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Performance of Sweet Sorghum Genotypes to Varying Levels of Nitrogen and Phosphorus*

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ABSTRACT

A field experiment carried out during *kharif* 1996 to find out good sweet sorghum genotypes for fodder purpose and optimum level of N and P to maximise yield. The treatments consisted of two genotypes (SSV-84 and SSV-12611), three levels of N (75, 100 and 125 kg/ha), two levels of P (50 and 60 kg/ha) and one control DFJ-1, a presently ruling variety. SSV-84 produced significantly higher green fodder (49.26 t/ha) than SSV-12611 (47.32 t/ha) and both were superior over local check DFJ-1. Both the sweet sorghum genotypes responded positively to N up to 125 kg per ha but not to P over 50 kg per ha.

(Received on 11th July, 2001)

INTRODUCTION

Despite the fact that India is having the highest livestock herd (> 400 million), it stands second in milk production on global basis. This is due to many reasons viz., low milk yielding breeds, extreme climatic conditions and lack of availability of nutritious green and dry fodder. Total fodder requirement to feed our cattle population during 1995-96 was around 850 and 1064 million tons dry and green fodder respectively and has reached to 950 and 1400 million tons respectively during 2000-01 resulting in a short fall of dry fodder, green fodder and concentrated feed to an extent of 33.5, 23 and 47 per cent respectively. This demands two fold approach on agronomists, first to screen good fodder yielding genotypes and

second to adopt suitable nutrition management to increase productivity of selected genotypes. Keeping these two objectives in mind the present field experiment was carried out to find out good sweet sorghum genotypes and optimum level of N and P to maximise yield.

MATERIALS AND METHODS

A field experiment conducted during *kharif* 1996 at Agriculture College Farm, University of Agricultural Sciences, Dharwad. The location of the site was situated at 15° 26' N latitude and 75° 07' E longitude with an altitude of 678 m above the mean sea level. Soil of the site was deep black with clay loam texture and was found to have 149.80, 41.00 and 329.00 kg of N, P₂O₅ and K₂O

* Part of M. Sc. (Agri.) thesis submitted by the senior author to University of Agricultural Sciences, Dharwad-580 005.

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per ha, respectively. The pH of the soil was 7.5. The rainfall received during the year 1996 was 791.80 mm which was 9.80 mm lesser than average of past 50 years. During the period of field experimentation (September 8th to October 10th 1995) rainfall of 413.90 mm was recorded.

The treatments consisted of two combination of two genotypes (G1=SSV-84 and G2=SSV-12611), three N levels (N1=75, N2=100 and N3=125 kg/ha) and two P levels (P1=50 and P2=60 kg/ha) and one control having DFJ-1, a presently existing variety released for this region. Totally 13 treatments were laidout in randomised complete block design and were replicated thrice. Nutrients were supplied in the form of urea, super phosphate and muriate of potash. Nitrogen was applied in two equal splits, 50 per cent at sowing and remaining 50 per cent at 30 days after sowing (DAS) whereas, P and K nutrients applied as basal dose while sowing. Crop spacing of 30 cm x 5 cm was followed using 30 kg seeds per ha. Crop was harvested at 50 per cent flowering stage for fodder purpose and data recorded on growth, green fodder yield and quality parameters.

RESULTS AND DISCUSSION

Use of appropriate situation or season, specific variety and proper crop management practices are most important to achieve targeted yields. The presently existing variety DFJ-1 though gives high biomass yield but cattle do not very much relish because of its fibrous stem. Therefore,

sweet sorghum varieties having juicy stem with less fibre considered in the study.

Sweet sorghum varieties (SSV-84 and SSV-12611) yielded 14.26 t per ha (41%) more green fodder than DFJ-1 (check 34.08 t/ha.). This increased green yield with sweet sorghum varieties was due to higher plant height (284.42 cm), LAI (5.30), inter nodal length and stem girth. Similar findings were reported by Desai and Deore, 1980 and Kudasomannavar, 1980.

Between two genotypes, SSV-84 produced significantly higher green fodder yield (49.26 t/ha) than SSV-12611 (47.32 t/ha.). The higher yield with SSV-84 was primarily due to taller plants (291.95 cm) and higher total dry matter per plant (75.85 g/plant). Channa Naik and Jayakumar (1994) and Ashwathama (1996) also found higher yield with SSV-84 in their studies. Nitrogen levels had significant effect on green fodder yield of sweet sorghum genotypes. The highest fodder yield of 55.66 t per ha was recorded with SSV-84 at 125 kg per ha followed by SSV-12611 at same level of N (53.53 t/ha).

Irrespective of genotypes, there was a significant increase in green fodder yield with increase in N level upto 125 kg per ha. However, sweet sorghum genotypes did not respond to higher P level over and above 50 kg P_2O_5 per ha. Similar was the observation made by Patel *et al.*, (1994) and these results confirm the findings of Rai *et al.*, (1989) also.

TABLE 1

Plant height, LAI and total dry matter production (at harvest) and green fodder yield of fodder sorghum varieties as influenced by fertilizer levels.

Treatment	Plant height (cm)			TDMP (g/plant)			Green fodder yield (t/ha)			LAI		
	G ₁	G ₂	Mean	G ₁	G ₂	Mean	G ₁	G ₂	Mean	G ₁	G ₂	Mean
Nitrogen (kg/ha)												
75 (N1)	270.53	252.38	261.46	70.32	66.72	68.52	42.51	40.41	41.46	5.17	5.03	5.10
100 (N2)	290.48	274.87	282.68	75.04	71.35	73.20	48.60	48.01	48.81	5.37	5.44	5.41
125 (N3)	314.82	303.45	309.13	82.21	75.40	78.80	55.66	53.53	54.60	5.55	5.46	5.51
Phosphorus (kg/ha)												
50 (P1)	294.22	277.07	285.64	75.43	70.23	82.86	49.15	47.17	48.16	5.31	5.24	5.28
75 (P2)	289.68	276.73	283.21	76.23	72.08	74.15	49.36	47.46	48.41	5.41	5.22	5.31
Mean	291.95	276.90	284.43	75.86	71.16	73.51	49.26	47.32	48.29	5.36	5.23	5.30
Check			259.93			62.69			34.04			4.90
Rest			284.42			73.51			48.29			5.30
Check Vs. Rest												
N	7.53	15.56	11.07	3.80	7.85	5.16	1.39	0.64	2.87	0.10	0.04	0.20
P	3.79	NS	NS	1.76	NS	NS	0.52	0.52	NS	0.03	0.03	NS
G	3.09	9.03	NS	1.43	4.22	NS	0.91	0.74	1.54	0.03	0.06	0.11
NXG	5.36	NS	NS	2.49	NS	NS	0.91	0.74	NS	0.06	0.05	NS
PXG	—	—	—	2.03	NS	NS	0.91	0.74	NS	0.06	0.06	NS
NXP	3.09	NS	NS	2.49	NS	NS	1.29	1.29	NS	0.09	0.09	NS
NXPXG	3.09	NS	NS	2.85	NS	NS	1.29	1.29	NS	0.09	0.09	NS

G1=SSV-84, G2=SSV-12611, Check=DFJ-1, rest = Mean of both sweet sorghum genotypes.

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Effect of Crop Geometry on Rainfed Cotton

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ABSTRACT

A field experiment was conducted at Gujarat Agricultural University, Arnej during 1994-95 and 1995-96 to find out optimum spacing for rainfed cotton (*Gossypium herbaceum* L) variety G. Cot. 13. The growth and yield attributes were increased with increase in inter and intra row spacings. Seed cotton yield was also increased with increase in inter and intra row spacing particularly during below normal rainfall year. On an average crop geometry of 180 cm x 45 cm produced the highest seed cotton yield. The wider inter and intra row spacing was also found more economical as it did not only increase the yield but also decreased the cost of cultivation.

(Received on 4th Sept., 2001)

INTRODUCTION

Of the various agronomic factors, optimum plant spacing between and within row plays important role in increasing yield of cotton particularly under rainfed conditions. The varieties of cotton grown in Bhal and Coastal Agro climatic Zone are of long duration (240 days) and often experience moisture stress during the reproductive phase due to interplant competition. Under such situation adoption of appropriate crop spacing helps in efficient utilization of soil moisture and may improve crop productivity. The present investigation was therefore taken up to generate information on optimum inter and intra row spacing for cotton G. Cot. 13.

MATERIALS AND METHODS

Field experiments were conducted during rainy season of 1994-95 and 1995-96 at Regional Research Station, Gujarat Agricultural University, Arnej. The soil of the experimental field was clayey in texture (Chromusterts), low in available nitrogen (203 kg/ha) and phosphorus (12.1 kg/ha) but high in available potash (713 kg/ha). The pH of the soil was 8.1. The treatments comprising

five inter row spacings (60, 90, 120, 150 and 180 cm) as main plots and three intra row spacings (30, 45 and 60 cm) as sub plots were tested in split plot design with four replications. Cotton var. G. Cot.-13 was sown on 2 and 19 July whereas crop was harvested on 15 and 6 March during 1994-95 and 1995-96, respectively. The crop was fertilized with 50 kg N and 25 kg P_2O_5 /ha. Half of nitrogen and entire dose of phosphorus were applied at sowing whereas remaining half dose of nitrogen was applied 45 days after sowing (DAS). The total rainfall received during *kharif* seasons of 1994-95 and 1995-96 was 854.2 and 395.5 mm with +37 and -36 per cent deviation from average rainfall (620 mm) of the station, respectively.

RESULTS AND DISCUSSION

Effect on growth and yield attributes

Inter row spacing had a significant effect on growth and yield attributes (Table 1). Plant height, effective and total number of branches/plant, number of bolls/plant and seed cotton yield / 100 bolls increased significantly with increased in inter row spacing from 60-180 cm. Thus the highest

TABLE 1

Growth and yield components of cotton as influenced by different inter and intra row spacing (mean data of two years).

Treatment	Plant height, cm	Number of branches per plant		No. of bolls/ Plant	Seed cotton yield/100 bolls, g
		Effective	Total		
Inter row spacing, cm					
60	67.35	4.69	7.25	9.58	179.9
90	75.58	6.04	8.25	13.88	187.5
120	82.83	7.34	9.37	18.73	191.0
150	85.81	8.63	9.87	26.19	196.7
180	89.53	8.63	10.25	32.87	198.4
CD (P=0.05)	4.04	0.67	1.61	8.67	7.1
Intra row spacings, cm					
30	74.68	5.62	7.85	14.13	185.0
45	80.63	7.08	9.16	20.53	190.0
60	85.35	8.08	9.99	26.10	196.8
CD (P=0.05)	NS	0.49	0.80	2.01	NS

value of all the growth and yield attributes were observed with the widest inter and intra row spacing of 180 cm. This might be due to increased reception of sun light and less competition between the plants under wider spacing. Further, the root proliferation is horizontal in this soil because of existence of impervious hard layer below 70 cm soil surface. Intra row spacing did not produce significant effect on plant height and seed cotton yield/100 bolls. However, it had a significant effect on effective and total number of branches/plant as well as on number of bolls/plant. Prasad and Prasad (1993) had also reported that intra row spacing did not alter the plant height but produced more number of bolls/plant.

Effect on yield and harvest index

Different inter row spacings did not significantly influence the seed cotton and stalk yield during first year and in pooled analysis but the effect was found significant in second year (Table 2). In second year seed cotton yield was increased with widening of inter row spacing from 60 to 180 cm. The highest seed cotton yield of 5.34 q/ha was obtained with the widest inter row spacing of 180 cm, but remained at par with that

of 150 cm inter row spacing. The trend was almost reverse in case of stalk yield. Inter row spacing of 90 cm remaining at par with 60 cm inter row spacing, produced significantly higher stalk yield as compared to rest of the spacings. These results are not in confirmation with those of Jadhav *et al.* (1993).

The pooled data revealed that the effect of inter row spacings on seed cotton and stalk yield was not consistent over years. This could be attributed to the variation in amount and distribution of rainfall during the years of experimentation. In 1994-95, total rainfall of 854.2 mm was received in 44 rainy days which was higher than average rainfall of 620 mm. In the good rainfall year, the yield of seed cotton was not influenced due to inter row spacings. In 1995-96, when receipt of rainfall was less than the average, the inter row spacing showed their significant effect on seed cotton yield. Thus, wider row spacing was found better during below normal rainfall year.

Intra row spacings failed to produce their

TABLE 2
Seed cotton yield (kg/ha) as influenced by different inter and intra row spacing.

Treatment	Seed cotton yield, q/ha			Stalk yield, q/ha			Harvest index		
	1994- 95	1995- 96	Mean	1994- 95	1995- 96	Mean	1994- 95	1995- 96	Mean
Inter row spacing, cm									
60	7.35	2.65	5.00	12.80	12.19	12.50	0.36	0.17	0.27
90	6.99	3.81	5.40	13.06	12.68	12.87	0.35	0.23	0.29
120	6.93	4.38	5.65	12.37	11.62	12.00	0.36	0.27	0.32
150	7.87	4.91	6.39	12.47	10.12	11.30	0.38	0.33	0.36
180	7.83	5.34	6.59	12.96	10.25	11.60	0.38	0.34	0.36
CD (P=0.05)	NS	1.04	NS	NS	0.95	NS	NS	0.047	0.039
Intra row spacing, cm									
30	7.32	3.68	5.50	13.61	12.58	13.09	0.35	0.23	0.29
45	7.38	4.37	5.87	12.30	11.19	11.75	0.38	0.28	0.33
60	7.48	4.60	6.04	12.28	10.35	11.32	0.38	0.31	0.34
CD (P=0.05)	NS	0.58	NS	1.08	0.72	0.64	0.024	0.032	NS

significant effect on seed cotton yield during first year and in pooled analysis. But in second year, wider intra row spacings of 60 and 45 cm produced significantly higher seed cotton yield than that of 30 cm intra row spacing. With regard to the effect of intra row spacings on stalk yield, it was noted that stalk yield of cotton decreased significantly with increase in intra row spacing during both the years of experimentation as well as on pooled basis.

Harvest index did not vary much due to variation in inter row spacing during first year but in second year and in pooled analysis, it increased markedly due to increase in inter row spacing from 60 to 180 cm (Table 2). The results further indicated that there was a tendency of increasing harvest index due to increase in intra row spacing from 30 to 60 cm during both the years. But the differences in harvest index due to different intra row spacings did not reach level of significance in pooled analysis. The results thus indicated that plants raised at narrow spacing enhanced vegetative growth rather than reproductive one and results in low harvest index.

Interaction effect

The interaction between inter and intra row spacings was not found significant in individual years but it was significant in pooled analysis (Table 3). Among the various combinations, 180 cm x 45 cm spacing produced the highest yield of 7.45 q/ha. It was at par with those of 150 cm x 30 cm, 150 cm x 45 cm, 120 cm x 60 cm and 180 cm x 60 cm spacings.

TABLE 3

Seed cotton yield (Q/ha) as influenced by interaction between inter and intra row spacing (R x P).

Inter row spacing, cm	Intra row spacing, cm			Pooled Mean
	30	45	60	
60	4.60	4.87	5.53	5.00
90	4.94	5.20	6.05	5.40
120	5.12	5.43	6.41	5.65
150	6.96	6.42	5.78	6.38
180	5.88	7.45	6.43	6.59
Mean	5.50	5.88	6.04	5.81

S.E.m. + = 0.40

C.D. 0.05 = 1.13

Economics

The widest inter row spacing recorded the highest net return (Rs. 6285/ha) and the highest B : C ratio (1.75) as it did not only increase the yield but also lowered the cost of cultivation. Similarly, the widest intra row spacing also proved the best on the basis of economics, net return being Rs. 4956/ ha and B : C ratio of 1.21. Manjappa *et al.* (1997) also observed maximum net return and the highest B : C ratio with widest spacing.

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TABLE 4

Monetary return and benefit : cost ratio as influenced by different inter and intra row spacings.

Treatment	Gross monetary return, Rs./ha	Cost of cultivation, Rs./ha	Benefit, Rs./ha	B : C Ratio
Inter row spacing, cm (R)				
60	7500	4600	2900	0.63
90	8100	4313	3787	0.88
120	8475	4020	4455	1.11
150	9585	3986	5599	1.40
180	9885	3600	6285	1.75
Intra row spacing, cm (p)				
30	8250	4104	4146	1.01
45	8805	4104	4701	1.15
60	9060	4104	4956	1.21

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Effect of Irrigation and Cutting Management on Growth and Yield of Lucerne (*Medicago sativa* L.)

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ABSTRACT

The field experiment comprising four irrigation levels (4, 60, 80 and 100 mm, cumulative pan evaporation) and three cuttings levels (50, 75 and 100 days after sowing) was conducted in split plot design at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Rabi* 2000-2001. There was significant increase in green fodder and seed yield of lucerne with increase in the level of irrigations. Scheduling of irrigation at 40 mm CPE recorded 27.32, 61.42 and 71.23 per cent more seed yield than 60, 80 and 100 mm CPE respectively. The green fodder and seed yield were also significantly increased with increase in number of cuttings from one to three. Cutting the crop thrice (50, 75 and 100 DAS) recorded 328.14 and 158.53 per cent more green fodder yield than cutting the crop once (50 DAS) and twice (50 and 75 DAS). Three cuttings gave significantly more seed yield (384 kg ha⁻¹) of lucerne than two (320 kg ha⁻¹) and one cuts (308 kg ha⁻¹) but difference between latter two treatments was not significant. For higher seed yield of lucerne, irrigation should be applied at 40 mm CPE and left the crop for seed production after taking three cuts for green fodder.

(Received on 16th Oct. 2001)

INTRODUCTION

Lucerne (*Medicago sativa* L.) is highly palatable nutritious and energy rich leguminous forage crop. Under proper management it can provide a continuous supply of green fodder for longer period (Nov.-June) in comparison to berseem (Dec.-April). The non availability of good seed in time hampered its cultivation in Maharashtra. Lucerne is notoriously erratic in seed production and seed yield is very low (50 to 250 kg ha⁻¹). Hence no acreage is devoted for seed production of lucerne. Low seed yield of lucerne is due to untimely last cutting of crop for forage and not to maintain desired soil moisture through irrigation water. Generally the crop is left for seed production after taking two to three cuts for green fodder. The seed yield of 300 to 400 kg ha⁻¹ was recorded at Nawagaon (Gujarat) after

two to three cuts for green fodder. The seed yield as high as 790 kg ha⁻¹ was recorded after four cutting for green fodder (Solanki, 1987). The information in respect of seed production of lucerne is very meagre in Maharashtra. In view of above the present investigation was undertaken to ascertain most appropriate combination of irrigation scheduling and time of last cutting for higher green fodder and seed yield of lucerne in Vidarbha region.

MATERIALS AND METHODS

The field experiment was conducted at Animal Husbandry and Dairying Department of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *rabi* season of 2000-2001. The experimental soil was clay loam in texture having total Nitrogen 0.054%, available P₂O₅ 32.34 kg ha⁻¹ and available K₂O 190.43 kg ha⁻¹ with pH

The significant increase in green fodder and seed yield was observed with increased in the levels of irrigation to its lower level (Table 1). The highest green fodder yield (255.28 q ha⁻¹) and seed yield (452 kg ha⁻¹) were recorded with I₁ treatment followed by I₂ treatment. The highest yield at I₁ treatment might be attributed to maintenance of favourable soil moisture in root zone of crop which reflected in higher values of growth and yield attributes. These results are in confirmation with the findings of Boehle *et al.* (1961) and Khot *et al.* (1997).

Effect of cutting management

Cutting the crop once at 50 DAS (C₁) recorded significantly more plant height (83.83 cm) than cutting the crop twice (C₂) and thrice (C₃) but difference between C₁ and C₂ was not significant. Cutting the crop frequently reduced plant height, (78.10 cm) which might be due to less vegetative regrowth of crop after each cutting for green fodder. However, the number of branches plant⁻¹ increased with increase in number of cuttings.

This might be due to more reproductive growth of plant rather than vegetative growth by cutting the crop frequently. Yield contributing characters viz., Number of capsules plant⁻¹, seed yield plant⁻¹ and test weight were showed significant with increase in number of cuttings from one to three for green fodder. However, the differences between C₁ and C₂ were not significant in respect of number of capsules plant⁻¹ and test weight (Table 1).

The green fodder yield was significantly increased with increase in the number of cuttings. Cutting the crop thrice (C₃) recorded 328.14 and 158.53 per cent more green fodder yield than cutting the crop once (C₁) and twice (C₂). These results are in conformity with the findings of Tomer *et al.* (1973). Data presented in Table 1 indicate that seed yield of lucerne was significantly more by leaving the crop for seed production after three cuts (C₃) for green fodder than two (C₂) and one cut (C₁) but the difference between C₁ and C₂ was not significant. These results confirm the findings of Dhaliwal and Bains (1983).

TABLE 2

Interaction effect of irrigation and cutting management on green fodder and seed yield lucerne.

Treatment		Green fodder yield (q ha ⁻¹)		
I/C		C ₁	C ₂	C ₃
I ₁		127.23	255.45	383.18
I ₂		106.05	200.40	325.79
I ₃		67.70	151.54	236.11
I ₄		43.05	104.70	183.88
C.D. (P=0.05)				13.52
		Seed yield (kg ha ⁻¹)		
I/C				
I ₁		370	392	595
I ₂		351	348	360
I ₃		262	278	301
I ₄		250	261	281
C.D. (P=0.05)				25

Note : I₁ - 40 mm CPE C₁ - Cutting at 50 DAS
 I₂ - 60 mm CPE C₂ - Cutting at 508.75 DAS
 I₃ - 80 mm CPE C₃ - Cuttings at 50, 75 and 100 DAS
 I₄ - 100 mm CPE

Irrigation x Cutting management

Data presented in Table 2 revealed that scheduling of irrigation at 40 mm CPE with three cuttings (I_1C_3) recorded significantly higher green fodder yield (383.18 q ha^{-1}) than all the treatment combinations. The higher yield under this combination might be due to fast regrowth of lucerne after each cut with moist soil conditions. Significantly higher seed yield of lucerne (595 kg ha^{-1}) was recorded when the crop was left for seed production after taking three cuts for green

fodder in combination with irrigation at 40 mm CPE (I_1C_3) than rest of the treatment combinations. This might be due to higher values of yield attributing characters under I_1 and C_3 treatments.

Thus it can be concluded that for higher seed yield of lucerne irrigation should be applied at 40 mm CPE and allowed the crop for seed production after taking three cuts at 50, 75 and 100 DAS for green fodder.

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Response of Kharif Maize to Inoculation with *Azotobacter* and *Azospirillum* at Varying Levels of Nitrogen

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ABSTRACT

A field experiment was conducted at the Main Maize Research Station, Godhra, Gujarat during 1998 to 2000 on sandy loam soil to assess the effect of *Azotobacter chroococcum* and *Azospirillum lipoferum* seed inoculation along with graded levels of nitrogen on grain and straw yield of kharif maize cv. GM-1. The results revealed that seed inoculation either with *Azotobacter chroococcum* or *Azospirillum lipoferum* gave significantly highest grain and straw yield 2558 and 2464 kg/ha and 3370 and 3252 kg/ha respectively. Application of nitrogen @ 80 kg/ha gave significantly highest net return of Rs. 17,520/-. The results revealed a saving of 20 kg N/ha when maize seed was inoculated with *A. chroococcum* and *Azospirillum lipoferum*.

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INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop mostly cultivated in low fertile soils of tribal belt of Gujarat in kharif and rabi seasons. Though maize is highly responsive to nitrogen and other inputs, their high cost limits their full use. It is, therefore necessary to explore alternative sources of fertilizers, especially nitrogen to fulfil the nitrogen requirement. It is proved in many cereal crops that the seed inoculated with *Azotobacter* and *Azospirillum* helps to fix the atmospheric nitrogen in the available form to plants and augments the nitrogen requirement. To assess their effect on grain and straw yield in maize, an experiment was conducted using *Azotobacter chroococcum* and *Azospirillum lipoferum* along with graded levels of nitrogen.

MATERIALS AND METHODS

Field experiment

A field experiment was conducted on sandy loam soil at Main Maize Research Station, Gujarat Agricultural University, Godhra (Gujarat) during kharif seasons of 1998, 1999 and 2000. The experiment was laid out in randomised block design with two biofertilizer seed inoculants i.e. *Azotobacter chroococcum* (ABA-1) and *Azospirillum lipoferum* (ASA-1) with untreated control along with five levels of nitrogen viz. 0, 20, 40, 60 and 80 kg/ha alone and in combination with biofertilizer seed inoculation. Nitrogen was applied in the form of urea in a split application, one half being at sowing time and the remaining as a top dressing at knee height and tasselling

Abbreviations :

1. ABA-1 : *Azotobacter chroococcum*, Anand -1.
2. ASA-1 : *Azospirillum lipoferum*, Anand-1.
3. I.C.B.R. : Incremental Cost Benefit Ratio.

stage in equal splits. A uniform basal dose of 30 kg P_2O_5 /ha was applied in the form of single super phosphate.

Seed Inoculation

The maize seeds of cv. Gujarat Maize -1 were inoculated with bio cultures viz. *Azotobacter chroococum* and *Azospirillum lipoferum* @ 25 gm/kg seeds containing 10^8 CFU/gram carrier prior to one hour of sowing.

RESULTS AND DISCUSSION

Data presented in Table 1 revealed that effect of seed inoculation treatments has significantly increased the grain yield in all the three years. Among the two seed inoculation treatment ABA-1 gave significantly higher yield in two out

of three years and in the pooled data. In case of dry fodder yield treatment ABA-1 was at par with ASA-1 in two years. However the pooled data ABA-1 was significantly superior over the other two treatments. Pooled analysis also revealed that seed inoculation with ABA-1 (2558 kg/ha) could increase the grain yield to the tune of 4 and 26% over ASA-1 (2464 kg/ha) and control (2038 kg/ha), respectively. Studies carried out by Cavallet *et al.* (2000) revealed that maize seed inoculation with *Azospirillum Spp* along with 70 kg N/ha increased the maize productivity by 17% (from 5211 to 6067 kg/ha) while cob length increased from 13.6 to 14.4 cm. Reddy *et al.* (1977) reported that *Azotobacter* seed inoculation significantly raised the grain yield of maize by 9-14%.

TABLE 1

Response of kharif maize to inoculation with *Azospirillum* and *Azotobacter* at varying levels of nitrogen (kharif 1998-2000).

Treatment	Grain yield (kg/ha)				Dry fodder yield (kg/ha)			
	1998	1999	2000	Pooled	1998	1999	2000	Pooled
(A) Bio-fertilizer								
B ₁ Control	2227	2128	1760	2038	2783	2746	2254	2594
B ₂ ABA-1	2696	2607	2372	2558	3370	3248	3138	3252
B ₃ ASA-1	2633	2532	2228	2464	3292	3317	2973	3194
(B) Nitrogen levels								
N ₁ -0 kg/ha	1501	1444	1156	1367	1876	1835	1499	1737
N ₂ -20 kg/ha	2126	1948	1713	1929	2657	2709	2230	2532
N ₃ -40 kg/ha	2583	2481	2093	2385	3228	3019	2745	2997
N ₄ -60 kg/ha	2982	2959	2611	2985	3727	3694	3454	3625
N ₅ -80 kg/ha	3403	3278	3028	3236	4254	3259	4012	4175
Isd B	107	50	171	67	134	121	217	ns
Isd N	138	64	220	87	173	156	280	ns
Isd B x N	ns	111	ns	ns	ns	270	ns	ns
Isd Y x B				ns				ns
Isd Y x N				ns				ns
Isd Y x B x N				ns				ns
C.V. %	5.7	2.7	10.8	6.8	5.7	5.2	10.4	2.1

Among the nitrogen doses, application of N @ 80 kg/ha was found to be significantly superior in increasing the grain as well as fodder yield in all the three years as well as in pooled analysis. No significant interaction between biofertilizer and nitrogen in two out of three years as well as in pooled analysis was absent. Hegazi *et al.* (1983) advocated that the maize seed inoculation with *Azospirillum* and straw amendment increase plant height, leaf-area index, shelling percentage, total yields of grain (180-270%), straw (150-170%) and nitrogen content (120-130%).

Considering the linear trend of nitrogen response and the definite effect of biofertilizer inoculation, an attempt has also been made to estimate the amount of nitrogen replaced by the biofertilizer treatments by fitting three separate equations for each biofertilizer treatments. The results are presented in Table 2.

TABLE 2

Nitrogen response equation fitted for three treatments.

Treatments	Constant (a)	Partial Regression coefficient (b)	R ² (%)
B ₁ (Control)	1189.27	21.2283	99
B ₂ (ABA-1)	1568.14	24.7550	99
B ₃ (ASA-1)	1507.97	23.9134	99

TABLE 3

Estimated Nitrogen requirement.

'N' doses for No bio - fertilizer (kg/ha)	Expected/ targeted grain yield (kg/ha)	Estimated 'N' requirement when seed inoculated with		'N' saving (kg/ha)	
		ABA-1	ASA-1	ABA-1	ASA-1
20	1614	1.85	4.44	18.15	15.56
40	2038	18.97	22.17	21.03	17.83
60	2463	36.10	38.34	23.90	21.66
80	2888	53.30	55.44	26.70	24.56
Mean				22.45	19.90

The result presented in Table 2 clearly suggest that close linear relation exists between the applied nitrogen and yield.

Comparison of regression co efficient of three equations indicated that increase in yield for per unit application of nitrogen was highest in case of ABA-1 (24.7550 kg) followed by ASA-1 (23.9134 kg). This clearly indicated that applied nitrogen efficiency was higher when seed are inoculated with biofertilizers.

In order to estimate the amount of nitrogen being saved due to seed inoculation with biofertilizer for various levels, the expected yields levels were worked out using the above fitted equations corresponding to no biofertilizer (B₁) keeping these expected yield as the targeted yields, the equations corresponding to biofertilizer applied (B₂ and B₃) were used to provide the estimated nitrogen requirement.

The data presented in Table 3 clearly indicated that sizable amount of nitrogen is saved when seed is inoculated with biofertilizer more so in ABA 1 (18 kg/ha) in case of first dose of nitrogen (20 kg/ha) whereas, it was to the tune of approximately 27 kg/ha for highest dose of nitrogen (80 kg/ha). On an average 22 and 20 kg of nitrogen /ha can be saved by inoculating the maize seeds before sowing with *Azotobacter chroococcum* and *Azospirillum lipoferum*.

Economics

TABLE 4

Economics of biofertilizers and Nitrogen levels in Maize.

Treatment	Fodder yield		Income			Cost of	Net	I.C.B.R.
	(kg/ha)		(Rs.)			cultivation	realiza-	
	Grain	Fodder	Grain	Fodder	Total	(Rs.)	tion (Rs.)	
(A) Bio-fertilizers								
B ₁ Control	2038	2594	12228	2594	14824	5143	9679	—
B ₂ ABA-1	2558	3252	15348	3252	18600	5165	13435	1:173.7
B ₃ ASA-1	2464	3194	14784	3194	17978	5165	12813	1:142.5
(B) Nitrogen levels								
N ₁ -0 kg/ha	1367	1737	8202	1737	9939	5143	4796	—
N ₂ -20 kg/ha	1929	2532	11574	2532	14106	5435	8671	1:13.3
N ₃ -40 kg/ha	2385	2997	14310	2997	17307	5647	11660	1:13.6
N ₄ -60 kg/ha	2851	3625	17106	3625	20731	5859	14872	1:14.1
N ₅ -80 kg/ha	3236	4175	19416	4175	23591	6071	17520	1:13.7

Market Price	Rs.	
1. 1.0 kg Grain	6.00	with Azospirillum produced maximum grain yield (32.6 q/ha) along with application of 50% dose with respective increase in cost of cultivation, yield and net profit of 4.03, 32.5 and 47.4% over the application of 50% recommended dose which was superior (12%) to the application of 100% recommended dose (80, 40 and 40 kg/ha of N, P and K) of crop.
2. 1.0 kg Fodder	1.00	
3. 1.0 kg 'N'	10.60	
4. Per ha seed treatment with biofertilizers including labour.	22.00	

The results presented in Table 4 revealed that maximum net realization of Rs. 13,435/- with highest ICBR (1:173.73) was obtained through mere inoculation, the seeds with *Azotobacter chroococcum* followed by *Azospirillum lipoferum* (Rs. 12,813/- ICBR 1 : 142.55). Maximum net realization of Rs. 17,520/- with ICBR value of 13.71 was obtained with 80 kg nitrogen application along with biofertilizer seed inoculation. Mishra *et al.* (1998) reported that maize seed inoculation

In present study, seed inoculation either with ABA-1 or ASA-1 was economically most efficient at lower doses of nitrogen fertilizer which not only increases yields but resulted in a saving of nitrogen also (22 and 20 kg/ha). Similarly Maskey (1977) obtained significant positive effects of *Azospirillum* inoculation when combined with low levels of N fertilization of about 45 kg N/ha⁻¹ in paddy and wheat crop.

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Response of Forage Sorghum Var. GJ-37 to Nitrogen and Phosphorus Fertilization

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ABSTRACT

An experiment as carried out during the *kharif* seasons of 1989-90 to 1996-97 to study the response of forage sorghum Var. GJ-37 to different levels of nitrogen and phosphorus fertilizers on medium black soils at Dhari. Application of 80 kg N/ha was found to be the optimum dose to increase green as well as dry fodder yield; net return and net ICBR. In case of phosphorus application, 80 kg P_2O_5 /ha produced significantly highest dry fodder yield, however 40 kg P_2O_5 /ha was found to be optimum dose in respect to net ICBR.

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INTRODUCTION

Sorghum (*Sorghum bicolor*) is an important source of forage for cattle. Among the different varieties of sorghum, GJ-37 is one of the forage variety producing high quality and quantity of fodder and found stable in biomass production. The main constraint of low production and productivity of forage sorghum crop is their cultivation in poor and marginal lands under rainfed condition with no or little use of fertilizers. The role of nitrogenous and phosphatic fertilizers in boosting agricultural productivity during past three decades is now well recognized (Singh and Singh, 1998). Fertilizer is a costly input and so it should be used judiciously to get maximum monetary return per unit cost. There is paucity of information on this aspect for Dhari region of North Saurashtra Agro Climatic Zone. Therefore, an experiment was conducted to study the response of forage sorghum var. GJ-37 to different levels of nitrogen and phosphorus.

MATERIALS AND METHODS

The field experiment was conducted during the *kharif* seasons of 1989-90 to 1996-97 at Grassland Research Station, Gujarat Agricultural University, Dhari. The soil of the experiment site was medium black having pH 7.6, E.C. 0.21 ds/M, 169 kg/ha total nitrogen, 41 kg/ha available phosphorus and 285 kg/ha available potash content. The treatments comprised 04 levels of nitrogen (00, 40, 80 and 120 kg N/ha) and 03 levels of phosphorus (00, 40 and 80 kg P_2O_5 /ha) were tested in randomised block design and replicated thrice. The crop was sown at 45 cm distance between two rows in June - July in each experimental year after receiving sufficient rainfall. Treatment wise full dose of phosphorus in the form of single super phosphate and half nitrogen dose in the form of urea were applied as basal dose and the remaining half dose of nitrogen in the form of urea was top dressed at 30 days after sowing. General cultural practices were

followed as per recommendation. The crop was harvested at flowering stage. The *kharif* seasonal rainfall was 609.4, 597.8, 281.6, 492.4, 605.9, 547.2 and 608.1 mm during 1989-90, 1990-91, 1991-92, 1992-93, 1994-95, 1995-96 and 1996-97, respectively. Standard statistical procedure was followed for analysing the results obtained.

RESULTS AND DISCUSSION

Effect of Nitrogen

The green and dry fodder yields were significantly influenced by various nitrogen levels

(Table 01 and 02). The results revealed that application of 80 kg N/ha and 120 kg N/ha were being at par with each other, produced remarkably higher green fodder yield as compared to rest of the nitrogen levels during 1990-91, 1992-93, 1994-95, 1995-96 as well as in pooled analysis. The results indicated similarity with Saheb *et al.* (1997) and Desale *et al.* (1999) who found that green fodder yield of sorghum crop increased with increasing levels of nitrogen upto the maximum dose of 120 kg N/ha.

TABLE 1

Green fodder yield as influenced by nitrogen and phosphorus.

Treatments	Green fodder yield in q/ha, years							
	1989	1990	1991	1992	1994	1995	1996	Pooled
Nitrogen (kg/ha)								
N ₁ = 00 (Control)	83.59	84.88	46.42	78.45	43.72	150.46	237.91	103.63
N ₂ = 40	95.80	104.17	33.44	106.74	79.09	243.05	182.61	120.70
N ₃ = 80	102.88	158.18	42.31	130.53	83.59	282.92	231.48	147.41
N ₄ = 120	106.73	153.04	49.51	143.39	82.30	353.65	204.47	156.15
S. Em. ±	8.79	13.11	7.63	5.38	6.49	10.91	7.08	12.33
C. D. at 5%	NS	38.44	NS	15.79	19.03	32.02	20.78	36.64
Phosphorus (kg/ha)								
P ₁ = 00 (Control)	100.30	128.76	36.65	119.59	65.58	236.30	240.16	132.48
P ₂ = 40	95.96	117.67	55.46	111.88	72.82	263.31	204.47	131.65
P ₃ = 80	95.48	128.76	36.65	112.84	78.12	272.95	197.72	131.79
S.Em. ±	7.61	11.35	6.61	4.66	5.62	9.45	6.13	5.12
C.D. at 5%	NS	NS	NS	NS	NS	27.73	17.99	NS

TABLE 2

Dry fodder yield, additional net return and net ICBR as influenced by nitrogen and phosphorus.

Treatments	Dry fodder yield in q/ha, years								Additional net return over control Rs./ha	Net ICBR
	1989	1990	1991	1992	1994	1995	1996	Pooled		
Nitrogen (kg/ha)										
N ₁ = 00 (Control)	45.01	48.86	18.13	35.75	23.01	53.75	77.16	43.09	—	—
N ₂ = 40	53.36	63.01	23.14	58.89	46.81	87.70	80.37	59.04	821	1:2.66
N ₃ = 80	59.15	99.02	23.40	81.40	50.15	90.14	81.01	69.18	1700	1:2.75
N ₄ = 120	60.44	106.99	29.96	87.31	50.79	104.68	99.66	76.99	1649	1:1.78
S. Em. ±	6.74	8.76	3.77	3.65	3.57	3.55	2.84	5.24		
C.D. at 5%	NS	25.71	NS	10.73	10.47	10.41	8.33	15.57		
Phosphorus (kg/ha)										
P ₁ = 00 (Control)	57.87	84.37	20.73	67.22	39.41	73.68	76.19	59.92	—	—
P ₂ = 40	52.56	71.85	31.05	65.00	43.78	80.05	83.91	61.17	836	1:1.11
P ₃ = 80	53.04	81.50	70.95	65.29	44.84	98.47	93.55	72.52	1400	1:0.98
S.Em. ±	5.83	7.59	3.26	3.16	3.09	3.07	2.46	2.84		
C.D. at 5%	NS	NS	9.59	NS	NS	9.01	7.22	7.95		

The results on dry fodder yield presented in table 02 indicate that increasing levels of nitrogen from 00 to 120 kg/ha progressively increased the dry fodder during all the individual years (except during 1989 and 1991) as well as in pooled analysis. The highest dry fodder yield was recorded with 120 kg N/ha, but statistically it was at par with 80 kg N/ha. With regard to monetary return, the treatment of 80 kg N/ha secured the highest additional net return of Rs. 1700/ha and net ICBR of 1:2.75. Kushwaha and Chandel (1997) and Vasanthi and Kumaraswami (1999) also reported that the dry matter yield of sorghum increased with increase in levels of nitrogen dose upto 150 kg N/ha.

Effect of Phosphorus

It was observed (Table 1) that the difference in green fodder yield due to phosphorus application was found significant only during 1995-96 and 1996-97 out of seven years of experiment and was nonsignificant in pooled results.

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The data on dry fodder yield presented in Table 02 reveal that the application of 80 kg P_2O_5 /ha produced significantly highest dry fodder yield during 1991-92, 1995-96, 1996-97 and in pooled results. In the remaining years, phosphorus could not produce any significant effect on dry fodder yield. In respect to monetary return, the application of 80 kg P_2O_5 /ha produced the highest additional net return of Rs. 1400/ha, while application of 40 kg P_2O_5 /ha gave highest net ICBR of 1:1.11. The results agreed with those of Vashishatha and Dwivedi (1997) and Sutaria *et al.* (1999).

The results indicated that application of nitrogen @ 80 kg/ha and phosphorus @ 40 kg/ha was found to be optimum dose in respect to fodder yield and monetary returns for forage sorghum Var. GJ-37 under rainfed conditions of North Saurashtra Agro Climatic Zone.

Genetics of Double Poddedness and its Significance in Improvement of Chickpea (*Cicer arietinum* L.)

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ABSTRACT

The results of present studies revealed that singal recessive gene governed the double poddedness in chickpea, single poddedness being dominant over the double poddedness. The F_2 population of both the crosses segregated in the ratio of 3 SP : 1 DP. Non-significant X^2 values with probability between 0.30 - 0.70 indicated good fit to the observed ratio. Further, non-significant X^2 value with probability between 0.20 - 0.30 in backcross population confirmed the monogenic F_2 ratio. Number of pods exhibited positive and stronger association with grain yield but its association with 100 seed weight was negative in both the cases. This indicated that there could be possibility of reduction in seed size while selecting high yielding plants. Hence due weightage should be given to yield as well as seed size while effecting selection. Further, regression analysis revealed that, the grain yield was more dependent on double pods/plant than single pods/plant.

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INTRODUCTION

Chickpea is the important crop for human nutrition and soil health. Normally, chickpeas have one flower or pod on each peduncle, but double pod types are not uncommon. Double pod (DP) types produced 6-11 per cent more grain yield than single pod - (SP) types (Sheldrake *et al.*, 1978). Double poddedness in chickpea is an important attribute which could be exploited in developing drought tolerant short duration varieties for cultivation in central and South Indian states, where growing season is short as compared to northern states. Such genotype may also find a place in northern states where chickpea is grown late in December.

This character is useful under adverse growing conditions but in general it associated with small seed size and susceptibility to *Fusarium* wilt. JG-

62, Selection 436 and others are the known examples. Hence present investigation was undertaken to know the genetics of double poddedness and feasibility for developing double podded genotypes with bold seed size and resistance to wilt.

MATERIALS AND METHODS

Artificial crossing in chickpea is tedious, hence two crosses and their backcrosses were effected for present study. Parents, F_1 , F_2 and BC_1 generation of two crosses viz., JG-62 x Vijay and JG-62 x ICC-4958 involving three diverse parents namely, Vijay (Single pod, wilt resistant), JG-62 (double pod, small seed) and ICC-4958 (single pod, bold seed) were grown in compact family block design with three replication. Single row was assigned for parents, F_1 , BC_1 and 30 rows for F_2 generation, spaced 30 cm apart with plant to plant

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distance of 15 cm. Single and double pod plants were counted in all the generations. Chi-square (X^2) test (Fisher, 1941) was used for testing the goodness of fit. For correlation analysis 20 single and double podded plant were selected and observed separately for number of pods/plant, 100-seed weight and grain yield/plant in each cross.

Correlation of total number of pods with 100 seed weight and grain yield/plant was estimated separately for single and double podded plants to understand the exact role of double poddedness in determining grain size and yield per plant.

RESULTS AND DISCUSSION

In double podded plants, it was observed that flowers are generally produced in twin conditions but, only few axile/peduncle produce double pods. This depends upon genotype and the environmental conditions. In the present investigation the crosses JG-62 x Vijay and JG-62 x ICC-4958 showed 14 and 11 per cent, respectively double podded plants in F_2 generation, while the well established double podded genotype JG-62 showed 70% double podded plants. However within double podded plants the double podded axils ranged from 2 to 38 per cent in cross JG-62 x Vijay and from 3 to 32 per cent in cross JG-62 x ICC-4958 in F_2 population. In general double podded percentage is higher in small podded plants than bold one.

Higher percentage of double pods does not necessarily mean the more number of double pods or total pods per plant. Hence due consideration should be given to more number of double pods or total pods rather than higher percentage of pods, while exercising selection.

In present studies both the crosses produced single podded F_1 s which indicated the dominance of single poddedness over the double poddedness. The F_2 population of both the crosses segregated in the ratio of 3 SP : 1 DP. Non-significant X^2 value in cross 1 ($X^2=0.67$, $P=0.30-0.50$) and cross 2 ($X^2=0.36$, $P=0.50-0.70$) indicated good agreement between observed and expected frequencies (Table 1). This indicated that single recessive gene was involved in the expression of double poddedness. Athwal and Brar (1964) also reported single recessive gene for double poddedness in chickpea. These monogenic F_2 ratios were confirmed by growing backcross population (90 plants in each cross) of both the crosses, which segregated in the ratio of 3 SP : 1 DP (Table 2). Non-significant X^2 value having probability between 0.20 - 0.30 in both the crosses confirmed the observed F_2 ratio (3:1). It was believed that, the double pod gene is linked with one of the wilt susceptible genes and double podded types generally were susceptible to *Fusarium* wilt. However through breeding, wilt resistance segregants with double podded character have been isolated (Kumar and Haware, 1983b; Girase, 1999).

TABLE 1

Segregation for double poddedness in F_2 generation of two crosses in chickpea.

Cross	Class	No. of F_2 plants		Deviation (O-E)	X^2	P-value	Ratio
		Observed	Expected				
JG-62 X Vijay	SP	345	337.5	-7.5	0.17	—	3:1
	DP	105	112.5	7.5	0.50	—	
	Total	450	450.0	0.0	0.67	0.30 0.50	3:1
JG-62 X ICC- 4958	SP	343	337.5	5.5	0.09	—	3:1
	DP	107	112.5	-5.5	0.27	—	
	Total	450	450.0	0.00	0.36	0.50- 0.70	3:1

TABLE 2

Segregation for double poddedness in BC₁ generation of two crosses in chickpea.

Cross	Class	No. of BC ₁ plants		Deviation (O-E)	X ²	P- value	Ratio
		Observed	Expected				
JG-62 X Vijay	SP	50	45	5	0.56	—	1:1
	DP	40	45	-5	0.56	—	
	Total	90	90	0		0.20- 0.30	1:1
JG-62 X ICC- 4958	SP	51	45	6	0.80	—	1:1
	DP	39	45	-6	0.80	—	
	Total	90	90	0	1.60	0.20- 0.30	1:1

SP = Single podded plants.

DP = Double podded plants.

Correlation analysis revealed that grain yield positively and significantly associated with pods per plant in single as well as double podded plants. Singh *et al.* (1997) also reported significant positive association between number of pods/plant and grain yield. However, 100 seed weight exhibited non-significant positive association with grain yield in single podded plants, whereas, its association with yield in double podded plants was negative but non-significant. Similarly 100 seed weight showed non-significant negative correlation with number of pods per plant in both single and double podded plants. Negative association between yield and 100 seed weight in double podded plants indicated that, there could be possibility of reduction in seed size while selecting high yielding plants. So it is better to consider yield as well as bold seed size simultaneously while selecting desirable segregants. Further negative association could be disrupted by biparental mating between segregants in F₂ generation

followed by selection of high yielding bold seeded plants. It is concluded that pods/plant is an important trait in improvement of yield in both single and double podded chickpea. Further association of pods/plant with yield was greater in double podded plants (0.953**) than single podded plants (0.829**). It was also interesting to know that, the association of number of single pods (0.87*) and double pods (0.44*) from double podded plant with grain yield was significantly positive. Further, regression analysis revealed that, grain yield was more dependent on double pods/plant (0.37**) than single pods/plant (0.13**) and both these traits contributed 92 per cent variability in grain yield. These finding enlighten that further improvement in grain yield of chickpea could be achieved by exploiting double poddedness in this crop by adopting the concept of transgressive segregation followed by selection.

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***In Situ* Conservation of Arthropod Natural Enemies of Crop Pests**

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ABSTRACT

An entomophagous park of 0.2 ha area conserved 28 species of arthropods *in situ*, which were natural enemies to several species of insect pests. The major entomophages conserved were *Trichogramma chilonis*, *Geocoris ochropterus*, *Chrysoperla carnea*, *Rogas alighrahensis*, *Chelomenus sexmaculatus*, *Coccinella septempunctata* etc. The entomophages were very active throughout the year in the park as it was not disturbed and kept free from insecticide applications. It is suggested that by establishing entomophagous Park, biodiversity of natural enemies of insect pests could be conserved, and this reserve could be utilized later for control of insect pests of crops.

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INTRODUCTION

There has been a phenomenal growth in agricultural production in India in the last four decades; mainly due to the introduction of high yielding crop varieties and adoption of modern technologies. Still, the losses due to pests and diseases remain as the major constraint in increasing the productivity. The annual loss due to pests was estimated to be over Rs. 8000 crores in 1983. Crop losses due to just one species of insect, *Helicoverpa armigera* (Hubner) which infests many economically important crops is estimated to be over Rs. 2000 crores per annum in the country (Raheja and Tewari, 1990).

Chemical pesticides have been very popular among the farmers to combat the ravages of crop pests in the last three decades. Out of Rs. 2800 crores worth of chemical pesticides used in agriculture, Rs. 1600 crores worth are spent on cotton crop alone, where as the crop occupies only about 5 per cent of the total cropped area in the country. Further Rs. 1100 crores worth of

chemical pesticides are used for the control of only bollworms in cotton (Ghosh, 2000). The ill effects of the chemical insecticides on the natural enemies have been known since last two decades which have been documented by Manjunath (1974); Yadav *et al.*, (1983); Natrajan, (1990) and Gill *et al.*, (1992). During the years, a few of the entomophages have become scarce (AICRP, 2000) in Gujarat. Therefore, it is imperative to find out ways and means to protect them from extinction. In the present study, an attempt has been made to conserve arthropod natural enemies and enhance natural biological control.

MATERIALS AND METHODS

Establishment of Entomophagous Park

During 1998-99 about 0.2 ha fallow land was selected for the establishment of entomophagous park at the Anand campus of Gujarat Agricultural University. In this park, the crops conducive to biocontrol agents were grown in appropriate succession keeping in mind the occurrence of

pests and their natural enemies. Besides, uneconomical plants, which harbour natural enemies, were also grown or allowed to grow. Selected flowering plants (both seasonal and perennial) as a food source for the adult parasitoids and predators were also grown. It was also ensured that some vegetation always remain in the park. No chemical insecticide was sprayed in this area. The area designated for the entomophage park was demarcated from the surroundings by a hedge of the *Lantana camera* except for a part of one of the sides where building stood. The arthropod natural enemy fauna was monitored regularly in the park and also in agricultural fields of the locality where pesticides were sprayed frequently.

RESULTS AND DISCUSSION

Although the area of the park was very small, it supported and conserved a good number (28) of entomophages (Table 1), which were mostly found about in pesticide treated areas (Table 2). The noteworthy result of the study was the activity of *Trichogramma* spp. on the eggs of *H. armigera*, *Earias vittella* Fab. and *Catopselia pyranthe* L. throughout the year. Since host eggs were continuously available on different host plants, population of *Trichogramma* remained very high in the area throughout the year. This suggests that by reserving even very small areas in different localities and agro-climatic/ geographic regions as entomophage park, the endemic populations of entomophages could be conserved. By doing so, the vast genetic variations that have evolved during the past million of years will be saved from extinction. Moreover, the genon that suits to each locality will be conserved *in-situ*. Another important feature of the study was the round the year abundance of butterfly, *C. pyranthe* which deposited large number of eggs on *Cassia occidentalis* L. These eggs were heavily parasitised by *T. chilonis* and *T. achaeae* (Table 3). Similarly, a large population of *Geocoris ochropterus* Fieber (Hemiptera: Lygaidae) and *Chelomenes sexmaculata* Fab. (Coleoptera:

Coccinelidae), *Chrysoperla carnea*, etc. were conserved even during summer months in sizeable numbers (Table 4 and 5). The other entomophages conserved included spiders, staphylenid, *Paederus fuscipes* Curtis, braconid, *Rogas aligarhensis* Quadri, Chrysopid, *Chrysoperla carnea* and *Trichogramma* sp. in good numbers. The flowering plants viz., marigold, *Tagetis erracta*, *camera* and *Justicia jendurosa* grown in the park served as good source of food for the natural enemies. *Lantana*, particularly attracted a large number of white butterfly, *C. pyranthe* (10-15 in number during September). Manjunath *et al.* (1970) reported attraction of *H. armigera* moths to the flowers of marigold for oviposition. He also reported that *H. armigera* eggs laid on marigold were heavily parasitised by *T. chilonis*. Similarly, *Bracon brevicornis* Wesm an ecto-larval parasitoid of black headed caterpillar of coconut, *Opisina arenosella* Walk lived longer and laid greater number of eggs, when the females were fed on nector of the flower of *J. jendurosa* (Yadav, 1985). In Egypt, *Lantana harbours* whitefly, *Bemisa tabaci* and its pupal parasitoid, *Encarsia mundus* (Rao and Reddy, 1992). Habitat manipulation have also been tried to enhance natural biological control (Bugg *et al.* 1991; Fye, 1972; Javier and Altieri, 1990; Letourneau and Altieri, 1983 and Nordlund *et al.*, 1984). Thus, from the present study it is apparent that by providing favourable niches and environment, entomophage fauna can be conserved. However, it remains to be seen how far such an entomophage fauna would be able to suppress the pest population in the target crop (s) grown in the vicinity without the intervention of chemical pesticides and how it sustains itself in the coming years. The study in this connection is under progress.

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TABLE 1

Various arthropod natural enemies found in the entomophagous park.

Species	Crops in which the entomophages found									
	Cassia	Cotton	Tomato	Sunn hemp	Marigold	Senna	Groundnut	Groundnut	Groundnut	Groundnut
<i>Trichogramma chilonis</i>	Cotton	Senna	Maize	Brinjal	Groundnut	Lucerne	Duranta			
<i>Chrysoperla carnea</i>	Cotton	Senna	Brinjal	Groundnut	Duranta					
<i>Mallada Boninensis</i>	Cotton	Duranta	Brinjal							
<i>Brown lacewing</i>	Cotton	Maize	Brinjal	Marigold	Groundnut	Lucerne	Sunn hemp			
<i>Geocoris ochropterus</i>	Cotton	Maize	Brinjal	Sunn hemp	Lucerne	Groundnut				
<i>Paederus fuscipes</i>	Cotton	Cotton	Brinjal	Groundnut	Sunn hemp					
<i>Rhinocoris fuscipes</i>	Tobacco	Cotton	Brinjal							
<i>Nesidiocoris tenuis</i>	Tobacco	Tomato	Mastgandha							
<i>Menochilus sexmaculatus</i>	Cotton	Maize	Brinjal	Groundnut	Sunn hemp	Lucerne	Duranta			
<i>Coccinella septempunctata</i>	Cotton	Maize	Brinjal	Groundnut	Sunn hemp	Lucerne				
<i>Coccinella transversalis</i>	Cotton	Maize	Brinjal	Groundnut	Sunn hemp	Lucerne				
<i>Rogas aligarhensis</i>	Cotton									
<i>Bracon greeni</i>	Cotton									
<i>Apanteles angaleti</i>	Cotton									
Mantis	Cotton	Lantana								
Nabis	Cotton	Sunn hemp	Lucerne	Groundnut						
Orius	Cotton	Maize	Marigold							
<i>Encarsia</i>	Cotton	Brinjal								
<i>Scymnus</i>	Cotton	Duranta	Maize							
Spiders										
<i>Clubiana sp.</i>	Cotton	Sunn hemp	Groundnut	Lantana	Maize	Lucerne				
<i>Oxyopes sp.</i>	Cotton	Sunn hemp	Groundnut	Lantana	Maize	Lucerne				
Crabs spider	Cotton									
Unidentified green spider	Tobacco									
<i>Charops obtusa</i>	Cotton	Cassia								
<i>Agathis</i>	Cotton									
<i>Apanteles sp.</i>	Cassia									
Syrphids	Cotton	Maize	Lucerne	Groundnut						
Predatory ants	Cotton	Groundnut	Cassia	Senna						

TABLE 2

Entomophage fauna found in park and irrigated cotton fields outside the park.

Species	Park	Places outside the park					
		Karjan (3)*	Awakhal (6)	Kurali (5)	Dhaboi (5)	Sinor (5)	Kayavarhon (6)
<i>Trichogramma chilonis</i>	+	-	+	-	-	-	-
<i>Rogas aligarhensis</i>	+	-	-	-	-	-	-
<i>Geocoris ochropterus</i>	+	-	-	-	-	-	-
<i>Chelomenus sexmaculata</i>	+	+	+	+	+	+	+
<i>Coccinella septempunctata</i>	+	-	-	-	-	-	-
<i>Chrysoperla carnea</i>	+	+	+	-	+	+	+
<i>Mallada boninensis</i>	+	-	-	-	-	-	-
Spiders							
<i>Clubiana</i> sp.	+	+	+	+	-	-	+
<i>Oxyopes</i> sp.	+	-	+	-	+	-	-
<i>Crabspider</i>	+	-	-	-	-	-	-
Unidentified green spider	+	-	-	-	-	-	-
<i>Rhinocoris fuscipes</i>	+	-	+	-	-	-	-
<i>Brumus</i> sp.	+	-	-	-	-	-	-
<i>Aphidius</i> sp.	+	-	-	-	-	-	-
<i>Scymnus</i> sp.	+	-	-	-	-	+	-
Ants	+	-	+	-	-	-	-
<i>Paederus fuscipes</i>	+	-	+	-	-	-	-
Mantis	+	-	+	-	-	-	+

Note : + = pres = absent

* Number of ' examined.

TABLE 3

Occurrence of *Trichogramma* sp. (*T. chilonis* and *T. achaeae*) in *Catopsilla pyranthe* on *Cassia* Anand during 1998-99.

Period		Per cent parasitism
August	I	25.4
	II	48.3
September	I	40.7
	II	25.8
October	I	32.5
	II	27.8
November	I	35.9
	II	42.4
December	I	30.2
	II	40.2
January	I	40.1
	II	47.9
February	I	72.8
	II	81.8
March	I	44.7
	II	51.6
April	I	54.2
	II	52.4
May	I	74.8
	II	78.5
June	I	85.5
	II	65.3
July	I	75.0
	II	66.6
August	I	60.0
	II	75.0
September	I	66.6

Note : I = first fortnight

II = second fortnight

TABLE 4

Population of predatory fauna in insecticides free (Entomophage park) and treated cotton field.

Sr. No.	Species	Mean population of entomophage/plant	
		Entomophage park	Chemical treated
1.	<i>Chrysoperla carnea</i>	0.15-2.6**	0.1-0.2
2.	<i>Menochilus sexmaculata</i>	0.8-14.09	0.1-0.2
3.	<i>Geocoris ohropterus</i>	0.2-2.2	0.0
4.	Spider	0.3-1.45	0.0
5.	Staphylenids	0.05-3.5	0.0

TABLE 5

Extent of parasitism by *Trichogramma* sp. and *Rogas aligarhensis* in cotton.

Sr. No.	Species	Per cent parasitism	
		Entomophage park	Farmers field
1.	<i>Trichogramma</i> sp.	75-96.2	0.0
2.	<i>Rogas aligarhensis</i>	5.0-33.1	0.0

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Laboratory Rearing of *Geocoris ochropterus* Fieber (Hemiptera : Lygeidae) on the Pupae of *Trichogramma chilonis* Ishii (Hymenoptera : Trichogrammatidae)*

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ABSTRACT

Laboratory study was conducted during 1997 at the Biological Control Research Laboratory, Anand, Gujarat Agricultural University to test the suitability of three different prey species for rearing of *Geocoris ochropterus* Fieber an important predator associated with cotton crop. The results revealed that 92 and 96 per cent of nymphs completed their development in 30 and 31 days when reared on fresh as well as cold stored pupae of *Trichogramma chilonis* Ishii, an egg parasitoid of lepidopterans, respectively. *T. chilonis* fed females lived longer and laid greater number of eggs and their oviposition period was also longer.

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INTRODUCTION

Geocoris ochropterus known to occur only in the Indian subcontinent is predacious on number of pests (Rangarajan *et al.*, 1964; Suba Rao *et al.*, 1965; and Mukhopadhyay, 1988). In spite of its potential as biological control agent it could not be utilized in pest suppression for want of its mass rearing techniques. However, a few attempts have been made to mass rear another Geocorine, *Geocoris punctipes* (Say) on artificial diets with 14-59 per cent success by Cohen (1981). Recently Mukhopadhyay and Sannigrahi (1992) reared *G. ochropterus* on cold preserved pupae of an ant, *Oecophylla smaragdina* Fabr. These studies have shown that *Geocoris* spp. can be reared on unnatural prey without adversely affecting its biological traits. However, longer

nymphal duration and cannibalistic nature of the predator was found to be major limitations. While working on this predator, we found it preying on the pupae of *T. chilonis*, an egg parasitoid of lepidopterans commonly produced by several laboratories and also commercially available. Therefore, studies were made on the suitability of fresh as well as cold stored pupae of *T. chilonis* and cotton aphid, *Aphis gossypii* Glover. Results obtained are presented in this paper.

MATERIALS AND METHODS

Maintenance of *G. ochropterus* colonies in the laboratory

The adults of *G. ochropterus* were collected from cotton fields with the help of plastic tubes. They were held in one liter transparent plastic jar

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having lid fitted with wire screen and fed with field collected *A. gossypii* daily. A fresh leaf of cotton Hybrid-6 was also kept, as phytophagy is common in this predator. Adult holding jars were stacked in wooden rack at laboratory temperatures of 24.2-32.0 °C, 33.0-96.0 per cent RH and 8 hours photoperiod. Eggs laid by the predator on leaves, wire screen, sides of plastic lid were removed daily with wet camel hair brush and placed in glass vial (10 X 2.5 cm). Dead adults were removed and fresh adults were kept in the plastic jar periodically to meet the demand of study. This procedure was continued until the studies were completed.

Availability of preys

Aphis gossypii colonies were collected from the insecticide free cotton fields, while pupae of *T. chilonis* were obtained from Biocontrol Research Laboratory, Anand.

Suitability of different preys

Nymphal developments : Twenty-five freshly hatched nymphs were held individually in glass vials (10 X 2.5 cm) using fine camel hair brush. Each nymph was fed with five different preys till the nymph became adult. The prey used were fresh pupae of *T. chilonis*, cold stored pupae (at 7±1°C) of *T. chilonis* and cotton aphid, *A. gossypii*.

Adult longevity and fecundity : Eight freshly formed pairs, reared on different preys were individually held in a transparent plastic containers (6.5 X 7.0 cm) and fed with different prey. Observations were recorded on nymphal duration, prey consumption by the nymphs and adults, fecundity, longevity, pre-oviposition, oviposition and post-oviposition periods of the predator when reared on different prey species. The experiment was conducted in completely Randomized Design.

RESULTS AND DISCUSSION

The results presented in Table 1 revealed that the nymphs of *G. ochropterus* when reared on

fresh as well as cold stored pupae of *T. chilonis* successfully completed the development and 92 and 96 per cent of them transformed into adults, respectively. Both nymphs and adults consumed greater number of stored pupae (3634.89) than fresh ones (2526.32). The females laid greater number of eggs (344.69) when reared on fresh pupae than those reared on one-month old stored pupae (308.99) suggesting better nutritive value of fresh pupae. The nymphs when reared on *A. gossypii*, only 60 per cent completed their development in 33.40 days and female laid fewer eggs (45.36) than those reared on *T. chilonis* pupae. The results also revealed that *T. chilonis* fed (both fresh as well as cold stored pupae) females lived longer and laid eggs for much longer period (37.76 and 44.24 days) than those reared on *A. gossypii* (19.0 days). During the course of study the predator was observed to feed on the adults of *T. chilonis* also. Mukhopadhyay and Sannigrahi (1992) reared *G. ochropterus* on the pupae of ant, *Oecophylla smaragdina*. In their studies the nymphs completed their development in 31.03 days. The female laid 277.0 eggs. Kapadia and Puri (1991) reported slightly shorter duration of 29.1 days when *G. ochropterus* nymphs were reared on *Bemisia tabaci* (Gennadius).

Thus, information generated will be useful in developing mass production technology of the predator and its supplemental releases in the field. The industries involved in the *Trichogramma* production can now use unsold stocks of the parasitoid for producing *G. ochropterus* or its conservation.

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TABLE 1

Biological traits of *G. ochropterus* when reared on different preys.

Sr. No.	Prey	Nymphal duration (days)	Prey consumption by nymphs	Prey consumption by adults	Fecundity	Longevity	Pre-oviposition period (days)	Oviposition period (days)	Post-oviposition period (days)
1.	Fresh pupae of <i>T. chilonis</i>	31.33	18.082 (327.62)	49.465 (2526.32)	18.457* (344.69)	6.629* (44.63)	1.866* (3.50)	6.252* (39.76)	1.310** (1.47)
2.	One month old cold stored pupae of <i>T. chilonis</i>	30.00	25.748 (665.73)	59.627 (3634.89)	17.460 (308.99)	7.131 (51.53)	1.933 (3.76)	6.594 (44.24)	1.972 (3.65)
3.	Cotton aphid, <i>Aphis gossypii</i>	33.40	15.917 (256.14)	17.765 (395.10)	6.420 (45.36)	5.053 (26.22)	2.062 (4.12)	4.376 (19.81)	1.609 (2.35)
	Mean	31.58	19.916 (415.52)	42.286 (2185.11)	41.111 (233.01)	6.271 (40.79)	1.942 (3.79)	5.738 (34.64)	1.630 (2.49)
	S. Em. $\pm$	0.267	0.431	3.153	0.720	0.293	0.051	0.308	0.180
	CD ($P=0.05$)	0.763	1.231	9.274	2.118	0.863	-	0.907	-
	CV%	3.28	8.38	21.09	14.43	13023	7.36	15.20	31.31

*x Transformed values.

** x+0.5 transformed values.

Number in the parentheses are re-transformed values.

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Larval Development of *Spodoptera litura* Fabricius in Relation to Castor Varieties and Biochemical Constituents

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ABSTRACT

The study on effect of biotic (castor varieties) conditions on development and fecundity of *Spodoptera litura* showed higher mortality on GCH-4 and GCH-5 within two days, whereas on castor VI-9 and GAUCH-1 lower larval mortality was observed for the 1st instar larvae. None of the larvae could survive and complete its development on DCS-9, VP-1, Geeta, CO-1, JI-35, GCH-4 and GCH-5 as against 40 to 56% larval survival on VI-9, GAUCH-1, 48-1, SKI-73 and SH-72. The larval period of *S. litura* found longer on SKI-73 and SH-72 than GAUCH-1, VI-9 and 48-1, whereas pupal period was found longer on castor SH-72 as compared to VI-9 and GAUCH-1. The fecundity on VI-9 remained higher than SH-72, SKI-73, 48-1 and GAUCH-1.

In biochemical analysis, higher content of total soluble sugars and amino acids in leaves of VI-9 and GAUCH-1 enhanced the feeding activity of *S. litura* larvae in comparison to GCH-4 and GCH-5. Higher quantity of peroxidase and polyphenol oxidase in leaves of GCH-4 and GCH-5 made them unfavourable to *S. litura* in comparison to VI-9 and GAUCH-1.

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INTRODUCTION

Castor (*Ricinus communis* L.) is grown in tropical and sub-tropical region of the world. Castor crop suffers heavily due to attack of various pests which reduce its yield. *S. litura* is a ubiquitous, polyphagous multivoltine, lepidopterous pest feeds on 112 cultivated crops all over the world (Moussa *et al.*, 1960). The development and survival of *S. litura* larvae have been found vary with the plant species (Thobbi and Srihari, 1967). Considering the economic importance and polyphagous nature of *S. litura*, it is very necessary to study the effect of different castor varieties on development of *S. litura*.

MATERIALS AND METHODS

In order to have mass multiplication of *S. litura* in the laboratory for the developmental study, large number of larvae were collected from the castor fields of the Anand campus of Gujarat Agricultural University. Larvae were reared in round galvanized cage (36 x 12 cm), containing tender castor leaves. The petiole of each leaf was wrapped with cotton wool and dipped in water to maintain the turgidity of the leaf. The top of the cage was covered by using muslin cloth and rubber bands. Everyday morning sufficient number of fresh leaves of respective castor varieties were provided to *S. litura* larvae after

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removing excreta and uneaten leaves from cage. The full grown larvae were transferred to the galvanized cage containing 6 cm layer of moist soil on bottom surface for pupation. The pupae were collected three days after pupation and kept with petridish in wooden cage. The freshly emerged moths with wooden cage having plastic strips so that freshly emerged moths can rest and oviposit it. The urethane foam piece was soaked in 5% honey solution and placed in the cage as food for the moths. Freshly emerged male and female moths of *S. litura* were paired and confined in a glass chimney (10 x 17.5 cm) covered with a muslin cloth for oviposition. The bouquet prepared of tender terminal shoots wrapped in cotton lint at cut end was kept in plastic vial containing water. Pre-oviposition, oviposition, post-oviposition, incubation period, larval period, number of larva survived, prepupa, pupa, sex, fecundity/adult were observed during the egg laying to mortality of adult.

To know the mechanism of resistance in castor varieties due to biochemicals viz., GCH-4, GCH-5, GAUCH-1 and VI-9 were selected and studied for their biochemical constituents at 10 weeks age of the crop. To determine the moisture content (Mehta and Lodha, 1979), sugars (Dubois *et al.* 1956), total amino acids (Lee and Takahashki, 1966), peroxidase activity (Guibault 1976) and polyphenol oxydase (ppo) were chosen samples by following standard techniques.

RESULTS AND DISCUSSION

The results of larval survival (%) on different castor varieties (Table 1) revealed 92 to 96% larval survival on SKI-73, VI-9 and GAUCH-1 as against 60 to 72% larval survival on GCH-4, GCH-5, DCS-9, JI-35 and Co-1 after one day of larval release. After 4 days of larval release, the larval survival found in the range of 80 to 84% on SKI-73, VI-9 and GAUCH-1 as against 4 to 28% larval survival in GCH-4, GCH-5 and CO-1. After one

week of larval release, GCH-4 (2%), GCH-5(4%), Geeta (4%), DCS-9(12%), CO-1(16%), VP-1(16%), JI-35 (20%) had considerably lower larval survival in comparison to SH-72(56%), SKI-73(64%), 48-1(68%), VI-9(72%) and GAUCH-1(72%).

The zero per cent larval survival was observed on GCH-4, GCH-5 and DCS-9 after 8, 10 and 11 days of release, respectively, whereas on VP-1, Geeta, Co-1 and JI-35 after 12 days of release as against 40 to 56% larval survival on SH-72, 48-1, SKI-73, VI-9 and GAUCH-1.

The relative rate of decline in survival percentage/day with respect to varieties.

$$y = a.e. - c X$$

Where, y = larval survival (%)

x = larval survival period (days)

c = relative rate of decline in survival (%)

a = constant.

The R² values for all the twelve equations were more than 0.82 suggesting that a very higher degree of variability in survival (%). The relative rate of decline remained the lowest in GAUCH-1 (0.049) followed by SKI-73 (0.058), VI-9 (0.058), SH-72 (0.060), 48-1 (0.060), JI-35 (0.294), CO-1 (0.339), VP-1 (0.386), GCH-4 (0.395), Geeta (0.396), GCH-5 (0.422) and DCS-9 (0.433).

The results (Table 2) showed significantly shorter incubation period of the *S. litura* eggs on GAUCH-1 (3.19 days) and SKI-73 (3.52 days) and SH-72 (3.63 days), whereas for VI-9 (3.27 days) and 48-1 (3.36 days) incubation period remained at par to those three varieties.

The larval period of *S. litura* found longer on SKI-73 (15.10 days) and SH-72 (15.67 days) than GAUCH-1 (14.15 days) and VI - 9 (14.35 days). The larvae reared on SH-72 had significantly longer larval duration than GAUCH-1, VI-9 and

TABLE 1

Survival (Z) of *S. litura* larvae on different castor varieties.

After days	Geeta	48-1	VP-1	VI-9	GCH-5	Co-1	GAUCH-1	SKI-73	JI-35	SH-72	GCH-4	DCS-9
0	100 (28)	100 (12)	100 (28)	100 (4)	100 (36)	100 (28)	100 (4)	100 (8)	100 (38)	100 (16)	100 (40)	100 (32)
1	72 (16)	88 (8)	72 (8)	96 (8)	64 (24)	72 (16)	96 (4)	92 (8)	72 (12)	84 (4)	60 (36)	68 (8)
2	56 (16)	80 (4)	64 (12)	88 (0)	40 (12)	56 (16)	91 (4)	84 (4)	60 (16)	80 (8)	24 (8)	60 (12)
3	40 (4)	76 (4)	52 (4)	88 (4)	28 (8)	40 (12)	88 (8)	80 (0)	44 (4)	72 (4)	16 (12)	48 (8)
4	36 (8)	72 (0)	48 (8)	84 (0)	20 (8)	28 (8)	80 (4)	80 (4)	40 (8)	68 (0)	4 (2)	40 (8)
5	28 (12)	72 (4)	40 (20)	84 (4)	12 (0)	20 (0)	76 (0)	76 (4)	32 (4)	68 (4)	2 (0)	32 (8)
6	16 (12)	68 (0)	20 (4)	80 (8)	12 (8)	20 (4)	76 (4)	68 (4)	28 (8)	64 (8)	2 (0)	24 (12)
7	4 (0)	68 (8)	16 (12)	72 (4)	4 (2)	16 (4)	72 (8)	64 (0)	20 (0)	56 (0)	2 (0)	12 (10)
8	4 (0)	60 (4)	4 (0)	68 (8)	2 (0)	12 (0)	64 (0)	64 (8)	20 (4)	56 (4)	0 (0)	2 (0)
9	4 (20)	56 (4)	4 (0)	60 (4)	2 (2)	12 (8)	62 (4)	56 (0)	16 (4)	52 (4)	0 (0)	2 (0)
10	2 (0)	52 (4)	4 (2)	56 (4)	0 (0)	4 (2)	60 (0)	56 (4)	12 (8)	48 (0)	0 (0)	2 (2)
11	2 (2)	48 (4)	2 (2)	51 (0)	8 (0)	2 (2)	60 (4)	52 (4)	4 (4)	48 (8)	0 (0)	0 (0)
12	0	44	0	52	0	0	56	48	0	40	0	0
Relative : rate of decline	0.396	0.060	0.386	0.058	0.422	0.339	0.049	0.058	0.294	0.060	0.395	0.433
R ²	0.96	0.97	0.94	0.96	0.97	0.93	0.98	0.99	0.84	0.82	0.84	0.93

Figures in parenthesis are per cent decline.

TABLE 2

Development and fecundity of *S. litura* on different castor varieties.

Variety	Incubation period (days)	Larval period (days)	Pre-pupal period (days)	Pupal period (days)	Pre-oviposition period (days)	Oviposition period (days)	Post-oviposition period (days)	Fecundity (Eggs/Female)	Sex Ratio (M : F)
VI-9	3.27	14.35	1.31	6.23	1.38	7.50	2.50	808.38	1 : 1.36
SKI - 73	3.52	15.10	1.48	6.48	1.25	7.00	2.25	737.13	1 : 1.10
48-1	3.36	14.59	1.45	6.36	1.13	7.38	2.38	743.00	1 : 1.20
SH-72	3.63	15.67	1.54	6.63	1.00	7.13	2.13	721.75	1 : 1.18
GAUCH -1	3.19	14.15	1.19	6.11	1.38	7.63	2.63	742.63	1 : 1.45
S.Em. ±	0.09	0.23	0.09	0.09	0.15	0.23	0.17	20.50	-
C. D. 0.005	0.26	0.65	NS	0.28	NS	NS	NS	58.59	-
C. V. %	13.82	7.69	34.55	7.66	34.15	8.82	20.29	7.52	-

48-1 (14.59 days). The pupal period remained significantly longer for the pupae formed from the larvae reared on SH-72 (6.63 days) as compared to VI-9 (6.23 days) and GAUCH-1 (6.11 days). SKI-73 (6.48 days) had significantly longer pupal period than GAUCH-1 (6.11 days). *S. litura* female moths obtained from the larvae reared on VI-9 (808.38) showed significantly higher fecundity than SH-72 (721.75), SKI-73 (73.13), GAUCH-1 (742.33) and 48-1 (743.00) which remained at par in fecundity.

The present observations are corroborate with Mondal and Bhattacharya (1998), Balasubramanian *et al.* (1984), Sankarperumal *et al.*, (1989).

TSS : Total soluble sugar present in the leaves of GAUCH-1 and VI-9 revealed higher ($6.32 \pm 0.005\%$ and $6.05 \pm 0.03\%$), whereas GCH-4 and GCH-5 found with 5.63 ± 0.79 and $5.75 \pm 0.92\%$ of TSS (Table 3).

Total amino acids

Total amino acids on dry weight basis in the leaves of GAUCH-1, VI-9, GCH-4 and GCH-5 was 0.307 ± 0.0025 , 0.281 ± 0.007 , 0.234 ± 0.002 and 0.241 ± 0.017 mg/g, respectively.

Moisture content

The moisture content available in the leaves of GAUCH-1, VI-9, GCH-4 and GCH-5 was 72.37, 61.16, 71.05 and 69.92 per cent, respectively.

Peroxidase specific activity

The peroxidase specific activity in the leaves of GAUCH-1, and VI-9 remained lower (0.29 ± 0.035 and 0.22 ± 0.01) than GCH-4 and GCH-5 (0.36 ± 0.005 and 0.30 ± 0.06).

Polyphenol oxidase specific activity

It is in leaves of GAUCH-1 and VI-9 found considerable lower (0.003 ± 0.012 and 0.013 ± 0.0049), whereas in GCH-4 and GCH-5 it was 0.11 ± 0.035 and 0.014 ± 0.0035 .

Dodia (1992) had also reported the positive influence of amino acids and sugars on feeding behaviour of first and second instar larvae of *H. armigera*. The higher peroxidase activity has been reported in *H. armigera* tolerant chickpea genotype (ICC-1245) than susceptible (L-550) genotype (Anonymous, 1995). Polyphenolic compounds present in pigeonpea adversely affected the activity of digestive enzymes which subsequently affected the nutrient utilization (Singh, 1984).

TABLE 3

Biochemical analysis of castor leaves.

Sr. No.	Variety	Moisture (%)	Dry weight basis		Peroxidase change in OD/minute/mg protein	Polyphenol oxidase change in OD/minute/mg protein
			Soluble Sugar (%)	Amino acid (mg/g)		
1.	GAUCH-1	72.37	6.32 ± 0.005	0.307 ± 0.0025	0.29 ± 0.035	0.003 ± 0.0012
2.	VI-9	68.16	6.05 ± 0.03	0.281 ± 0.007	0.22 ± 0.01	0.013 ± 0.0049
3.	GCH-4	71.05	5.63 ± 0.79	0.234 ± 0.002	0.36 ± 0.005	0.11 ± 0.0035
4.	GCH-5	69.92	5.75 ± 0.92	0.241 ± 0.017	0.30 ± 0.06	0.014 ± 0.0035

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Effect of Plant Growth Regulators on Growth and Flowering of Gladiolus CV. Friendship

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ABSTRACT

A field experiment was conducted to study the effect of GA₃ (50, 100 ppm), CCC (250, 500 ppm) and TIBA (150, 300 ppm), NA (100, 200 ppm) on growth and flowering of gladiolus in a completely randomized design. The growth regulators were applied twice, first at six weeks after planting and second at eight weeks after planting. There was significant increase in plant height and leaf area by GA₃ 100 ppm. GA₃ 100 ppm also resulted in earliest flowering (nearly 10 days) and reduced the total crop duration (12.8 days). GA₃ 50 ppm produced longest spike and rachis length and maximum number of florets per spike. Significant increase in floret diameter, was however, reported with GA₃ 100 ppm, whereas various treatment failed to influence the length of spike.

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INTRODUCTION

Manipulation of production process with plant growth regulators may be one of the most important advances to be achieved in agriculture. The practical use of growth substances in horticulture has assumed invariable significance due to revealed capacity of many compounds to exploit many significant mechanism in plant. The use of growth regulating substances viz. GA₃ in gladiolus (Mukhopadhyay and Bankar, 1986; and Ravidas *et al.*, 1992) NAA in tuberose (Pal and Das, 1990) CCC on tuberose (Hassan and Agina, 1980), B-9 in hippeastrum (Bhattacharjee, 1983a), TIBA in lily (Sujatha and Bhattacharjee, 1992) and MH in dahlia (Bhattacharjee, 1984a) affect the various physiological processes with in the

plant and ultimately affecting growth and flowering. In view of the increasingly important role of these growth substances an investigation was carried out on the effect of GA₃, NAA, CCC and TIBA on growth and flowering of gladiolus cv. Friendship.

MATERIALS AND METHODS

The investigation was conducted at the Horticultural Demonstration Farm and Nursery, Department of Horticulture, Gujarat Agricultural University, Sardar Krushinagar during the year 1995-96. The experiments was laid out in completely randomized design with nine treatments replicated three times. The corms were planted during the first week of October by

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following ridge and furrow method at a spacing of 45 X 30 cm. The plant growth regulators, namely GA₃, NAA, CCC and TIBA were used, each at two levels. Foliar sprays of growth regulators were given twice, first at six week after planting and second at eight weeks after planting. There were 20 plants per treatment. In order to access the effect of various treatments more precisely, all the plants were subjected to uniform cultural practices during the period of investigation. The observations on height of plant, leaf area, number of days taken from planting to emergence of spike, number of florets per spike, diameter of florets and length of florets were recorded.

RESULTS AND DISCUSSION

The data presented in tables indicate that all the plant characters studies showed significant results except length of floret. Maximum plant height and leaf area (58.88 cm and 628.38 cm², respectively) were recorded with GA₃ 100 ppm (Table-1). This effect of GA₃ on plant height and

leaf area is due to its action on cell division and cell enlargement. On the other hand growth retardants decreased the height of plant. The minimum plant height (41.98 cm) and leaf area (359.97 cm²) were recorded in CCC 500 ppm. This effect of growth retardant is because they produced shorter stem length through inhibition of cell division and elongation of sub-apical meristems. Dua *et al.*, (1984) and Ravidas *et al.*, (1992) reported greater plant growth by GA₃ treatment in gladiolus. The earliest flowering and minimum total crop duration (78.60 and 102.86 days, respectively) were recorded in GA₃ 100 ppm treatment, here as growth retardant at higher concentration delayed the flowering and increased the total crop duration. This is because Gibberellins are quite effective in reducing the juvenile period of plants. Early flowering in gladiolus by GA₃ treatment was also reported by Auge (1982), Mukhopadhyay and Bankar (1986), and Ravidas *et al.* (1992). The delayed flowering by growth retardants may be due to the overall slower growth and development. Bhattacharjee (1983b) reported delayed flowering by CCC in lily.

TABLE 1

Effect of plant growth regulators on growth characters.

Treatments	Plant height (cm)	Leaf area (cm ²)	Days taken from planting to spike emergence (days)	Total crop duration (days)
GA ₃ 50 ppm	56.22	528.38	85.86	110.52
GA ₃ 100 ppm	58.86	628.38	78.60	102.86
NAA 100 ppm	46.28	610.98	96.86	122.40
NAA 200 ppm	48.82	596.86	96.00	122.40
CCC 250 ppm	46.80	444.50	87.72	113.00
CCC 500 ppm	41.98	359.97	98.60	123.74
TIBA 150 ppm	44.44	450.38	86.40	111.86
TIBA 300 ppm	42.32	409.28	95.20	121.06
Control	49.96	407.10	88.46	114.06
S.Em.±	0.988	9.087	1.058	1.557
C.D. (0.05)	2.936	19.092	3.143	4.627

Maximum spike and rachis length were produced by GA₃ 50 ppm treatment (127.68 cm and 59.98 cm, respectively) and the minimum spike and rachis length 83.04 and 29.01 cm, respectively, were produced by TIBA 150 ppm (Table 2). The increased effect may be due to that the GA₃ might have increased auxin content in tissue as it is involved in auxin synthesis. However, the effect vice-versa was recorded under the influence of NAA. Bhattacharjee (1984b) and Ravidas *et al.* (1992) also reported increased spike and rachis length by GA₃ 50 ppm resulted in maximum number of florets per spike (16.93), which was at par with GA₃ 100 ppm (16.66). Whereas minimum number of florets per spike

were recorded in CCC 250 ppm. Ravidas *et al.* (1992) and Mahesh and Misra (1983) also reported the positive influence of GA₃ treatment in increasing the number of florets per plant in gladiolus, and Biswas *et al.* (1983) in tuberose. Maximum diameter of floret (12.56 cm) was produced by GA₃ 100 ppm, which was at par with GA₃ 50 ppm (12.04 cm), whereas minimum diameter was observed in control (9.78 cm). The treatments failed to influence the length of florets. This increased diameter of floret is due to increase in petal size by increasing cell size. Bhattacharjee (1984b) and Dua *et al.* (1984) in gladiolus also reported very similar results.

TABLE 2

Effect of plant growth regulators on spike characters.

Treatment	Spike length (cm)	Rachis length (cm)	No. of florets/spike	Floret diameter (cm)	Length of florets (cm)
GA ₃ 50 ppm	127.68	59.98	16.93	12.04	12.20
GA ₃ 100 ppm	121.10	56.46	16.66	12.56	12.30
NAA 100 ppm	108.56	41.62	14.53	11.16	11.68
NAA 200 ppm	110.48	42.80	14.66	10.52	10.70
CCC 250 ppm	92.97	34.60	10.26	11.88	10.82
CCC 500 ppm	113.06	44.92	15.46	10.18	12.04
TIBA 150 ppm	83.04	29.01	12.06	11.48	10.98
TIBA 300 ppm	119.36	49.05	15.06	10.36	11.36
Control	115.57	48.75	13.73	9.78	12.12
S.Em. ±	2.861	1.05	0.189	0.378	1.063
C.D. (0.05)	8.501	3.121	0.560	1.124	N.S.

Conclusion

GA₃ 100 ppm had significantly increased plant height and leaf area in Gladiolus cv. Friendship. This level was proved to responsible for early flowering (10 days), to reduce the total crop duration (12.8 days) and to increase floret diameter. But GA₃ 50 ppm produced the longest spike and rachis; and highest number of florets per spike.

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Effect of IBA and NAA on Root Initiation of Various Varieties of Bougainvillea Species

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ABSTRACT

A nursery experiment on seven varieties of bougainvillea cuttings treated with IBA and NAA (each at 3000, 4000, 5000, 6000 ppm or control) during spring season at North Gujarat condition revealed that different levels of growth regulators (IBA and NAA) significantly effected rooting in hardwood cuttings of bougainvillea cultivars. IBA 6000 ppm was found superior on percentage of rooting, which was also at par with the NAA 3000 ppm treatment. Rooting percentage incerased with the incerasing trend of IBA concentration but which was reverse in levels of NAA. Among the six cultivars tested the cultivar 'Blondie' was found with the highest rooting and cultivar 'Snow White' was with the lowest rooting.

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INTRODUCTION

Bougainvillea is one of the most popular flowering plant grown in the garden for decoration. The large number of varieties bears beautiful flowers during summer and winter. Due to hard nature of the cuttings, the rooting is difficult and hence the garden growers are facing difficulty in multiplying plants from the cuttings. One of the new approaches is the use of the plant growth regulators for inducing rooting in bougainvillea (Bhattacharjee and Balkrishna, 1983). Hence plant growth regulators were tried for quicker multiplication of bougainvillea at nursery level.

MATERIALS AND METHODS

To study the rooting of cuttings in seven varieties of bougainvillea namely Mahara, Roseville's Delight, Blondie, Lady Mary Baring, Snow White, Mary Palmer and Thimma, the cuttings of these varieties were treated by plant growth regulators viz; IBA and NAA (each at 3000, 4000, 5000, 6000 ppm concentration and control). The experiment was conducted at Gujarat Agricultural University, S.K. Nagar in the month of February - April 1995 and it was laid out in a factorial completely randomized design with three replications.

Hardwood cuttings of 15-20 cm lengths and of about 0.8-1.0 cm diameter with 4-6 nodes were taken from years old plants in the month of February. These cuttings were dipped for 15 seconds in the

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plant growth regulators of desired concentration and then inserted 2/3 of its length in to the bags, filled with garden soil as media into polythylene bags containing identical planting mixture. These bags were watered daily and kept under shade. The data were recorded 50 days after planting of the cuttings and was subjected to statistical analysis after transformation of the present values.

RESULTS AND DISCUSSION

Effect of growth regulators : All the levels of growth regulators proved significantly superior over control for the rooting of cuttings. Among the different levels, maximum rooting (68.09 per cent) was obtained in IBA 6000 ppm and it was followed by the lowest level (3000 ppm) of NAA (66.42 per cent) (Table - 1). Rooting percentage increased with the increasing level of IBA concentration whereas the increased concentration of NAA gave decreased rooting percentage.

These results are in agreement with the findings

of Bhattacharjee and Balkrishna (1983), Awad *et al.* (1988) and Joshi *et al.* (1989). It may be due to the enzymatic action of IAA oxidizes on exogenously applied auxin in the process of formation of root primordia in which there is division of cells of phloem parenchyma or paricycle is resulted. And, thus, this may be enhanced higher percentage of rooting.

Effect of varieties : The results presented in table-1 indicated that variety Blondie (V3) produced the highest rooting percentage (73.51) followed by Lady Mary Baring (V4), Roseville's Delight (V2), Mahara (V1), Mary Palmer (V6) and Thimma (V7), respectively. The lowest percentage of rooting (42.95) was recorded in variety Snow White (V5). These results are in agreement with the findings of Mishra and Singh (4).

Interaction effect : The interaction effect between different levels of growth regulators and varieties (G X V) was found non-significant.

TABLE 1

Effect of growth regulator (G) and varieties (V) on percentage of rooted cutting.

Interaction (G x V)	I.B.A. (ppm)				N.A.A. (ppm)				Control (G9)	Mean
	3000 (G1)	4000 (G2)	5000 (G3)	6000 (G4)	3000 (G5)	4000 (G6)	5000 (G7)	6000 (G8)		
V1	55.33 (50.06)	63.33 (53.01)	66.66 (55.01)	70.00 (57.08)	68.33 (56.04)	65.00 (54.01)	60.00 (51.04)	55.00 (48.13)	48.33 (44.31)	61.66 (52.06)
V2	61.66 (52.01)	66.66 (55.01)	70.00 (57.08)	73.33 (59.21)	71.66 (58.13)	68.33 (56.04)	63.33 (53.01)	57.33 (49.49)	51.64 (46.20)	64.88 (44.02)
V3	70.00 (57.05)	75.00 (60.31)	78.00 (62.59)	81.66 (65.00)	70.00 (63.78)	76.66 (61.43)	71.66 (58.13)	66.66 (55.05)	61.66 (52.01)	73.51 (59.48)
V4	66.66 (55.01)	71.66 (58.13)	76.00 (60.95)	78.33 (62.59)	76.66 (61.43)	73.33 (59.21)	68.33 (56.04)	68.44 (53.07)	58.33 (50.06)	70.30 (57.39)
V5	40.00 (39.50)	45.00 (42.40)	45.33 (44.31)	51.66 (46.21)	50.00 (45.26)	46.66 (43.35)	41.66 (40.47)	36.33 (37.54)	26.66 (31.39)	42.95 (41.16)
V6	51.66 (46.21)	56.66 (49.09)	60.00 (51.04)	63.33 (53.01)	61.66 (52.01)	58.33 (50.06)	53.33 (47.17)	48.33 (44.31)	40.00 (49.50)	54.81 (48.05)
V7	46.66 (43.35)	51.66 (46.21)	55.00 (48.13)	58.33 (50.06)	56.66 (49.09)	53.33 (47.17)	48.33 (44.31)	43.33 (41.43)	35.00 (36.55)	49.81 (45.155)
Mean	56.42 (49.03)	61.42 (52.02)	64.90 (54.16)	68.09 (56.17)	66.42 (55.11)	63.09 (53.04)	58.09 (50.02)	52.96 (47.00)	45.94 (42.86)	59.70 (51.05)

	G	V	G x V
S.E.m ±	0.32	0.37	0.95
C.D. at 5	0.90	1.02	N.S.
C.V.%	2.84	2.84	

G indicates level of growth regulator.

V indicates variety.

N.S. indicates Non-significant.

Figures in the parenthesis indicate transformed values.

Different levels of growth regulators (IBA and NAA) significantly affected on rooting in hardwood cuttings of bougainvillea cultivars. IBA 6000 ppm was found superior on percentage of rooting, which was also at par with the NAA 3000 ppm treatment. Rooting percentage increased with the increasing trend of IBA concentration but which

was reverse in levels of NAA. Among the six cultivars tested the cultivar 'Blondie' was found with the highest rooting and cultivar 'Snow White' was with the lowest rooting.

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Impact of Correspondence Course on Animal Husbandry Organised by GAU

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ABSTRACT

The present study was carried out to know impact of correspondence course on animal husbandry organised by GAU for field assistants of Gujarat Sheep and Wool Development Corporation to improve their knowledge through teachers' made questionnaire in the year 2000-2001. The results of the research revealed that respondents of middle age group having SSC and above education took advantage of this correspondence course. Majority of respondents perceived that this correspondence course is most useful and they acquired additional knowledge in various subjects/areas of animal husbandry. It is also reflected that majority (76.25%) respondent had highly favourable to favourable attitude towards this correspondence on animal husbandry and they had not faced any constraint during the said correspondence course.

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INTRODUCTION

A correspondence course on Animal Husbandry was conducted by the university for field assistants of Gujarat Sheep and Wool Development Corporation to improve their knowledge. The field assistants were involved in extension activities as well as first aid of sheep diseases and marketing of wool. They do not have any formal education in the field of animal husbandry earlier. Therefore, to improve scientific knowledge in the field, the course was designed in form of 34 lessons, self-study and evaluation apart from field training.

It was discussed in the coordination committee for extension activities that it is necessary to evaluation / study impact of different extension programmes organised by GAU. In this context, the research study was carried out in the year 2000-2001 with additional intension to know the difficulties faced by the participants along with

their opinions and suggestions regarding the correspondence course. So that in future, the necessary planning and modifications may be made on the basis of the studies.

Objectives

1. To know personal characteristics of the participants.
2. To determine the utility of correspondence course on Animal Husbandry organised by GAU.
3. To study the knowledge acquired by participant after completion of the correspondence course on Animal Husbandry.
4. To know the perception of trainees to various lessons.
5. To determine the attitude of the participants towards the correspondence course on

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Animal Husbandry

6. To find out the constraints faced by participants with regard to the correspondence course on Animal Husbandry.
7. To seek the suggestions of the participants for improvement of the course.

MATERIALS AND METHODS

The study was conducted in Gujarat State. The participants who joined the correspondence course on Animal Husbandry organised by GAU during the year 1996-97, were the respondents in the present study i.e. 80 out of 112 participants. Appropriate teachers made questionnaire was developed for the purpose. The data were collected through mailing the preset questionnaires.

Utility of different subjects included in correspondence course on animal husbandry.

The utility of various subjects included in correspondence course on Animal Husbandry organised by Gujarat Agricultural University was measured with the help of '3 points rating scale' Most useful, Useful and Least Useful with the score value of 3, 2 and 1 respectively. To assign the rank, the mean score for each item was calculated.

Attitude towards correspondence course on animal husbandry

Attitude of the respondent towards correspondence course on animal husbandry organised by GAU was measured by teachers made attitude scale. The selected six statements for final format of the attitude scale were randomly arranged. There were five response columns representing a 5 point agree disagree continuum

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

Constraints faced by respondents

Constraints faced by the respondents during the correspondence course on Animal Husbandry organised by GAU were elicited through simple open-ended questions of different categories viz., (a) regarding correspondence (b) receipt of volume in time (c) examination (d) preparation of exercise and (e) others. Number of respondents facing the same constraints were counted in frequency and percentage.

Suggestion of respondents for improvement of the course in future

An attempt was also made to know suggestions of the respondents for improvement of the correspondence course in future.

The respondents' suggestions were elicited through a simple open ended question. They were asked to give their suggestions for improvement of the such course in future. Number of respondent making the similar suggestions were counted in frequency and percentage.

RESULTS AND DISCUSSION

A. Personal characteristics

Profile of age and previous education of the respondents is given in Table-1.

TABLE 1
Distribution of respondents according to their age and previous education.

Sr. No.	Character	Group	Number of respondents	Percentage
1.	Age	Upto 30 years	0	0.00
		31 to 50 years	79	98.75
		Above 50 years	1	1.25
2.	Education	Upto SSC	0	0.00
		SSC Pass	53	66.25
		Above SSC to graduate	19	23.75
		Graduate	8	10.00

Data presented in Table-1 revealed that nearly 98.75 per cent of respondents were of middle age group i.e. 31 to 50 years indicating that youth and old respondents could not get the advantage of the correspondence course on animal husbandry. It is also revealed that all the respondents were having SSC and above education.

B. Utility of various subjects/areas included in correspondence course on animal husbandry

Mean scores worked out on perception of respondents for usefulness of various subjects/ areas included in correspondence course on animal husbandry organised by GAU are given in Table-2.

TABLE 2

Mean utility scores of various subjects/ areas included in the correspondence course on animal husbandry.

Sr. No.	Subject/area	Mean Score	Rank
1.	Preliminary information on anatomy & function.	2.81	V
2.	Digestive system of animal and its function.	2.82	IV
3.	Reproductive system of animal and its function.	2.87	III
4.	Animal Breeds	2.55	XI
5.	Animal Housing & Equipments	2.51	XII
6.	Calf raising	2.66	VII
7.	Management of milking animals	2.88	II
8.	Feed requirements of various classes of animals	2.65	VIII
9.	Fodder production and storage	2.45	XIV
10.	Pasture	2.56	X
11.	Breeding and Management of sheep & goats	2.64	IX
12.	Poultry production	2.43	XV
13.	Animal Health & Disease Control	2.93	I
14.	Animal Products & Marketing	2.48	XIII
15.	Artificial Insemination	2.71	VI

It can be seen from the Table - 2 that among fifteen subject/areas, animal health and disease control got highest mean utility score (2.93) and secured first rank followed by management of milking animals with second rank and reproductive system of animal and its function with third rank. Majority of the respondents opined that all the subjects/areas included in correspondence course on animal husbandry organised by GAU were found useful.

C. Utility of Field Training organised under the correspondence course on animal husbandry :

Frequencies and percentage were calculated regarding utility of field training organised under

the correspondence course on animal husbandry perceived by respondents are given in Table -3.

TABLE 3

Distribution of respondents according to utility of field training organised under the correspondence course on animal husbandry.

Extent of usefulness	Number	Per cent
Most useful	65	81.25
Useful	04	5.00
Less Useful	0	0.00
Not useful	0	0.00
Opinion not given	11	13.75
Total	80	100.00

It is revealed from Table-3 that more than 80.00 per cent respondents believed this correspondence course is most useful.

D. Knowledge acquired by respondent of the correspondence course on animal husbandry

The objective of the correspondence course

was to increase the knowledge of respondents on the various subjects/ areas of animal husbandry. Information regarding perception of respondents on knowledge acquired after correspondence course on various subjects/areas of animal husbandry is given in Table-4.

TABLE 4

Distribution of the respondents according their perception on the knowledge acquired after the correspondence course on animal husbandry.

Sr. No.	Subject/Areas	Number	Percentage
1.	Anatomy of animals	74	92.50
2.	Function of digestive system	73	91.25
3.	Function of reproductive system	74	92.50
4.	Characteristics of cattle and buffalo breeds of Gujarat	68	85.00
5.	Various methods of calf raising	74	92.50
6.	Care and management of milking animals	75	93.75
7.	Care & management of breeding bulls	78	97.50
8.	Feeds and feeding of various classes of animals	80	100.00
9.	Silage making	73	91.25
10.	Urea treatment of wheat straw	70	98.75
11.	Disease of animals and their control measures	76	95.00
12.	Poultry feeds	78	97.50
13.	Marketing of milk	73	91.25
14.	Artificial Insemination	73	91.25
15.	Housing of animals	75	93.75

The Table-4 indicates that in general majority of the respondents perceived that they have acquired additional knowledge in various subjects/ areas of animal husbandry viz. (i) feed and feeding of various classes of animals (ii) urea treatment of wheat straw (iii) cares and management of breeding bulls (iv) diseases of animals and their control measures (v) poultry feed, etc. after the correspondence course on animal husbandry.

E. Presentation and publication of various volumes of correspondence course on animal husbandry

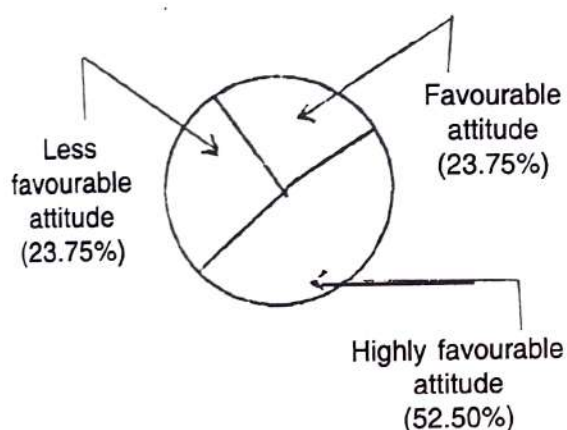
Cent per cent respondents gave following responses regarding presentation and publication of various volumes of correspondence course on animal husbandry organised by GAU :

- (i) Volumes are attractive
- (ii) Figures and photographs included in different lessons of course are useful
- (iii) Presentation of information is interesting
- (iv) Volumes of this course are worth to be stored for future use.
- (v) All of them have stored all the volumes

of this course as they will be useful to them in future.

F. Attitude of respondents towards correspondence course on animal husbandry organised by GAU

The distribution of the respondents according to their attitude towards the correspondence course on animal husbandry organised by GAU is depicted in figure-1. Majority (76.25%) of them had highly favourable attitude towards the correspondence course on animal husbandry.



The attitude score obtained by respondents varied from 22 to 30 with average value of 27.95 having standard deviation 2.65 and co-efficient of variance of 9.41% suggesting that the group was homogenous in this respect.

G. Constraints faced by respondents during the correspondence course on animal husbandry

Most of the respondents had not faced any constraint during the correspondence course. However, some of them are given below :

a. During field training:

- (1) Ten per cent respondents faced the problem of inadequate lodging and boarding facilities.
- (2) Five per cent respondents faced the problem of faulty transportation facility.

(3) One respondent faced the problems of shortage of time, equipments and training.

b. One respondent faced the problem regarding receipt of volume in time.

c. Others

(1) Few respondents have not received certificates.

(2) Few respondents could not give due attention to the correspondence course as they were engaged in their official duties like purchasing of wool.

H. Suggestions of respondents for improvement in future

To an open question there were suggestions that detail information of following topics should be included in the correspondence course on animal husbandry in future :

1. Diagnosis and control measures of emerging diseases of animals.
2. New medicines and equipment of surgery in animals.
3. New recommendations.
4. Postmortem of large animal.

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

Moreover, they also opined that this type course should be organised interval of every five year.

Conclusion :

From the study it can be concluded that the correspondence course on animal husbandry organised by GAU is very useful and well oriented. However, the suggestions for improvement in such course are given below:

A. Following courses should be included in the course :

1. Diagnosis and control measures of emerging diseases of animals.
2. New medicines and equipment of surgery in animals.

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3. New recommendations.

4. Postmortem of large animal.

B. Figures and photographs may be published in four colours.

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Growth Analysis of the Karimnagar District Cooperative Central Bank (KDCCB) Andhra Pradesh

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ABSTRACT

An attempt is made to study the growth of the Karimnagar District Co-operative Central Bank. The compound growth rates of physical indicators viz., number of branches, Government employees under Fundamental Rule 127 were statistically significant, but others viz., beneficiaries covered, total number of employees were statistically non-significant. The compound growth rates of financial indicators viz., total share capital paid-up share capital, borrowings, deposits mobilized, investments, total liabilities, current assets, current liabilities, income, expenditure and advances outstanding during the study period were statistically significant. Authorised share capital credit disbursed and recovery percentage were statistically non-significant.

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INTRODUCTION

The emergence of green revolution during late sixties and introduction of new agricultural technology in India has changed the nature of agriculture. Yield incerasing technology which involves high input use, required higher farm finance. Majority of the farmers in India are small and marginal, they are financially poor and are unable to make high investments in agriculture and hence resort to borrowing. Thus, credit has to be made available at the appropriate time, through appropriate source to the needy farmers.

One of such credit providing institutions to the farmers in India is co-operative bank. In Andhra Pradesh the co-operative credit structure is a 3-tier system consisting of Primary Agricultural Co-operative Credit Societies (PACCS) at village level. District Co-operative Central Bank (DCCB) at district level and Andhra Pradesh State Co-operative Bank (APCOB) at State level.

The Karimnagar District Co-operative Central Bank (KDCCB) was established in the year 1921. Since its inception the bank has been providing credit to the farmers of the district. With the introduction of 'Single Window Delivery System' on 1-4-1987, Bank has been providing short, medium and long term loans to its members. The bank has been mobilizing deposits through it's 28 branches and 528 various Co-operative Societies. Of the total 528 Co-operative Societies, 208 Societies were Primary Agricultural Co-operative Credit Societies (PACCS) Distributed throughout the District and were dealing with the farmres.

In this study an attempt is made to analyse the growth of the KDCCB in terms of both physical and financial indications and to make projections for selected indicators.

MATERIALS AND METHODS

To study the growth compound growth rates

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were estimated for selected physical and financial indicators.

An exponential function of the following types was employed to estimate the growth rates :

$$Y = ab^t$$

where

Y = Indicator

a = Constant

b = Regression co-efficient (rate of change in Y per unit change in time)

t = Time

Annual average compound growth rate in percentage :

$$r = (b-1) 100$$

For the selected physical and financial indicators projections were also made for 2005 A.D. using the following trend equation.

$$Y_c = ab^t$$

Where

Y_c = Trend value

a = Constant

b = Regression Co-efficient

t = Time (20 Years)

The important physical indicators considered were number of branches, number of beneficiaries covered, total number of employees, number of bank's own staff and number of Govt. employees under Fundamental Rule 127. The important financial indicators considered were total share capital, borrowings of the bank, credit disbursed, deposits mobilised, investments made, owned funds, total assets, total liabilities, current assets, current liabilities, income, expenditure, recovery percentage and advances outstanding.

RESULTS AND DISCUSSION

The compound growth rates were computed for the selected physical and financial indicators for the period of 10 years from 1985-86 to 1994-95.

Physical Indicators

The compound growth rates of selected physical indicators are presented in Table 1.

The number of branches grew at a meager rate of 0.72 per cent per annum. It had opened only 2 branches in this period of study, as there were already sufficient number of branches spread across the district.

TABLE 1

Physical performance indicators compound growth rates and projections

Sr. No.	Indicator	Compound Growth Rate (1985-86 to 1994-95) Percentage per annum	Estimates of Trend Equation $Y_c = ab^t$ t=20	Trend Value in Number for 2005 A.D.
1.	Beneficiaries covered	5.0919 (0.988) N.S.	$Y_c = 207826.2 \times 1.050912^t$	561083
2.	Number of Branches	0.7212 (2.744) *	$Y_c = 25.366 \times 1.00712^t$	29
3.	Total Number of employees	3.5281 (1.667) N.S.	$Y_c = 330.1993 \times 1.035282^t$	661
4.	Bank's own staff	3.2942 (1.503) N.S.	$Y_c = 319.5613 \times 1.032942^t$	611
5.	Govt. Employees under F.R. 127	6.5410 (4.910)**	$Y_c = 11.6037 \times 1.06541^t$	41

Note : Figures in paranthesis indicate 't' value for log b

* indicate significant at 5% level

** indicate significant at 1% level

N.S. indicate not significant

The number of beneficiaries covered by the bank grew at a low rate of 5.09 per cent per annum which was statistically non-significant. The reason is attributed to wide fluctuations in number of beneficiaries covered by the bank each year.

A similar trend was observed in the growth rate of total number of employees by the Bank during the study period. The growth rate of total number of employees was low at 3.55 per cent per annum, which was statistically non-significant as the Bank had opened only 2 branches in the study period. The rate of growth in bank's own staff was low at 3.29 per cent annum, which was statistically non-significant, whereas, the rate of growth of government employees recruited under Fundamental Rule 127 was statistically significant at 6.54 per cent per annum.

Projection for Physical Indicators :

The projection made for physical indicators for the bank for 2005 AD are presented in Table 1.

It is envisaged that by 2005 AD the number of beneficiaries covered by bank would increase marginally to 5,61,083 when compared to 1994-95 figure 4,63,585. By 2005 AD the number of branches are projected to increase by only one to take the total to 29 branches. The total number of employees are set to touch 661 wherein bank's own staff and the Government employees under Fundamental Rule 127 would increase in 611 and 41 respectively by 2005 AD.

Financial Indicators

The financial management performance of a bank can be judged by examining the growth of various financial indicators. The compound growth rates for selected financial indicators were calculated and are presented in Table 2.

TABLE 2

Physical performance indicators compound growth rates & projections

Sr. No.	Indicator	Compound Growth Rate (1985-86 to 1994-95) Percentage per annum	Estimates of Trend Equation $Y_c = ab^t$ $t=20$	Trend Value in Lakh Rupees for 2005 A.D.
1.	Total share capital	8.4603 (2.335)*	$Y_c = 1095.0501 \times 1.084603^t$	5559.89
2.	Authorised Share Capital	7.8568 (1.732) N.S.	$Y_c = 689.2075 \times 1.078568^t$	3128.24
3.	Paid-up share capital	9.4598 (6.527)**	$Y_c = 398.4856 \times 1.094598^t$	2499.44
4.	Borrowings	11.6514 (4.049)**	$Y_c = 3201.6010 \times 1.116514^t$	29016.88
5.	Credit disbursement	4.5882 (0.097) N.S.	$Y_c = 2167.7040 \times 1.048817^t$	5623.34
6.	Deposit mobilisation	16.228 (20.456)**	$Y_c = 574.7857 \times 1.16228^t$	11633.79
7.	Investments	11.4228 (5.389) **	$Y_c = 352.1065 \times 1.114228^t$	3063.06
8.	Owned funds	8.6281 (3.861) **	$Y_c = 533.8776 \times 1.08628^t$	2736.80
9.	Total Assets	13.5793 (3.289)*	$Y_c = 7425.0948 \times 1.135793^t$	94773.25
10.	Total Liabilities	13.7379 (5.483)**	$Y_c = 7467.320 \times 1.13739^t$	98009.66
11.	Current Assets	9.7292 (5.211)**	$Y_c = 1448.805 \times 1.097290^t$	9277.99

12.	Current Liabilities	13.4651 (11.432)**	$Y_c = 1001.447 \times 1.134651^t$	11527.78
13.	Income	14.5985 (6.527)**	$Y_c = 352.525 \times 1.145985^t$	5379.83
14.	Expenditure	13.08 (3.890)**	$Y_c = 401.5487 \times 1.1308^t$	4693.04
15.	Recovery Percentage	1.1392 (0.132) N.S.	$Y_c = 30.1627 \times 1.011392^t$	37.83
16.	Advances Outstanding	11.8014 (5.546)**	$Y_c = 3628.561 \times 1.118014^t$	33781.53

Note : Figures in paranthesis indicate 't' value for log b.

* indicate significant at 5% level.

** indicate significant at 1% level.

N.S. indicate not significant.

The total share capital of the bank registered a growth rate of 8.46 per cent per annum indicating that the bank was financially sound. The over all growth rate of authorised share capital was 7.86 per cent per annum but it was statistically non-significant because the authorised share capital increased to Rs. 1200 lakhs in 1986-87, there after there was no increase in it. The growth rate of paid-up share capital was 9.46 per cent per annum. Whatever growth recorded in the total share capital was only because of increase in paid-up share capital.

A substantial growth rate of 11.65 per cent per annum was observed in case of borrowings by the bank which can be attributed to the increased credit disbursement needs and increased outstanding.

Owing to wide fluctuations in the amount of credit disbursed. The growth rate stood at a meager 4.59 per cent per annum. There is perceptible need of better strategies of credit disbursement to be evolved by the bank to cater to the larger sections of needy farmers.

The bank had registered a better growth rate of 16.23 per cent per annum in mobilising deposits through various schemes. The reasons for this could be better efforts put in by the officials, provision of higher interest on the deposits by 0.5% over that of other commercial banks and an insurance coverage on the deposits upto Rs. 1 lakh.

The investments made by the bank on debentures, National Saving Certificates, fixed deposits and shares recorded a growth rate of 11.42 per cent per annum.

The owned funds shown a growth rate of 8.62 per cent per annum, due to increased investments and reserved. The growth rate of total asstes (13.58 % per annum) was less than the growth rate of total liabilities (13.74% per annum). Thus, there is an imperative need for the bank to bring down the growth rate of total liabilities with proper planning.

Similar behaviour was observed in growth rates of current asstes and current liabilities. The growth rates of current assets and current liabilities were 9.73 per cent per annum and 13.46 per cent per annum respectively revealing the bank's inadequacy in meeting immediate obligations.

The bank registered net profits as the growth rate of income was higher i.e., 14.6 per cent per annum when compared to that of expenditure which stood at 13.08 per cent per annum.

The sustenance of any bank in the long run mainly depends on it's ability for the timely recovery of the loans disbursed. The recovery percentage of loans revealed a meager growth of 1.14 per cent per annum. This poor recovery of loans resulted in increasing the growth rate of bank's outstanding at 11.8 per cent per annum. To reduce borrowings, total liabilities and loans

outstanding bank need to improve credit recovery percentage.

Projections for selected financial indicators

The projections made for the selected financial indicators for 2005 AD are given in Table 2.

By 2005 AD the total share capital would increase from Rs. 2132.95 lakhs at present (1994-95) to Rs. 5559.89 lakhs. The authorised share capital and paid up share capital are projected to rise from Rs. 1200 lakhs and Rs. 932.95 lakhs to Rs. 3128.24 lakhs and Rs. 2429.40 lakhs respectively. The borrowings by the bank are respected to reach from Rs. 8790.04 lakhs to Rs. 29016.88 lakhs, credit disbursement from Rs. 4801.16 lakhs to Rs. 4801.16 lakhs to Rs. 5623.34 lakhs, deposits mobilized from Rs. 2796.89 lakhs to Rs. 11633.79 lakhs. Investment from Rs. 1016.40 lakhs to 3063.06 lakhs and owned funds from Rs. 1150.9 lakhs to Rs. 2736.80 lakhs. The gap between the total asstes and liabilities would for the increase to worsen the bank's financial status. The total assets and total liabilities would reach from Rs. 23298.66 lakhs and Rs. 23836.65 lakhs to Rs. 94773.25 lakhs and Rs. 98009.66 lakhs respectively.

Besides that current asstes and current liabilities are expected to reach from Rs. 3961.47 lakhs and Rs. 3518.35 lakhs to Rs. 9277.99 lakhs and Rs. 12527.78 lakhs respectively, which would make the current ratio less than unity i.e., by 2005 AD the bank would not be in a position of meeting its short term obligations, income would increase from Rs. 1403.65 lakhs to 5379.83 lakhs and expenditure from Rs. 1591.35 lakhs to 4693.03 lakhs, the recovery percentage would rise from 34.25 per cent to 37.83 per cent and advances

outstanding would increase from 10547.49 lakhs to 33781.53 lakhs.

Conclusions

The compound growth rates of the physical indicators viz., Number of branches (0.72%), Government employees under Fundamental Rule 127 (6.54%) during the study period were statistically significant. But for other financial indicators viz, Beneficiaries covered (5.09%) and total number of employees (3.53%) growth rates were statistically non-significant.

The compound growth rates of financial indicators viz., total share capital (8.46%), paid-up share capital (9.46%), borrowings (11.65%), deposits mobilised (16.23%), investments (11.42%), total liabilities (13.74), current assets (9.73%), current liabilities (13.47%), income (14.60%), expenditure (13.08%) and advances outstanding (11.8%) during the study period were found to the statistically significant. Authorised share capital (7.88%), credit disbursed (4.59%), Recovery percentage (1.14%) were statistically non-significant.

The projections for physical and financial indicators have also been worked out for 2005 AD.

From the growth rates of selected physical and financial indicators, it is evident that KDCCB has made good progress during the study period. But some drawbacks were identified, which need to be corrected. The total liabilities had grew at a higher rate then the total assets and owned funds during the study period. Hence the bank has to take sufficient measures to reduce its liabilities. It is also imprerative for the bank to improve on the front of credit recovery percentage, so that the advances outstanding is reduced.

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Groundnut Genotypes Identified for the Cultivation in the Summer Season with Fresh Seed Dormancy and Higher Yield Performance

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ABSTRACT

One hundred groundnut (*Arachis hypogaea* L.) germplasm accessions belonging to Spanish group were screened for fresh seed dormancy during three summer seasons (1995, 1996, 1997). Eleven genotypes were identified as having fresh seed dormancy with germination percentage <30%. These genotypes were also evaluated for yield performance during three summer seasons (1998, 1999 and 2000). Five genotypes were found to possess fresh seed dormancy with higher pod yield than the local checks (GG 5, TG 26 and ICGS 44). Hence, J 33, JB 811, J 28, JB 866 and R 9251 may effectively be utilized for incorporating fresh seed dormancy in future breeding programmes.

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INTRODUCTION

In groundnut, yields are very high (2000 kg/ha) in the summer seasons as compared to the *kharif* season (900-1000 kg/ha) In Gujarat, about 1.25 lakh hectares is sown for the groundnut cultivation in summer season. In summer season cultivation under irrigated situations short duration groundnut cultivars belonging to Spanish group are preferred for example cv. GG 2. Mainly in cultivar GG 2 and mostly in all Spanish types lack of fresh seed dormancy is a serious problem (Nautiyal *et al.* 2001). As summer season crop is harvested in the month of May-June, this period coincides with the pre-monsoon showers, as a consequence a substantial number of pods get sprouted, either in the crop standing in the field or in harvested crop lying in the field for drying. Considerable yield losses about 20-50% have been reported due to *in situ* sprouting of seeds.

(Nagarjun and Radder, 1983; Reddy *et al.*, 1985). Attempts have been made to induce seed dormancy by foliar spray of maleic hydrazide (Nagarjun and Radder, 1983), but either dormancy failed to be induced or it is not stable and economic. Hence, there is a need to evolve a variety, which is having high yield with Fresh Seed Dormancy (FSD) of even few days. In view of this, present study was undertaken with an objective to select cultures with FSD by screening large number of germplasm and to evaluate yield performance of selected cultures in comparison with local checks (GG 5 and ICGS 44 and TG 26).

MATERIALS AND METHODS

100 Spanish germplasm accessions were screened for fresh seed dormancy during the summer season of 1995, 1996 and 1997 at main Oilseeds Research Station, Gujarat Agricultural

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University, Junagadh. Pods were picked up and shelled immediately after harvest for germination study. Seeds were surface sterilized with 1% HgCl_2 . Three replicates, each of 50 seeds were kept for germination at seven days after harvest in an incubator at 30° C in rolled germination towels. After seven days of incubation, seeds were counted to calculate germination percentage following the ISTA 1993 protocol. Seeds were scored as having germinated if the axis had elongated and broken through the seed coat to the minimum length of 0.5 cm. The genotypes showing germination < 30% were considered to be dormant. 11 genotypes identified based on exhibiting consistently <30% germination in all the three years were selected for conducting field trials in summer season of the years 1997, 1998 and 2000. 11 selected genotypes along with three check varieties (ICGS 44, TG 26 with FSD and GG 5, without dormancy) were sown in a randomized block design (RBD) with three

replicates at Main Oilseeds Research Station, GAU, Junagadh. Seeds were sown at a spacing of 30 cm (between rows) and 10 cm (between plants) in a plot size of 6 rows each of 5 m length. All the recommended agronomic and plant protection practices were followed. Pod and haulm yield were recorded at the final harvest.

RESULTS AND DISCUSSION

The degree of fresh seed dormancy recorded in the three years varied, but the relative performance of the genotypes for germination remained same. During the year 1998, 1999 and 2000, germination % varied between 10% to 70%; 10% to 96% and 10% to 90% respectively. In the mean germination percentage of the three years, the range varied from 09% to 72%. Percentage recorded by ICGS 44 and GG 5 respectively. 5 genotypes viz., J 33, JB 811, J 28, JB 866 and R 9251 consistently exhibited < 30% germination (Table 1) for all the three years.

TABLE 1

Germination percentage of various promising groundnut genotypes with fresh seed dormancy during the years 1998, 1999 and 2000 as well as mean of three years.

Sr. No.	Name of Entry	Germination (%)			Germination (%) mean of three years
		1998	1999	2000	
1.	ICGS-44	15	03	10	09
2.	R-9251	10	10	20	13
3.	J-33	25	22	20	22
4.	JB-811	30	27	25	27
5.	J-28	35	28	24	29
6.	JB-866	60	19	10	30
7.	JB-940	20	68	55	31
8.	PBNG-26	10	52	59	39
9.	TG-26	42	46	51	46
10.	PBNG-8	10	65	66	47
11.	JB-646	40	69	70	60
12.	JB-(FDR)-62	70	96	91	86
13.	GG-5	70	76	71	72
14.	ICGS-86143	40	93	90	74

Pod yield of various genotypes differed significantly (Table-2). During the year 1998, the yield of J 33 was significantly higher than the check GG 5. However, it was at par with genotypes ICGS 86143, JB 646, PBNG 26, JB 811 and JB (FDR) 62. R 9251 exhibited the lowest yield, but statistically it was at par with GG 5. During the year 1999 the numerically highest pod yield was recorded by ICGS 86143, however, all

the genotypes were statistically at par. In the year 2000, again the genotype ICGS 86143 stood first with respect to pod yield and it was at par with J 33, JB 646, PBNG 8, PBNG 26, J 28 and JB 940. When the data were pooled and analyzed it showed that pod yield was the highest (2540 kg/ha) in ICGS 86143 followed by J 33, JB 646 and PBNG 8. Also, they were statistically at par with each other and performed better than the local checks.

TABLE 2

Pod yield of various promising groundnut genotypes with fresh seed dormancy during the years 1998, 1999 and 2000 as well as pooled data.

Sr. No.	Name of Entry	Pod yield (kg/ha)			Pod yield pooled (kg/ha)
		1998	1999	2000	
1.	ICGS-86143	2098	2419	3102	2540
2.	J-33	2268	2257	2865	2469
3.	JB-646	1910	2251	3068	2409
4.	PBNG-8	1736	2373	3073	2394
5.	PBNG-26	2097	2118	2737	2318
6.	J-28	1620	2263	2836	2240
7.	JB-866	1997	1852	2633	2161
8.	JB-811	1866	1973	2552	2131
9.	JB-(FDR)-62	1895	2072	2315	2094
10.	R-9251	1273	2199	2263	1912
11.	JB-940	1317	1800	2859	1992
12.	GG-5	1606	2106	2240	1984
13.	TG-26	1548	1979	2315	1947
14.	ICGS-44	1563	2425	2216	2068
	S.Em.±	173.86	158.27	144.76	136.40
	C.D. at 5%	505.51	NS	421.00	396.00
	C.V.%	10.99	12.76	09.47	12.61

Haulm yield varied significantly during the individual years i.e. in 1998, 1999 and 2000 (table 3). In the year 1998, J 33 and JB 940 recorded significantly highest yield, and were better than GG 5. The magnitude of haulm yield was comparatively low in 1999 and no entry could record significantly higher haulm yield than the check varieties. In the year 2000, ICGS 44 topped, followed by JB 811, R 9251, JB (FDR) 62 and

J 33. However, in pooled analysis all the genotypes remained statistically at par with each other, but the numerically highest haulm yield was recorded in ICGS 44.

The performance of genotypes viz. J 33, JB 811, J 28, R 9251 and JB 866 over the seasons showed that they could be better substitute as varieties in the areas where *in situ* germination is

TABLE 3

Haulm yield of various promising groundnut genotypes with fresh seed dormancy during the years 1998, 1999 and 2000 as well as pooled data.

Sr. No.	Name of Entry	Haulm yield (kg/ha)			Haulm yield pooled (kg/ha)
		1998	1999	2000	
1.	ICGS-86143	4398	3883	6424	4902
2.	J-33	7118	6481	7350	6983
3.	JB-(FDR)-62	5903	6366	8218	6829
4.	JB-940	7060	5440	7059	6520
5.	J-28	3993	5208	7060	5421
6.	JB-811	4225	6076	8623	6308
7.	R-9251	3704	6713	8449	6289
8.	JB-646	4688	5845	8160	6231
9.	PBNG-26	6308	4977	6944	6076
10.	PBNG-8	5845	4919	7176	5980
11.	JB-866	5440	4514	7176	5710
12.	GG-5	5093	5729	8102	6308
13.	TG-26	4456	5035	6771	5421
14.	ICGS-44	5729	6366	9375	7157
	S.Em.±	443.06	365.54	403.26	843.25
	C.D. at 5%	1288.23	1062.84	1172.53	NS
	C.V.%	14.53	11.43	09.50	11.41

a serious problem due to lack of fresh seed dormancy at maturity. The importance of development of Spanish bunch varieties of groundnut with dormancy has been reported by various workers (Ramchandran *et al.*, 1967; Varisai *et al.* 1969; Gautreau 1984; Pandya and Patel, 1986; Wadia *et al.*, 1987 and Khalfaoui, 1991). However, very few Spanish bunch varieties with the fresh seed dormancy have been developed., Studies have also been made to understand the nature of dormancy in peanut (Upadhyay and Nigam, 1999) and Nautiyal, *et al.* (1993) which has revealed that defining dormancy characteristics of groundnut cultivars might be difficult, and that is the reason that

genotypes with a short FSD should be identified through screening. Mathur *et al.* (2000) have identified two cultures with fresh seed dormancy by screening the advanced breeding material in groundnut.

Thus, these genotypes viz. J 33, JB 811, J 28, R 9251 and JB 866 possessed fresh seed dormancy with higher pod yield over the seasons, hence, they may be tested at multi location for their yielding ability. In addition these genotypes may be used as donor parents for incorporation of fresh seed dormancy in future breeding programme.

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Short Communications

Influence of Irrigation and Spacing on Yield Quality Water Use and Economic of Rustica Tobacco (*Nicotiana rustica* L.)

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One of the measures for obtaining higher yield of rustica tobacco, an important nonfood cash crop of North Gujarat, is adoption of optimum plant population under different water regimes to provide each plant an adequate opportunity for CO_2 assimilation and dry matter production. To determine the effect of irrigation schedules and spacings on yield, quality and water use, an experiments with rustica tobacco cv. 'GC 2' was carried out in split plot design with four replications during *rabi* 1996 in loamy sand soil of Sardar Krushinagar. Irrigation schedules (0.5, 0.7, 0.9 and 1.1 IW : CPE ratios) were taken in main plots and spacings (75 cm X 45 cm, 75 cm X 60 cm, 60 cm X 45 cm and 60 cm X 60 cm) in sub-plot. The soil was neutral in pH, containing 181, 42 and 104 kg/ha of available N, P and K, respectively. The field capacity, permanent wilting point and bulk density were 8.94%, 2.84% and 1.59 g/cc, respectively. All recommended cultural operations were carried out as per need of crop.

Irrigating the crop at 1.1 IW : CPE ratio (16 irrigations) produced the highest cured leaf and dry stalk yields and was at par with 0.9 ratio (14 irrigations). Both the ratios were significantly

superior to rest of the IW : CPE ratios (Table-1). Higher yield with more number of irrigations might to due to proper utilization of nutrients and also better formation and accumulation of photosynthates. Spangle score of leaf progressively increased while total N content of leaf progressively decreased with successive increase in IW : CPE ratios from 0.5 to 1.1. Limited supply of water under low IW : CPE ratios (0.5 and 0.7) produced statistically identical nicotine content which was significantly higher than that of adequate supply of water (0.9 and 1.1 IW : CPE ratios). Decreased in total nitrogen and nicotine content of leaf with increase in number of irrigations might be due to dilution effect as there was increase in yield by about 37% over 0.5 IW : CPE ratio. Consumptive use of water increased with increase in IW : CPE ratios from 0.5 to 1.1, while water use efficiency decreased with increase in IW : CPE ratios. Maximum net realization (Rs. 23,283/ha) and BCR (2.36) were obtained with 0.9 IW : CPE ratio. These results confirm the finding of Chaudhary, 1995.

Among the 4 spacings, significantly the highest cured leaf and dry stalk yields were recorded under 60 cm X 60 cm spacing. While the lowest yields were obtained under narrow spacing of 60 cm X 45 cm. This might be due to more competition for resources such as space, nutrient, moisture and radiation under narrow spacing. Crop sown at 75 cm X 60 cm produced the highest spangle score, total nitrogen and nicotine content of leaf, which was at par with that of 60 cm X 60 cm but appreciably higher than 60 cm X 45 cm and 75 cm X 45 cm spacings.

TABLE 1

Effect of irrigation and spacing on yield, quality, water use and economics of rustica tobacco.

Treatments	Spangle score (0-4)	Cured leaf yield (kg/ha)	Stalk yield (kg/ha)	Total N (%)	Nicotine content (%)	CU (mm)	WUE (kg/ha-mm)	Net realization (Rs/ha)	Benefit : Cost ratio
IW : CPE ratio									
0.5	1.62	2,165	471	2.96	5.27	401	5.40	9,889	1.59
0.7	2.06	2,890	574	2.87	5.25	540	5.35	18,562	2.10
0.9	2.75	3,305	680	2.70	4.93	670	4.93	23,283	2.36
1.1	3.25	3,415	715	2.61	4.60	715	4.71	23,104	2.23
CD at 5%	0.25	239	49	0.05	0.28	-	-	-	-
CV%	12.99	10	10	2.48	6.85	-	-	-	-
Spacing (cm)									
60 X 45	2.12	2,722	567	2.57	4.65	617	4.41	15,208	1.82
60 X 60	2.60	3,173	648	2.87	5.12	567	5.59	21,665	2.26
75 X 45	2.35	2,920	609	2.72	4.90	585	4.99	18,543	2.07
75 X 60	2.71	2,959	615	2.90	5.15	557	5.31	19,409	2.14
CD at 5%	0.18	194	31	0.08	0.20	-	-	-	-
CV%	10.46	9	7	4.21	5.59	-	-	-	-

Improvement in nicotine and total nitrogen content in leaf lamina with wider spacing could be due to low competition within crop plants for availability of nitrogen in soil. These results are in agreement with those reported by Upadhyay *et al.* 1994. Consumptive use of water decreased with decrease in plant population. Maximum water use

efficiency was recorded with 60 cm X 60 cm spacing while it was the lowest under 60 cm X 45 cm spacing. The highest net realization (Rs. 21, 665/ha) and BCR (2.26) were realized when the crop was raised with 60 cm X 60 cm plant spacing.

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Effectiveness of Sowing Methods and Fertilizers on the Incidence of Rice Leaf Folder, *Cnaphalocrocis medinalis* Guen.

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Introduction of high yielding varieties with intensive cultivation have created a favourable environment for insect pests. Among the various pest attacking to rice crop, the leaf folder (LF), *Cnaphalocrocis medinalis* Guen. is one of the important insect pest in Gujarat. Earlier, it has been recorded as minor pest, but now it has assumed the status of a major pest in the state. Upadhyay *et al.* (1975) reported that an average infestation of 73% of the pest resulted in reduction in grain yield to the extent of 13.68 g/ha.

Influence of fertilizer levels on the incidence of *C. medinalis* has been reported by many workers (Chandragiri *et al.* 1974; Dhaliwal *et al.* 1979; Upadhyay *et al.* 1981, Dhaliwal and Singh, 1985; Rajendran 1985; Saroja *et al.* 1987; Yein and Das 1988; Suresh *et al.* 1991 and Sudhakar *et al.* 1993. However, few (Rajendran 1985, Yein and Das, 1988 and Sathiyandam *et al.* 1991) have assessed the incidence of LF in rice crop having different plant density level of spacing level. No. detailed work has been done on the impact of sowing methods on the LF incidence in Gujarat. Keeping this in mind, the present study

was carried out to evaluate the influence of two sowing methods *i.e.* sprouted seed method and transplanted method and level of two commonly used fertilizers on the incidence of rice LF.

A field experiment was conducted in a split plot design with three replications during *kharif* 1994 and 1995 at the Main Rice Research Station, Gujarat Agricultural University, Nawagam. Two methods of sowing *i.e.* sprouted seed method (M1) and transplanting at 20 x 15 cm (M2) were kept as main plot treatments. Similarly, four levels of nitrogen (50, 100, 150 and 200 kg N/ha) and three levels of phosphorus (0, 25 and 50 kg P_2O_5 /ha) were arranged as sub-plot and sub-sub-plot treatments, respectively. Gross and net plot size were 6.0 x 2.4 and 5.4 x 1.6 m respectively. Variety used for experimental purpose was GR-11 with seed rate of 40 and 20 kg/ha for sprouted and transplanting method of sowing, respectively. Sprouted seeds were sown at the date (first August 1994 and fifteen August 1995 during first and second year if experimentation, respectively) of raising the nursery and trasplating was followed after 25 days of sowing. The entire quantity of P_2O_5 was applied as basal dose at the time of puddling. Nitrogen was applied in 3 split *i.e.* 40% at puddling, 40% at tillering and remaining 20% at panicle initiation stage.

Observations were made during third week of October when incidence of LF was at peak level. Total number of leaves and LF damaged leaves were counted for 10 hills selected at randon from each net plot and expressed in

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TABLE 1

Influence of sowing methods and fertilizer levels on the incidence of rice leaf folder.

		LF Damage (%)		
		1994	1995	Pooled
Sowing method				
	M ₁	30.94 (26.72)*	29.82 (25.67)	30.38 (26.19)
	M ₂	21.30 (13.37)	28.99 (24.44)	25.14 (18.91)
S.E.m.		0.202	0.402	3.11
C.D. at 5%		1.227	NS	NS
C.V. (%)		4.63	8.21	6.88
N	N ₁ 50 kg/ha	22.71 (15.09)	19.64 (11.38)	21.18 (13.24)
	N ₂ 100 kg/ha	24.72 (18.08)	25.66 (18.86)	25.19 (18.47)
	N ₃ 150 kg/ha	27.02 (21.63)	32.67 (29.22)	29.85 (25.43)
	N ₄ 200 kg/ha	30.02 (25.37)	39.64 (40.75)	34.83 (33.06)
	S.E.m.	0.383	0.690	2.763
	C.D. at 5%	1.182	2.126	NS
	C.V. %	6.23	9.96	8.53
	P ₁ 0 kg/ha	26.72 (20.91)	28.91 (24.38)	27.81 (22.64)
	P ₂ 25 kg/ha	26.05 (19.95)	29.53 (25.19)	27.79 (22.57)
	P ₃ 50 kg/ha	25.59 (19.28)	29.78 (25.60)	27.68 (22.44)
	S.E.m.	0.270	0.388	0.255
	C.D. at 5%	0.780	NS	NS
	C.V. %	5.07	6.46	5.90

* Data in parentheses indicate the original value.

NS = Not significant.

percentage. The percentage value was converted to angular value and then subjected to statistical analysis. Data obtained are presented in Table-1.

Observations revealed that sprouted seed method (M1) had more plant population in comparison of transplanted method (M2). Methods of sowing has no influence on the pest incidence. In present study, the non-significant variation in LF incidence between the two

methods of sowing indicated that the plant population/density had no influence on the pest attack. Rajendran (1985), Yein and Das (1988) and Sathiyandam *et al.* (1991) also supported the present findings. Leaf folder damage recorded in different levels of N showed significant impact during 1994 and 1995, however pooled analysis revealed non-significant variation (Table-1). The extent of LF damage increased (from 13.24 to 33.06%) with the increasing doses of nitrogenous

fertilizers (from 50 to 200 kg N/ha). This is in agreement with the finding of Chandragiri *et al.* (1974), Dhaliwal *et al.* (1979), Upadhyay *et al.* (1981), Dhaliwal and Singh (1985), Rajendran (1985), Saroja *et al.* (1987), Yein and Das (1988), Thakur and Mishra (1989) and Sudhakar *et al.* (1993). In contrast to this, Suresh *et al.* (1991) noted that there was no difference in LF incidence with respect to nitrogen levels. The impact of

phosphorus fertilizer on LF damage was not noticed in pooled results. Interaction between year X method (Y X M), year X nitrogen (Y X N) and year X phosphorus (Y X P) were found significant.

Present study concluded that the sowing methods evaluated had no impact of LF incidence, however LF incidence increased with the increasing doses of N fertilizers.

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Response of Fertility Levels and Plant Growth Regulators on Character and Yield of Potato

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Poor productivity of potato in Madhya Pradesh was observed due to the low soil fertility and also imbalanced use of fertilizer. Therefore the balanced application of fertilizers (N, P, K) reported by Shukla and Singh (1976) and exogenous application of plant growth regulators (PGRs) by Sarkar and Singh (1984) at optimum concentration and at proper stage on the crop can play a vital role in enhancing the yield. A field experiment was carried out to show the efficacy of different levels of fertility and PGRs on Kufri Jyoti variety.

The field experiment was conducted in factorial randomized block design with four replications during 1998-99 at the Research Farm, College of Agriculture, Indore. The crop was planted on 10 November 1998 at 60 X 20 cm at a depth of 4.5 cm fifteen treatments comprising of fertility levels 150:200:100 (Recommended dose of NPK), 112, 5:75:75 (25 per cent less of recommended dose of NPK) 187.5:125:125 (25 per cent more of recommended dose of NPK) and plant growth regulators GA_3 100, 200 $Mg\ l^{-1}$ and cycocel 250, 500 $Mg\ l^{-1}$ were used. The chemical fertilizers were applied manually before sowing in the form of urea, single super phosphate and muriate of potash. The half of nitrogen with full quantity of P and K were applied as basal

and the remaining quantity of nitrogen was top dressed at 30 days after planting. Gibberellic acid and distilled water were sprayed at 33 days after planting at 4-5 leaf stage of plant and cycocel at 50 days after planting. The stage of application of both PGRs are different due to the growth promoting and growth inhibiting nature of plant growth regulators. Five plants were tagged at random in each treatment for recording the observation on number of sprouts, number of levels, plant height, leaf area, fresh and dry weight of shoot fresh and dry weight of tuber and tuber yield.

Perusal of the data (Table 1) indicate that the plant height, fresh weight of shoot fresh weight of tubers were significantly affected by both the fertility levels and the PGRs. Among the fertility levels F_3 was found superior as compared to the other levels while 200 ppm conc. of Gibberellic acid was found superior for these characters. Similar findings were also reported by Patel *et al.* (1996) in potato crop.

The average number of leaves per plant was significantly affected by fertility levels only, while the dry weight of shoot dry weight of tubers and tuber yield are only influenced by growth regulators. The maximum dry weight of shoot and dry weight of tubers is found with 200 $mg\ l^{-1}$ GA_3 and 250 $mg\ l^{-1}$ cycocel respectively. The cycocel treatment gave the maximum tuber yield due to increased photosynthetic efficiency of plants by persistent greenness of leaves for longer tuber yield was associated with cycocel 500 $mg\ l^{-1}$ similar results were also reported by Alam and Islam (1989), Shadeque and Pandita (1982) and Patel *et al.* (1996).

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TABLE 1

Response of fertility levels and plant growth regulators on Kufri Jyoti variety of potato for growth and tuber yield.

Treatment	No. of sprouts (30 DAP)	No. of leaves (90 DAP)	Plant height (90 DAP)	Leaf area/ plant (90 DAP)	Fresh wt. of shoot (90 DAP) (g)	Dry wt. of shoot/ plant (0 DAP)(g)	Fresh wt. of tuber (90 DAP) (g)	Dry wt. of tuber (90 DAP) (g)	Tuber yield (q/ha)
A. Fertilizer levels									
150:100:100 (F ₁)	2.50	34.67	63.70	40.87	312.46	22.78	215.35	48.40	297.88
112.5:75:75 (F ₂)	2.48	33.49	62.50	38.41	311.53	22.76	200.00	48.62	295.23
187.5:125:125 (F ₃)	2.87	35.15	64.40	41.14	313.30	22.73	218.80	50.00	298.40
S.E.(m) ±	0.048	0.31	0.31	0.55	0.26	0.19	2.70	2.40	1.36
C.D. at P = 0.05	0.138	0.90	0.89	1.57	0.25	N.S.	7.70	N.S.	N.S.
B. Growth regulators									
None (G ₀)	2.45	33.69	63.10	36.71	313.84	24.63	180.85	44.00	270.10
100 ppm GA (G ₁)	2.82	34.74	66.40	37.61	320.46	24.72	220.39	48.19	281.48
200 ppm GA (G ₂)	2.73	35.34	67.40	39.87	321.87	24.78	215.45	53.14	281.03
250 ppm cycocel (G ₃)	2.48	33.77	60.30	43.04	319.48	24.68	220.00	58.41	323.01
500 ppm cycocel (G ₄)	2.49	33.83	60.00	43.71	318.49	24.02	224.25	58.39	339.68
S.E. (m) ±	0.062	0.41	0.40	0.71	0.34	0.02	3.48	3.09	1.76
C.D. at P = 0.05	0.17	—	1.16	2.03	0.98	0.07	9.95	8.84	5.09

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Phagostimulant Property of a Weed, *Euphorbia elegans* L. Against *Helicoverpa armigera* (Hubner) on Chickpea

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During the course of investigation on evaluation of a weed, *Euphorbia elegans* L. (Family : Euphorbiaceae) for its insecticidal properties against *Helicoverpa armigera* (Hubner), it was found that the chickpea leaves treated with seed oil of this weed exhibited more feeding of the test insect. With this phenomenon, an attempt has been made to study the phagostimulatory behaviour of *H. armigera* to leaf extract and seed oil of this spurge. This plant is a prominent weed in the chickpea fields of Ghed area of West-South Saurashtra region of Gujarat State. It grows up abundantly in winter alongwith the chickpea crop and remains upto summer season.

TABLE 1

Incremental rate feeding and excretal weight of *H. armigera* fed on chickpea larvae treated with *Euphorbia* leaf extract (5%) and seed oil (0.5%).

Larval instar	Incremental rate over the check							
	Leaf feeding after hours						Excretal weight after 72 hrs of feeding (gms)	
	Seed oil			Leaf extract			Seed oil	Leaf extract
	24	48	72	24	48	72		
I	5.0	26.7	1.8	1.1	2.0	0.9	2.0	1.6
II	2.2	15.0	3.6	1.8	7.9	1.4	2.5	3.75
III	4.8	13.0	20.7	2.5	5.1	6.4	1.25	2.5
Av.	4.0	18.2	8.7	1.8	5.0	2.9	1.92	2.62

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The *Euphorbia* seed oil extracted by acetone was used to determine its phagostimulant property against *H. armigera* in laboratory during February 1997. For this purpose, chickpea leaves were sprayed with solution prepared from *Euphorbia* oil 0.5%, dried and exposed to *Helicoverpa* larvae for their feeding for three days. Five larvae of each instar were kept individually in petridishes (9 x 2.5 cm) for each set and repeated thrice. The chickpea leaves sprayed with only water served as control. Observations on leaf area consumed in the leaf was assessed by visual gradations following 0 to 10 scales. The excreta produced by individual larvae was also collected daily and subsequently it was weighed after three days of larval feeding. The leaf extract prepared by crushing and pressing the weed of leaves was also tested at 5 per cent following the same procedure. Data thus obtained were converted into the proportional rate of increase compared to the control as the incremental rate.

Data (Table -1) indicated that the incremental rate of leaf feeding by first, second and third

Helicoverpa larvae was higher on next day of feeding and it was 26.7, 15.0 and 13.0 in the respective larval instars. First instar larvae fed comparatively faster than second and third instar larvae. The third instar larvae increased their feeding rate with their development i.e. 4.8, 13.0, and 20.7 in 24, 48 and 72 hrs of feeding respectively. In leaf extract, larvae also fed more on next day of feeding, while third instar larvae fed more leaf on the third day of feeding compared to first and second instar larvae, and they increased feeding rate with development e.g. 2.5, 5.1 and 6.4 in 24, 48 and 72 hrs of feeding, respectively. Overall data also indicated that the *Helicoverpa* larvae fed more on leaves treated with seed oil than those treated with leaf extract.

The excretal weight of second and third instar larvae was higher (3.75 and 2.50 gm, respectively) when they fed on the chickpea leaves treated with leaf extract as compared to those fed on the chickpea leaves treated with seed oil i.e. 2.50 and 1.25 gm, respectively. This clearly indicated that the *Euphorbia* leaf extract 5% had increased the food consumption as compared to the leaves treated with *Euphorbia* seed oil 0.5%. The second instar larva had consumed more food in comparison to third instar larva.

The results showed that the *Helicoverpa* larvae exhibited more phagostimulatory behaviour on the seed oil than on leaf extract treated leaves. Later instar larvae responded more than early instar larvae. It was evident that the *Euphorbia* oil stimulated *Helicoverpa* larvae for more feeding, though feeding on leaf extract treated

leaves produced more excretal weight than those feeding on oil treated leaves. It meant that the *Helicoverpa* larvae digested comparatively more food when they fed on seed oil treated leaves compared to feeding on leaf extract treated leaves. The study showed that *Euphorbia elegans* acted as a phagostimulant to this pest. This is the first record of *H. armigera* as phagostimulant.

Biochemically *Euphorbia* spp. contain a quinone-euphorbol and its seeds contain fats as a conjugated polythenoid acid mainly rich in oleostearic acid (Florkin and Manson, 1962). Feeding of insect on plant is enhanced by carbohydrates, amino acids, sterols, vitamins as well as specific phagostimulant (Schoonhoven, 1972). The commercial phagostimulant has previously been studied against *Spodoptera litura* and *H. armigera* (Meisner *et al.* 1984, Korat and Lingappa, 1996). Parrott *et al.* (1968) reported a feeding stimulant for pink bollworm in water extract of cotton. The present finding revealed that the leaf extract and seed oil of *Euphorbia elegans* contains a phagostimulant of *H. armigera* larvae. Its practical utility can, however, be enhanced after overcoming its irritant nature. The phagostimulants enhanced the activity of biopesticides (Bt and NPV) and have a synergistic effect on toxicity of some synthetic insecticides (Meisner *et al.*, 1984) and thus the present finding can become useful to obtain effective control of *H. armigera*.

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Population Dynamics of *Liriomyza trifolii* (Burgess) on Castor and Fenugreek under Middle Gujarat Agro-Climatic Zone*

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American serpentine leafminer, *Liriomyza trifolii* (Burgess) (Diptera : Agromyzidae) is an important polyphagous pest, got accidentally introduced in India during 1990-91 and now has attained the status of a serious polyphagous pest in different crops (Viraktamah *et al.*, 1993). Kapadia (1994) and Jyani (1999) reported 57 host plants of serpentine leafminer. Though, the pest has been recorded on many cultivated crops, the information on seasonal activity of *L. trifolii* on castor and fenugreek, the important host crops in middle Gujarat region is scanty. The present study was undertaken to know the population dynamics of the pest in relation to biotic and abiotic factors.

A field trial on population dynamics of *L. trifolii* infesting castor and fenugreek was carried out at Agronomy farm, Gujarat Agricultural University, Anand during 1998-99. The castor (GCH-4) crop was sown in an area of 40 m x 30 m during first week of July, whereas fenugreek (Local) was sown in an area of 20 m x 12 m during first week of November, 1998. The castor crop

was sown at 90 x 45 cm distance, whereas the fenugreek crop was raised by broadcasting method. Each plot was divided into 6 equal quadrants. From each quadrant, 5 plants were randomly selected for recording the observations. The observations on larval population and mine-density were recorded from three (3rd, 4th and 5th leaf from top) leaves in castor and 10 leaves in fenugreek with the interval of 7 days starting from first week of germination and continued till harvest of the crop. The number of leaves damaged by leaf miner were counted from each randomly selected plant and per cent leaf damage was worked out. To know the activity and extent of parasitism due to different parasitoids the infested leaves of castor and fenugreek were collected at weekly intervals and brought to the laboratory during the study period. On the basis of total number of larvae and emergence of larval-pupal parasitoids, per cent parasitism was calculated.

Data on population fluctuation of *L. trifolii* on castor (Table 1, Fig. 1) indicated that the pest incidence (0.96 larva/leaf) commenced during second week of July (28th std. week). Then, activity increased gradually in subsequent weeks and reached to its first peak (87.63 larvae/leaf) during the 2nd week of October (41st std. week). Mine density was maximum (98.54 mines/leaf) during this period, whereas the leaf damage was 66.07 per cent. Thereafter, the pest activity decreased gradually up to 4th week of November (47th std. week). It again increased from last week of November and attained the second peak

* Part of M.Sc. (Agri.) thesis submitted by senior author.

TABLE 1

Population abundance of *L. trifolii* on castor in relation to biotic and abiotic factors.

Std. Week	Month and week	No. of larvae/leaf	No. of Mines/Leaf	Leaf damage (%)	Parasitism (%)			Abiotic factors				
					Ch	Gr	Total	Mean temp. (°C)	Rain-fall (mm)	Sun-shine (hrs)	Rainy days	R.H. (%)
28	July II	0.96	0.96	87.58	0.00	0.00	0.00	28.94	52.40	0.79	2	82.78
29	July III	2.55	2.76	76.26	0.00	0.00	0.00	29.27	25.50	4.61	2	79.69
30	July IV	6.87	7.29	70.52	0.00	0.00	0.00	30.09*	-	6.73	0	71.90
31	Aug I	4.29	6.87	70.64	0.00	4.35	4.35	28.73	263.20	2.30	6	86.74
32	Aug II	12.62	15.32	71.25	1.90	3.00	4.90	20.49	41.50	1.10	4	88.32
33	Aug III	29.56	33.68	70.39	0.00	3.00	3.00	28.40	17.80	4.61	2	81.02
34	Aug IV	23.75	30.45	73.57	2.20	6.70	8.90	30.34	27.20	5.90	1	79.11
35	Aug V	27.44	35.74	69.53	0.00	6.15	6.15	28.07	31.20	3.29	4	85.62
36	Sep I	44.67	54.42	68.22	1.00	8.00	9.00	29.24	67.20	7.77	2	76.25
37	Sep II	72.76	97.57	68.55	2.15	10.55	12.70	28.20	149.40	5.13	6	86.78
38	Sep III	64.54	78.59	69.75	2.25	9.10	11.35	28.08	51.40	3.59	3	85.58
39	Sep IV	60.74	75.66	62.26	2.25	11.20	13.45	29.54	38.20	6.97	1	78.36
40	Oct I	80.45	94.78	60.02	3.95	8.45	12.40	30.20	12.60	9.01	1	72.94
41	Oct II	87.63	98.54	66.07	4.77	10.20	14.97	31.26	3.40	9.36	1	68.10
42	Oct II	63.46	74.54	59.75	3.55	11.65	15.20	26.35	65.70	5.79	3	82.40
43	Oct III	67.85	79.65	56.58	2.75	11.50	14.25	27.34	0.00	8.37	0	67.65
44	Nov I	43.48	70.29	54.52	4.00	9.45	13.45	27.72	0.00	8.54	0	62.57
45	Nov II	15.34	70.22	54.57	0.00	2.65	2.65	25.72	11.00	9.29	1	58.26
46	Nov III	14.27	32.56	63.15	0.00	0.00	0.00	24.02	-	9.19	-	62.71
47	Nov IV	5.79	35.08	63.74	0.00	0.00	0.00	23.19	-	9.33	-	61.94
48	Nov V	11.85	42.50	65.19	1.26	2.75	4.01	21.66	-	9.76	-	57.55
49	Dec I	8.64	36.05	67.96	1.25	2.00	4.25	21.90	-	9.83	-	54.51
50	Dec II	19.74	43.79	70.22	0.00	3.00	3.00	21.25	-	7.14	-	53.76
51	Dec III	36.27	54.70	73.73	1.64	3.95	5.59	20.81	-	8.79	-	67.95
52	Dec IV	31.62	52.10	73.15	1.15	4.00	5.15	19.74	-	9.43	-	61.96
1	Jan I	16.55	62.22	72.25	0.65	3.65	4.30	19.91	-	8.73	-	60.89
2	Jan II	14.95	62.46	70.20	0.00	3.25	3.25	17.19	-	9.69	-	57.82
3	Jan III	4.24	62.45	70.00	0.00	0.00	0.00	20.48	-	9.50	-	62.10
4	Jan IV	0.00	60.77	70.00	-	-	-	19.79	-	9.60	-	69.24
	Av.	31.35	50.40	70.24	2.30	6.22	7.94	25.92	57.20	6.92	2.60	68.67

Ch = *Chrysotomysia* sp.Gr. = *Gronotoma* sp.

(36.27 larvae/leaf) during 3rd week of December (51st std. week). At the second peak, the mine density was 54.70 per leaf and the leaf damage was 73.73 per cent. The pest activity declined thereafter as the crop withered and disappeared from February onwards. It clearly showed that *L. trifolii* remained active from July to January on castor with two distinct peaks in middle Gujarat Agro-climatic zone.

Incidence of *L. trifolii* of fenugreek was first observed (3.15 larvae/10 leaves) during 4th week of November (47 std. week), increased during

subsequent periods and reached to its peak (13.60 larvae/10 leaves) during last week of December (52nd std. week). when the crop was 50 days old (Table 2). At the same time, the mine density and leaf damage was 17.16/10 leaves and 38.50 per cent, respectively. The extent of parasitism was 2.75 per cent during high pest activity therefore, the pest infestation was decreased and finally disappeared in last week of January (Fig.1).

Significant positive correlation was observed (Table 3) between *L. trifolii* population and biotic

TABLE 2

Population abundance of *L. trifolii* on fenugreek in relation to biotic and abiotic factors.

Std. week	Month and week	No. of larvae/ 10 leaves	No. of mines/ 10 leaves	Leaf damage (%)	Parasitism (%)			Abiotic factors		
					Ch	Gr	Total	Mean temp. (°C)	R.H. (%) (hrs)	Sun-shine (hrs)
46	Nov III	0.00	0.00	0.00	-	-	-	24.02	62.71	9.19
47	Nov IV	3.15	3.15	56.50	0.00	0.00	0.00	23.19	61.94	9.33
48	Nov V	2.73	3.00	42.70	0.00	0.65	0.65	21.66	57.55	9.76
49	Dec I	3.77	4.84	36.75	0.00	0.60	0.60	21.90	54.51	9.83
50	Dec II	10.44	13.95	31.45	0.00	1.65	1.65	21.25	53.76	7.14
51	Dec III	8.55	10.65	31.76	0.65	2.50	3.15	20.81	67.95	8.79
52	Dec IV	13.60	17.16	38.50	0.00	2.75	2.75	19.74	61.96	9.43
1	Jan I	9.90	14.77	38.75	0.60	2.55	3.15	19.91	60.89	8.73
2	Jan II	10.65	16.95	40.20	0.00	3.00	3.00	17.19	57.82	9.69
3	Jan III	5.55	13.00	40.53	0.00	1.20	1.20	20.48	62.10	9.50
4	Jan IV	2.26	12.80	38.67	0.00	0.00	0.00	19.79	69.24	9.60
5	Jan V	0.00	15.00	38.46	-	-	-	17.87	57.12	9.94
	Av.	7.06	11.03	39.57	0.63	1.86	2.02	20.62	60.80	9.22

Ch = *Chrysonotomyia* sp.Gr. = *Gronotoma* sp.

factors in castor ($r=0.927^*$) and fenugreek ($r=0.898^*$). With increase in the pest population, the parasitoid activity also increased. Among the abiotic factors, the mean temperature had significant correlation ($r=0.431^*$) with *L. trifolii* population in castor. Similarly, the pest population had positive association with relative humidity (R.H.) sunshine hours, rainfall and rainy days in castor. Bagmare *et al.* (1995) found positive correlation between abiotic factors and *L. trifolii* population. This reports strongly supports the above established relationship. However, no significant relationship between larval population of *L. trifolii* and abiotic factors (mean temperature, relative humidity and sunshine hours) were found in fenugreek crop. The non-significant relationship existed between larval population

and abiotic factors may be due to narrow range of upper and lower limit of abiotic factors.

The above study revealed that the *L. trifolii* remained active from July to January on castor and attained two peaks 41st and 51st standard weeks (2nd week of October and 3rd week of December), whereas it was found from November to January, being maximum with peak activity during last week of December in fenugreek crop. The significant and positive relationship were observed between larval population of *L. trifolii* and biotic factors. Among abiotic factors, mean temperature had significant positive association with larval population of the pest on castor.

TABLE 3

Correlation coefficient (r) between larval population of *L. trifolii* and biotic as well as abiotic factors.

Host	Biotic factors			Abiotic factors				
	<i>Chrysonotomyia</i> sp.	<i>Gronotoma</i> sp.	Total	Mean Temp. (°C)	R.H. (%)	Sunshine (hrs.)	Rainfall (mm)	Rainy days
Castor	0.836*	0.912*	0.927*	0.431*	0.256	0.049	0.082	0.199
Fenugreek	0.338	0.933*	0.898*	-0.367	0.413	-0.456	--	--

* Significant at 5% level.

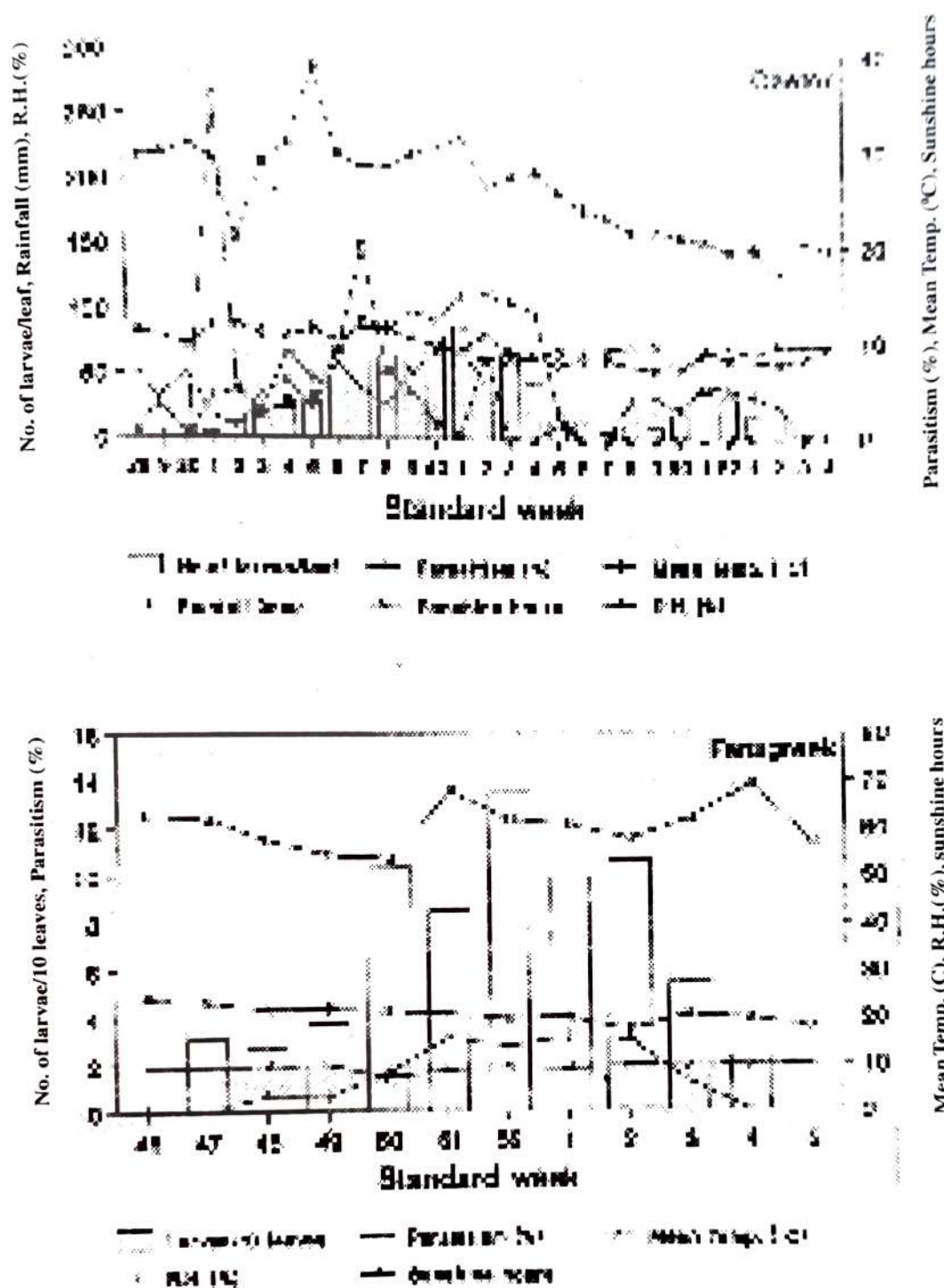


Fig. 1 : Activity of *L. trifolii* on castor and fenugreek

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Screening of Brinjal Cultivars and Inoculation Methods Against Stem and Branch Blight Disease Caused by *Phomopsis vexans**

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In Junagadh region a local brinjal cultivar aradia long grown under *kharif* season was found to be severely affected with stem and branch blight disease caused by *Phomopsis vexans* in the past 2-3 years. The disease was also noticed in different entries grown at Vegetable Research Farm (VRF) of Gujarat Agricultural University, Junagadh. This pathogen is reported to affect all the stages of growth and symptoms like damping off, leaf blight, stem canker, collar rot and fruit rot have been recorded (Singh, 1992). The disease observed in Junagadh area produced only stem and branch blight symptoms in *kharif* brinjal. Under natural condition, the disease was noticed 45 days after transplanting. Affected branch showed drooping of leaves followed by drying of whole plant. Considering its typical symptoms and damages, the present investigation was undertaken to study the mode of entry and screening of different brinjal cultivars against *P. vexans*.

Inoculation methods and host parts

P. vexans is reported to produced symptoms on different plant parts viz. fruit, stem, leaf etc. The pathogen under study was isolated from infected stem. To know the relative efficacy of different methods of inoculation on local cultivar aradia long, a pot experiments was conducted during *kharif* 1999. Following methods were used along with uninoculated control:

1. Pin prick method : One stroke of gentle pressing on stem / leaf / fruit surface with one cm diameter pin pricker made from steel needles tied around a thin wooden stick keeping their pointed ends 5 mm out.

2. Tooth brush method : Little pressure for 5 to 10 seconds with new hard tooth brush on stem/ leaf / fruit surface.

3. Petiole scar (only on stem) method : Leaf along with petiole was removed from stem, then inoculation on exposed petiole scar.

4. No injury : Inoculum is to be placed on uninjured surface of stem / leaf / fruit.

Fifteen days old PDA culture bit having 5-8 pycnidia was used for inoculation. Stem and leaf inoculation was carried out on two months old plants, while medium sized fruits of full grown plants were selected for fruit inoculation. Separate pot plants were kept for stem, leaf and fruit inoculation and also for each of the inoculation methods. The inoculated area was covered with moist absorbent cotton and loosely tied with thin

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plastic to maintain humidity. The plastic was removed after five days. The observations for disease initiation were recorded after 15 days of inoculation.

Screening of brinjal cultivars / entries

A pot trial was laid out to study the resistance against *P. vexans*. Twenty brinjal cultivars / entries received from VRF, Junagadh were tested during late *kharif* 1999. Twelve pots of each cultivar with single plant, were raised and when plants were of two months age, six plants of each cultivar were artificially inoculated using pin prick method. Remaining six plants were also pin pricked followed by no inoculation and kept as control. In each plant single branch was inoculated and observations were recorded after fifteen days of inoculation. On the basis of disease reaction, cultivars were graded into different categories as follows:

Disease reaction	Grade
1. No symptom on any part of plant	Immune (I)
2. Only inoculated spot necroted.	Resistant (R)
3. Necrosis over passing inoculated area but less than 2 cm in length.	Moderately susceptible (MS)
4. Long necrotic lesion without drying of branch	Susceptible (S)
5. Whole inoculated branch dried	Highly susceptible (HS)

The results as presented in Table 1 revealed that the typical disease symptoms were developed only on stem when inoculated. Pathogen failed to produce symptoms on leaves and fruits. Only pin prick method was found effective for infection. Hence injury to stem or branch was necessary for the infection of *P.*

TABLE 1

Efficacy of inoculation methods and disease development on different plant parts of brinjal.

Method of inoculation	Disease development*		
	Stems	Leaves	Fruits
No injury	-	-	-
Tooth brush	-	-	-
Petiole scar (on stem)	-	-	-
Pin prick	+	-	-
	(typical stem blight symptoms produced)		

* = Mean of four replications

+ = Symptoms developed

- = No symptom development

vexans under study. Similar observations have been made by Singh and Chand (1986) for symptoms development on fruits. Although results of present investigation are differing in regard to fruit rot development, as injured fruits did not get infection.

The results given in Table 2 showed that none of the entry under test was found to be immune.

All the inoculated plants of AB-98-1, AB-98-4, AB-98-15, Aradia long, Green gota (Anand), JBL-1, JBL-3, JBL-4, JBBL-1, JBPL-2, Junagadh long and Junagadh oblong were infected (100 % infection). Among the entries showing 100 per cent infection, inoculated branches in AB-98-4 and JBPL-2 got dried hence rated as highly susceptible, other fall in the category of

susceptible. The entries in which 33 and 66 per cent inoculated plants produced symptoms, showed moderately susceptible and resistance reaction respectively. The inoculated plants in the entries viz. AB-98-20, Dhandhusar long, Doli-5 and JBL-2 showed 66 per cent infection and categorised as moderately susceptible. Four entries namely Green gota, JBPL-6, Junagadh

ravaiya and PLR-1 were observed as resistant against blight disease and developed only little necrosis on inoculated spot. No symptoms were observed in control plants. More or less similar types of results were recorded during the screening of different entries against *P. vexans* in brinjal (Ahmed, 1987; Raut and Sapkal, 1994).

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TABLE 2

Reaction of brinjal cultivars against branch blight.

Entry	No. of plants Inoculated	No. of plants infected	Per cent plant infected	Disease rating
AB-98-1	6	6	100	S
AB-98-4	6	6	100	HS
AB-98-15	6	6	100	S
AB-98-20	6	4	66	MS
Aradia long	6	6	100	S
Dhandhusar long	6	4	66	MS
Doli-5	6	4	66	MS
Green Gota	6	2	33	R
Green Gota (Anand)	6	6	100	S
JBL-1	6	6	100	S
JBL-2	6	4	66	MS
JBL-3	6	6	100	S
JBL-4	6	6	100	S
JBPL-1	6	6	100	S
JBPL-2	6	6	100	HS
JBPL-6	6	2	33	R
Junagadh long	6	6	100	S
Junagadh oblong	6	6	100	S
Junagadh ravaiya	6	2	33	R
PLR-1	6	2	33	R

Note : No symptom produced in uninoculated plants of all entries.

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Management of Black Banded Disease of Mango

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Mango cultivation in Gujarat is mainly concentrated in South Gujarat. The occurrence of black banded disease of mango caused by *Rhinocladium corticolum* Massee in the state has been reported by Vala *et al.*, (1985). Now it occurs in all the mango growing areas of Gujarat. In long term association under humid condition affects vigour and productivity of mango orchard. The Gujarat state department of agriculture does not certify black banded affected grafts for selling. Hence it has become a serious problem for orchard and nursery owners. Earlier Gujarat Agricultural University has recommended yearly six sprays-schedule for its control (Khandar *et al.*, 1998). But it was necessary to modify the same and make it more economic. Present investigation was conducted with the aim to give more practical and economic spray schedule for the management of black banded malady in mango orchards.

A field trial was conducted at government Seed Farm, Talala (Dist. Junagadh) during 1997 - 2000 on 10 yr old mango orchard of cv. Kesar. The experiment was arranged in RBD, considering two trees for each treatment. For every selected tree two branches in opposite direction were selected as two replications so as to make four replications in each treatment. In

each replication (selected branch) three black spots/bands were marked with four small dots of oil paint colour (red) on both the ends of vertical and horizontal directions. Marking of spots was done twice during whole course of experiment i.e. May, 1997 and May, 1999. After second marking, first marking spots/bands were cancelled. Measurement of marked spots was taken before (May, 1997 and May, 1999) and after completion of treatment schedule (December, 1998 and December, 2000). During observation diseased spot colour index was also noted using the following:

Spot Colour	Weightage
Dark black	3
Light dark	2
Sparse light dark	1
No spot	0

The experiment was conducted with 12 treatments, including (1) Bordeaux paste 10% (CuSO_4 100 g + lime + water 11) (2) Carbendazim 0.15% (Bavistin 50 wp 3 g/l) (3) Copper Oxychloride 0.25% (Blue Copper 50 wp 5 g/l) (4) Hexaconazole 0.01% (Contaf 5 EC 2 ml/l) (5) Propiconazole 0.05% (Tilt 25 EC 2 ml/l) and (6) Control (water spray only). All these six treatments were applied by two methods (i) spray or pasting on branches without rubbing marked black bands/spots (A) and (ii) rubbing marked black bands/spot with coir-brush followed by spray of pasting (B) Except Bordeaux paste treatments other treatments were applied as spray. Bordeaux paste treatments was given only on marked spots twice in a year i.e. before monsoon and one month after completion of monsoon. Spraying was done on all the branches of respective tree, thrice in a year i.e. before monsoon (June 1st week), mid

TABLE 1

Fungicidal effect on spot size and colour of black banded disease in mango.

Sr. No.	Treatments	Per cent spot increased			Per cent spot decreased			Spot colour index reduction		
		May-97 to Dec.-98	May-99 to Dec.-00	Mean	May-97 to Dec.-98	May-99 to Dec.-00	Pooled mean	May-97 to Dec.-98	May-99 to Dec.-00	Mean
1.	Bordeaux paste 10 % (A)	-	-	-	90.00 (100.00)	90.00 (100.00)	90.00 (100.00)	2.75	2.83	2.79
2.	Bordeaux paste 10 % (B)	-	-	-	90.00 (100.00)	90.00 (100.00)	90.00 (100.00)	2.42	2.68	2.55
3.	Carbendazim 0.15 % (A)	-	-	-	37.85 (37.75)	35.44 (33.67)	36.64 (35.65)	1.75	1.50	1.63
4.	Carbendazim 0.15 % (B)	-	-	-	30.60 (26.29)	69.60 (78.67)	50.10 (58.85)	1.84	2.42	2.13
5.	Copper oxychloride 0.25 % (A)	-	-	-	42.96 (46.53)	42.12 (45.02)	42.54 (45.75)	1.92	1.67	1.79
6.	Copper oxychloride 0.25 % (B)	-	-	-	90.00 (100.00)	71.08 (81.18)	80.54 (90.59)	2.75	2.17	2.46
7.	Hexaconazole 0.01 % (A)	14.41	10.19	12.30	-	-	-	0.84	0.50	0.67
8.	Hexaconazole 0.01 % (B)	42.54	20.86	31.70	-	-	-	1.34	1.58	1.46
9.	Propiconazole 0.05 % (A)	43.55	25.46	34.51	-	-	-	1.17	0.42	0.80
10.	Propiconazole 0.05 % (B)	75.23	27.01	51.12	-	-	-	1.25	1.50	1.38
11.	Check (A)	62.22	70.02	66.12	-	-	-	0.25	0.17	0.21
12.	Check (B)	39.43	37.46	38.45	-	-	-	1.42	0.83	1.13
	S.E.m. ±	-	-	-	1.91	5.94	9.58	-	-	-
	C.D. at 5 %	-	-	-	5.74	17.91	27.69	-	-	-
	C.V. %	-	-	-	5.99	17.91	13.59	-	-	-

(Figures given in parentheses are retransformed values)

Maximum colour index : 3.0

A = Marked spots not rubbed.

B = Marked spots rubbed before treatment application.

monsoon (August) and one month after completion of monsoon (October). Statistical analysis of only effective treatment was done.

Diseased spot area reduction

The treatment of Bordeaux paste, carbendazim and copper oxychloride significantly reduced black bonds in mango. The triazole fungicides under present investigation failed to control the disease. Among the effective treatments Bordeaux paste treatments were found most effective and treated spots were totally disappeared. Thus four applications of Bordeaux paste during two schedule periods gave 100% control of treated spots on branches. Bordeaux paste 10% treatment was equally effective under both the methods of application. Next effective treatments were copper oxychloride 0.25% and carbendazim 0.15% which gave 90.59 and 58.85 per cent disease reduction respectively when applied after rubbing. Here rubbing has increased the efficacy of fungicides. In case of copper oxychloride application after rubbing, disease reduction is increased almost 100 per cent (90.59%) as compared to application on unrubbed spots (45.75%) (Table 1).

Diseased spot colour reduction

Except Bordeaux paste application, the spot colour index reduction was higher when treatments were followed by rubbing. Maximum colour index reduction was 2.79 in Bordeaux paste treatment on unrubbed spots. Spot colour index reduction was also > 2.0 in rubbed treatments of Bordeaux paste 10% (2.55), copper oxychloride 0.25% (2.46) and carbendazim 0.15% (2.13). Spot

colour reduction in rubbed control was also higher (1.13) as against 0.21 in unrubbed control. This finding showed that only rubbing will not be useful, unless it is followed by spraying of effective fungicides.

In the past Bordeaux paste and Bordeaux mixture has been reported effective against the disease (Reddy *et al.*, 1961). They have mentioned gunny rubbing or ganji treatment after pasting or spraying. This might be suggested to remove paste/spray residue after some period.

Similarly good control was received with bavistin (Narasimhudu *et al.*, 1987). Khandar *et al.*, (1998) also suggested six sprays/year with ziram 0.1% or carbendazim 0.03% or copper oxychloride 0.25% for black banded control. The present findings match with earlier reports, but the efficacy was increased when spraying followed by rubbing. Besides these total number of spray/paste applications are also reduced. Although practically pasting is not feasible for whole tree but combination of pasting and spraying is the better way to combat this disease. It can be recommended from these results that for effective management of black banded disease of mango, the spots on stem and branches up to manageable height should be paint with Bordeaux paste 10% before monsoon and one month after completion of monsoon and spraying of copper oxychloride 0.25% or carbendazim 0.15% on remaining branches of affected trees to be followed before monsoon, mid monsoon and one month after completion of monsoon.

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Influence of Cab on Noise Level of Farm Tractors*

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Tractor is an important source of power on the farm and most suited prime mover in substitution to animal power. During the tractor operation, tractor operator together with the tractor forms a man-machine system. Tractor driver's comfort and safety needs serious thought as far as his overall performance is concerned.

Noise is an important aspect of working environment, which has received much attention for many decades. Noise is conveniently and most frequently defined as 'unwanted sound'. Noise affects the sensitivity and reaction rates of the operator. Therefore, it is desirable to reduce the operator's exposure from the noise on the field.

Tractors were considered to be likely to provide the most damaging environment, bearing in mind the noise levels and duration of exposure. It affects the performance of the operator by lowering its concentration and interfere with worker-to-worker communication in the team. Noise also causes discomfort to the operator with respect to the nervous tension, irritation and

fatigue. Tractor operator's noise exposure is obviously very unsatisfactory showing that hearing is at risk.

Noise level of 35 hp tractor were above the safe limit for 8 hr working period and ranged between 90 to 100 dBA (Bansal *et al.*, 1982). Sealed cab is some 15 dBA superior to the cabless conditions and opening the back of the sealed cab allows the noise to rise by 1 to 2 dBA (Graham and Marples, 1971).

By introduction of the cab the sound level reaching the operator's work-place inside the cab was restricted. Digital sound level meter having electronic condenser microphone of 1/2 inch standard size was employed for noise measurement in accordance with IS : 5994-1970. Test was conducted under different field operations and sound level was recorded on cabless as well as the cab fitted tractor.

Noise level measurement on the cabless tractor for all the operations C_1 , C_2 and C_3 alongwith different timing levels T_1 , T_2 and T_3 ranged from 90.90 to 98 dBA. This noise level was beyond the limit of recommended noise level for the operator in man-machine system. It crossed the audible noise limit because of high engine noise, noise which was already present in the environment and unusual odd noise due to malfunctioning and wear and tear of machine/engine components.

* Part of M. Tech. (Agric. Engg.) thesis submitted by S. Pund to Gujarat Agril. University, Sardar Krushinagar.

TABLE 1

Noise level (dBA) measurement during different field operations.

Time/Operation	R_1	R_2	R_3	Mean
T_1C_1	82.0 (91.0)	88.0 (96.0)	86.0 (99.0)	85.33 (95.33)
T_1C_2	84.0 (90.0)	86.0 (93.0)	85.0 (92.5)	85.0 (91.83)
T_1C_3	83.5 (95.0)	88.0 (97.0)	87.5 (100.0)	86.38 (97.33)
T_2C_1	82.5 (90.0)	88.0 (97.0)	84.0 (97.0)	84.83 (94.66)
T_2C_2	83.0 (89.0)	85.0 (93.0)	83.0 (90.7)	83.66 (90.90)
T_2C_3	84.0 (95.0)	85.0 (98.0)	87.0 (101.0)	85.33 (98.0)
T_3C_1	81.5 (90.0)	84.0 (95.0)	85.5 (96.0)	86.66 (93.66)
T_3C_2	85.0 (90.0)	87.0 (94.0)	85.0 (93.0)	85.66 (92.33)
T_3C_3	85.0 (94.0)	86.0 (99.0)	86.5 (99.5)	85.83 (97.50)

Note : Figures in parentheses indicate the values of noise level on the cabless tractors.

T_1 : 8.00 to 10.00 a.m.

C_1 : Transportation

T_2 : 12.00 to 2.00 p.m.

C_2 : Harrowing

T_3 : 4.00 to 6.00 p.m.

C_3 : Ploughing

After mounting the cab on the tractor, it was found that the sound level inside the cab was 83.66 to 86.66 dBA which was quite below the safe limit of the sound level for the human ear. Table 1 revealed that the noise level in both the

cases was not significantly affected by the timing level. It was observed from Figure 1 that the noise level inside the cab was quite below the safe noise level for 8 hr work period as compared on the cabless tractor for all the operations under

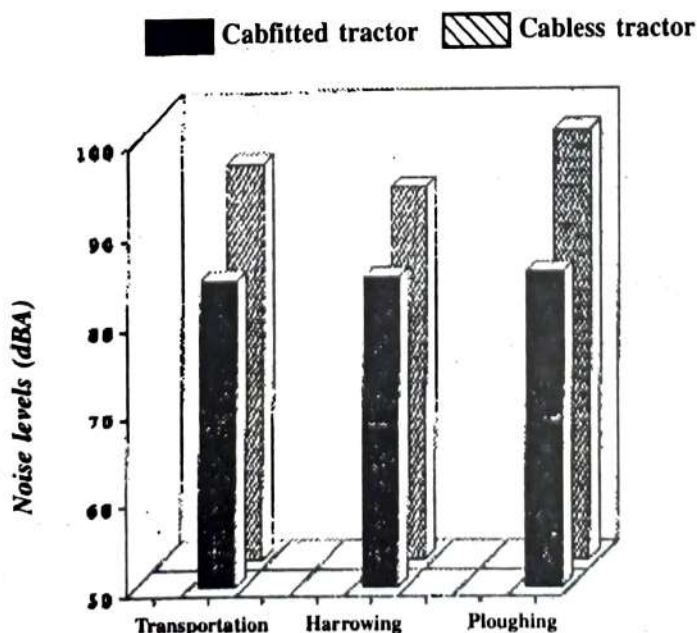


Fig. 4.15 : Comparison of noise level on cabless and cab fitted tractor during different operations.

consideration.

Safe noise level inside the cab was achieved by using the soft wood and coconut fibre in the construction of the cab for closing the opening,

as these materials have the sound absorbing properties and don't allow the sound to reflect with higher intensity than that of its original.

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A Note on Nutritive Value of Pigeon Pea Mixture [*Cajanus cajan* (L.) Millsp.] Gotar and Wheat Straw Mixture in Cattle

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Pigeon pea is a major pulse crop grown alone or as a mixed crop in an area of 32.56 to 36.14 lakh ha with a production of 24.30 to 26.66 lakh tonnes of grains (Bhan and Mishra, 1998 & Rajasekhar *et al.*, 1998) in the country. The area under pigeon pea in Gujarat was 3.60 lakh ha in 1998-99 (Tyagi, 2000). The seed/grain to available dry fodder ratio is 1:1.5 to 2.0 in pigeon pea. This indicates that huge quantity of pigeon pea crop residues will be available for feeding of ruminants. The pigeon pea crop residues comprised of tender stems, pods cover, immature pods and seeds including leaves are locally known as *gotar*. Traditionally livestock owners feed mixture of *gotar* and straw to livestock because of their indigenous knowledge which proved to be scientifically beneficial as it improves digestibility due to associative effect of feeds (Maynard *et al.*, 1985).

Due to lack of information on nutritive value of different fodder combination, an effort was made to evaluate pigeon pea *gotar* and wheat straw mixture in 75:25 ratio for its nutritive value in cattle.

The experiment on nutritional evaluation of

pigeon pea *gotar* and wheat straw mixture was conducted on five bullocks with average body weight 343.16 ± 17.11 kg. Each bullock was fed 6.0 kg pigeon pea *gotar* and 2.0 kg wheat straw mixture daily in morning during the course of experiment. After completion of 14 days preliminary period, a metabolism trial of 7 days collection period was conducted following conventional method. During trial period bullocks were offered water four times every day. Daily representative samples of fodders offered their refusals, faeces and urine were collected and pooled for trial period. These pooled samples were analysed as per standard method (AOAC, 1980) for different constituents.

The proximate composition of pigeon pea *gotar* and wheat straw fed to bullocks is given in Table 1.

Data given in Table 1 suggested that pigeon pea *gotar* (straw) contained 11.13 per cent CP and 5.70 per cent EE on dry matter basis. Similar values for CP (10.90 per cent) and EE (4.60 per cent) in pigeon pea *gotar* were reported by Patel *et al.* (1963). The CP content of wheat straw was 3.01 per cent only. Bullocks on an average consumed 5.76 kg dry matter per day, 1.69 kg/100 kg body weight and 72.46 g/kg W^{0.75} and maintained their body weight. These data suggested that bullocks consumed sufficient amount of dry matter to meet their maintenance requirement. Patel *et al.* (1963) reported similar data for dry matter intake for bullocks fed pigeon pea (*tur*) *gotar* alone. Daily water consumption was found to be 23.76 litres per animal and 4.13 litres per kg dry matter intake.

TABLE 1

Chemical composition (per cent on dry matter basis) of fodders, digestibility coefficient and balances of nutrients of whole ration.

Constituents Particulars	CP	EE	CF	NFE	Ash	Silica	P	Ca
Pigeon pea <i>gotar</i>	11.13	5.70	23.68	47.39	12.10	5.07	0.16	1.49
Wheat straw	3.01	2.11	38.69	46.03	10.16	5.23	0.06	0.55
	CP	EE	CF	NFE	OM	DM		
Av. Digestibility coefficients	36.33 ±1.95	44.45 ±3.31	71.25 ±1.36	57.68 ±1.19	59.01 ±1.19	52.53 ±1.10		
Av. balance (g per day per animal)								
Nutrients Particulars	Nitrogen (N)		Phosphorus (P)		Calcium (Ca)			
Total intake	86.27 ±2.79	(100.00)	9.58 ±0.31	(100.00)	91.71 ± 3.15	(100.00)		
Excreted through faeces	54.99 ± 2.84	(63.74)	8.38 ± 0.56	(87.47)	69.52 ± 3.77	(75.80)		
Excreted through urine	23.61 ± 1.40	(27.37)	0.04 ± 0.01	(0.42)	1.25 ± 0.14	(1.36)		
Total voided	78.60 ± 3.72	(91.11)	8.42 ± 0.56	(87.89)	70.77 ± 3.79	(77.16)		
Balance	+ 7.67 ± 2.91	(8.89)	+ 1.16 ± 0.45	(12.11)	+ 20.94 ± 1.97	(22.84)		

The average values for digestibility coefficients presented in Table 1 indicated that the digestibility of CF was the highest (71.25 per cent) and that of CP was the lowest (36.33 per cent). However digestibility coefficients of NFE, OM and DM were in between. Similar trend of digestibility coefficients of proximate nutrients was also observed by Patel *et al.* (1963) being highest for CF (76.80) and lowest for CP (11.80) in bullocks fed pigeon pea *gotar* alone. The average data for digestibility and balance of nutrients in bullock fed pigeon pea *gotar* and wheat straw combination are presented in Table 1.

In spite of lower digestibility of CP, nitrogen balance was positive (+7.67 ± 2.91). Daily consumption of CP and DCP by each bullock was 539.18 and 195.49 g, respectively. The DCP consumption was sufficient to meet maintenance requirement of bullocks having 350 kg body

weight (Sen *et al.*, 1978 and ICAR, 1985) as it is reflected in positive nitrogen balance and maintenance of body weight during the course of experiment. Calcium balance was also positive (+20.94 ± 1.97), while that of phosphorus was marginally positive (+1.16 ± 0.45). This may be due to lower amount of phosphorus in comparison to calcium in the experimental feeds which led to wider calcium phosphorus ratio. The major route of excretion of nitrogen (63.74 per cent), phosphorus (87.47 per cent) and calcium (75.80 per cent) was through faeces. Overall bullocks could retain 8.89 per cent nitrogen, 12.11 per cent phosphorus and 22.84 per cent calcium. Patel *et al.* (1963) reported negative balances of nitrogen, phosphorus as well as calcium in bullocks fed pigeon pea *gotar* and positive balances of these nutrients in bullocks fed *guar gotar* as a sole feed. This may be because of more DM intake, superior CP digestibility (61.00 Vs 11.80) and higher intake

of Ca and P by bullocks fed *guar gotar* in comparison to bullocks fed pigeon pea (*tur*) *gotar*. Hence these findings suggested that bullocks utilized the nutrients present in pigeon pea *gotar* and wheat straw more efficiently when these fodders are fed in combination than separately. The mixture of pigeon pea *gotar* and wheat straw in 75:25 ratio when fed to cattle provided 3.30 per cent DCP and 54.79 per cent TDN on dry matter basis. Hence it is worth to feed pigeon pea *gotar* alongwith cereal crop residues like wheat straw

as it can very well correct most of the deficiencies of cereal straws and can reduce the requirement of concentrate mixture of adult large ruminants at least for maintenance.

It is concluded that the said combination of pigeon pea *gotar* and wheat straw when fed to cattle is sufficient to meet their nutrient requirements for maintenance without supplementation of concentrate mixture.

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Determination of Nutritive Value of Wheat Straw and Groundnut Haulm Mixture in Crossbred Bullocks

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In Saurashtra region livestock owners are feeding traditionally the mixture of wheat straw and groundnut haulm (contained thin stems, leaves and immature groundnuts) to their livestock. It is well documented that feeding a mixture of different types of feeds/fodders enhances their digestibility due to associative effect (Ranjhan, 1981 and Maynard *et al.*, 1985). Data are not available on nutritive value of such combination in literature, hence an effort was made to determine the nutritive value of wheat straw and groundnut haulm mixture.

Six crossbred (J x K x HF) bullocks of average body weight 261.8 ± 9.3 kg were used for this experiment and were fed a mixture of 4.0 kg

wheat straw and 3.0 kg groundnut haulm daily. After a preliminary feeding of 21 days, a metabolism trial of 7 days duration was conducted by conventional method. The representative samples of feeds offered, leftover, feces and urine were collected daily during collection period and pooled samples were analysed following standard procedures (AOAC, 1980).

Chemical composition of feeds offered to bullocks is presented in Table 1. The average dry matter consumption was 5.30 kg per day per animal and 2.03 kg/100 kg body weight. The amount of dry matter consumed was sufficient to maintain the body weight of the animals and to meet their maintenance requirement. Groundnut haulm has 11.88 per cent crude protein on dry matter basis. The average data for digestibility (%) of nutrients are presented in Table 1.

Feeding of wheat straw and groundnut haulm mixture provided 3.90 per cent DCP and 56.77 per cent TDN on dry matter basis. However, Shukla *et al.* (1985) reported 5.67 per cent DCP and similar values of TDN for groundnut haulm alone. Lower DCP content under present study

TABLE 1

Chemical composition (per cent on dry matter basis) and digestibility of fodders mixture fed to animals.

Constituents	DM	OM	C. Protein	E. Ext.	C. fibre	N.F.E.	Ash	Silica	P	Ca
Fodders										
Wheat straw	-	-	3.76	3.32	39.51	43.22	10.19	7.09	0.12	0.52
Groundnut haulm	-	-	11.88	4.00	24.50	49.42	10.20	2.06	0.34	2.20
Digestibility%	54.16	59.14	53.90	69.12	64.01	56.88	-	-	-	-
	± 1.52	± 1.33	± 2.21	± 1.94	± 1.20	± 1.78				

nt be due to feeding of groundnut haulm and at straw mixture as against sole feeding of ndnut haulm reported by Shukla *et al.* (1985).

The balances of nitrogen (N) and calcium (Ca) e positive, while that of phosphorus was gative (Table 2). These data suggested that retion of N was 46.13 and 33.89 per cent rough feces and urine, respectively and animals retained about 20 per cent N. However, case of P and Ca main route of excretion was

found to be through feces. The per cent excretion of P through feces was 149.70, which led to negative phosphorus (P) balance. Therefore it is advised to feed or supplement mineral mixture or some other source of phosphorus when this mixture is fed to cattle and buffaloes. The main reason for negative phosphorus balance may be due to deviation in calcium and phosphorus ratio because of high calcium content (2.20 per cent) in groundnut haulm.

TABLE 2
Average balance of N, P and Ca (g per day per animal) of fodders mixture fed to animals.

Nutrients						
Particulars	N		P		Ca	
Total intake	74.71	(100.00)	13.40	(100.00)	82.78	(100.00)
	±1.52		±0.34		± 1.56	
Excreted through faeces	34.46	(46.13)	20.06	(149.70)	57.88	(69.92)
	± 1.79		± 1.09		± 2.44	
Excreted through urine	25.32	(33.89)	0.09	(0.67)	3.49	(4.22)
	± 1.66		± 0.02		± 0.31	
Balance	+14.93	(19.98)	- 6.75	(- 50.37)	+21.41	(25.86)
	± 1.48		± 0.87		± 1.77	

Figures indicate per cent of intake.

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