwu and Brambaifa, 2012). For actual risk assessment and regulation of drug residues in milk, it is necessary to determine the prevailing level of different milk residues by monitoring them. Screening for drug residue is necessary to ensure that foods or dairy products containing violative residues are not introduced into the food chain (Mitchell *et al.*, 1998). Thus, the present study was undertaken for the analysis of ciprofloxacin residues in dairy animals' milk in order to monitor the residual concentration of ciprofloxacin in their milk. Limit of quantification (LOQ) and limit of detection (LOD) were 0.01 µg/ml and 0.003 µg/ml, respectively.

MATERIALS AND METHODS

A total of 49 milk samples of cows (29) and buffaloes (20) were collected randomly from unorganized farms and farmer's door steps. The area of collection included two district of North Gujarat namely, Banaskantha and Aravalli. Approximately, 10 ml of milk sample was collected in milk collection bottle from each animal. The samples were labelled properly and transported to the laboratory in thermo-cooled container jacketed with ice and stored in the refrigerator at -40°C till further processing. The concentration of ciprofloxacin in milk was analysed using LC-FD (Liquid Chromatography with Fluorescent Detector) with the excitation and emission wavelengths of 295 and 500 nm, respectively. Mobile phase comprised of mixture of acetonitrile and buffer (50:50) and kept at flow rate of 2.0 ml/min. Buffer was prepared by mixing 560 µl of phosphoric acid and 550 µl of triethylamine in one litre of HPLC water. For sample extraction and preparation, 5 ml acetonitrile and 0.5 ml phosphoric

acid were mixed with 5 ml milk and vortexed for 1 minute. Then mixture was centrifuged at 4000 RPM for 10 minutes and 1 ml supernatant was mixed with equal volume of dichloromethane. It was then vortexed and re-centrifuged at 10000 RPM at 4°C. Finally, aqueous layer was separated and 20 µl processed sample was injected into HPLC machine. The peak area was used for calculation of concentration on the basis of standard curve.

RESULTS AND DISCUSSION

In the present ciprofloxacin residue analysis by LC-FD, the linearity of the analytical method was proved at seven different level of concentration (in duplicates) in milk samples ranging from 0.01 to 10 µg/ml, and value of the mean co-relation co-efficient (R^2) was found to be 0.9591 (Figure 1). Limit of quantification (LOQ) and limit of detection (LOD) were 0.01 µg/ml and 0.003 µg/ml, respectively. Recovery of ciprofloxacin from known milk standards were above 80%. Representative chromatogram for the analysis of standards is shown in Figure 2. Established MRL (Maximum Residue Level) for ciprofloxacin and enrofloxacin in milk of all animal species is 100 µg/kg (*i.e.* 0.1 ppm) set by Regulation No. 99/508 of European Union legislation (European Commission, 1999). Many methods have been developed and validated for the estimation of ciprofloxacin residues in milk *viz.* optical immunobiosensor assay (Mellgren and Sternesjo, 1997), HPLC-DAD (Cinquina *et al.*, 2003), HPLC and TLC with direct bioautography (Choma, 2006), fluorimetric spectrometry method (Hui-Ping *et al.*, 2006), capillary electrophoresis-electrochemiluminescent method (Zhou *et al.*, 2008), LC-UV, LC-FD, LC-MS and LC-MS/MS (Hermo *et al.*, 2008) and indirect competitive ELISA (Huang *et al.*, 2010) but reports on presence of ciprofloxacin residues in milk samples from field is lacking. In the present study, all 49 milk samples were found to be negative for ciprofloxacin residues.

CONCLUSION

A validated LC-FD method was used to monitor the ciprofloxacin residue levels in the milk of milching animals. Out of 49 milk samples collected from dairy animals, none was found to contain the detectable concentrations of ciprofloxacin above its MRL. It is concluded that the milk samples collected in the study do not possess any harmful residual concentration of ciprofloxacin.

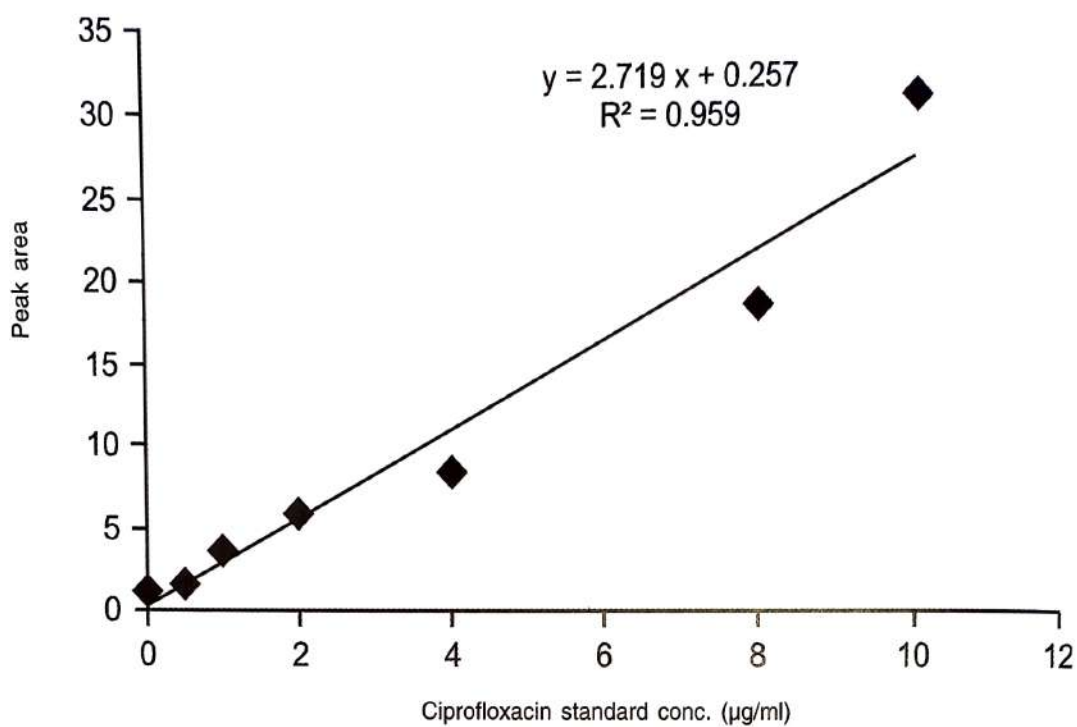


Fig. 1 Standard curve of ciprofloxacin spiked in milk (X-axis shows concentration in µg/ml whereas Y-axis indicates the peak area)

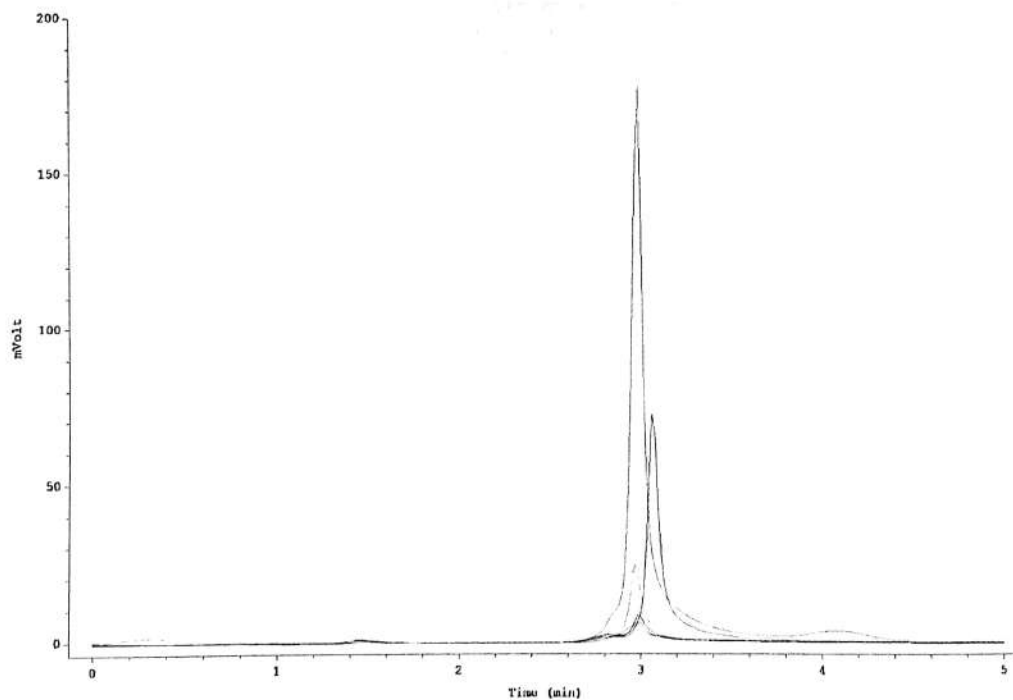


Fig. 2 Chromatogram of ciprofloxacin standards

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