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RESEARCH JOURNAL



S.D.Agricultural University
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VOLUME : 29 : NUMBER : 1 & 2

JANUARY & JULY, 2004
(Published : March 2006)

GAU RES. J. 29 (1 & 2)

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Seed proteins studies in diverse cytoosteriles of sorghum (*Sorghum bicolor* (L.) Moench)

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Abstract

The seed proteins patterns in diverse cytoosteriles and their maintainers in sorghum was studied. The banding pattern showed that the male sterile and corresponding maintainer lines differed from each other and these critical differences could be valuable biochemical tool to identify fertility-sterility status of the genotypes.

Keywords : Seed proteins, cytoosteriles, Sorghum.

Introduction

All commercial hybrids of sorghum developed till date are based on milo (A_1) cytoplasm. The need for utilising non-milo sources of cytoplasm in hybrid production was felt in order to avoid disease and environmental hazards. With this in view the available diverse cytoplasm has to be characterised for commercial exploitation. Characterization of diverse cytoosteriles based on fertility restoration was attempted earlier also (1,2) but studies on characterization of diverse cytoosteriles based on biochemical markers are limited. An attempt was made using soluble proteins and isozymes from anthers (3) as well as seed (4,5). These studies were limited to indigenous cytoplasmic source only. The present study aims to characterise diverse cytoosteriles sorghum with the help of seed proteins, using diverse source of cytoplasm.

Material and methods

The CMS lines 104A belong to (A_1) cytoplasmic group, MS 840 to A_2 cytoplasmic group, SP A_3 -4A to A_3 cytoplasmic group and MS CS 3541 (mal) to the A_4 source of cytoplasm and their respective maintainers were used for soluble seed protein electrophoretic banding patterns.

Extraction of protein

One gram seed material was grinded and made into paste with 2.0 ml of 0.2 M phosphate buffer (pH 7.2) in pestle and mortar. The sample was centrifuged at 10,000 rpm for 20 minutes in sorvall RC-5B super speed centrifuge. After centrifugation the supernant (protein extract) was collected and stored frozen for protein estimation and electrophoresis.

Estimation and separation of protein

The amount of total protein present in the seed extract was estimated by the method Lowry *et al.* (4) polycramide gel electrophoresis was used to separate the seed proteins. The electrophoresis procedure described by Walker (6) was adopted.

Then 40 μ l protein/sample was loaded seperately with the help of a microsyringe into each well of the polymerised gel. Electrophoresis was conducted in cold (about 4°C) by applying initially 10-15 mA current for one hour which was subsequently increased to 30 mA. The gel was stained and destained to visualise as many bands as possible. The relative migration (R_m) of each band was calculated and used for comparison. The staining intensities were defined as dense medium and light.

$$R_m = \frac{\text{Distance migrated by proteins from origin (cm)}}{\text{Distance migrated by tracking dye(cm)}}$$

SDS-PAGE soluble protein banding patterns from four different diverse cytoplasmic sources 104 A, MS 840 A2, SPA3-4A and MS CS 3541 (mal) differ qualitatively (presence and absence of specific bands) and qualitatively (staining intensity of bands). This was obvious because of non-isogenic nature and differences in cytoplasm. The relative migration (R_m) of values of different diverse cytoosteriles and its maintainers are presented in Table 1. Comparison of the electrophoretic pattern of the CMS lines with their respective maintainers despite of their isogenic nature showed qualitative differences of the polypeptide patterns of 104A with 104B showed 6 and 9 bands respectively.

However four bands corresponding to Rm values 0.69, 0.79, 0.86 and 0.92 were common in both the isogenic lines. Similarly comparison of electrophoretic patterns of other three CMS lines with respective maintainers showed similarities in banding pattern to varying extent. A distinct characteristics protein bands at Rm 0.66 and 0.82 was observed in 104 A (milo) cytoplasm

and absent in other non-milo cytoplasm. The bands with Rm values of 0.80 and 0.87 were common in both lines ms 840 A₂ and SP A₃-4A. Similarly the band with Rm value of 0.78 was common in SP A₃-4A and MSCS 3541 (mal). Tripathi et al. (3) reported that the protein band with Rm 0.71 was present only in milo cytoplasm and absent in other male steriles whereas,

Table 1. Seed protein banding pattern of four diverse male steriles (A) of sorghum and their maintainers (B)

RM	A ₁		A ₂		A ₃		A ₄	
values	104 A	104B	MS840A ₂	840A ₂ B	SPA ₃ -4A	SPA ₃ -4B	MSCS 3541 (Mal.)	CS 3541 (Mal.) B
0.40				+				
0.42				+				
0.45			+	+				
0.48					+	+		+
0.49				+				
0.52				+				
0.54							+	+
0.55		+	+					
0.57							+	+
0.59				+				
0.60		+	+					
0.62					+			
0.65						+	+	
0.66	+			+				
0.67								+
0.69	+	+			+	+		
0.70							+	+
0.71						+		
0.72		+		+				
0.73						+	+	+
0.74						+		
0.75				+	+		+	
0.76			+					
0.77			+	+				
0.78					+		+	
0.79	+	+		+				
0.80			+	+	+	+		
0.82	+							
0.83		+		+		+	+	
0.86	+	+					+	
0.87			+	+	+	+		
0.90		+			+	+		
0.92	+	+	+	+			+	
0.94				+	+			
0.96				+	+	+		+
0.97								+
Total	6	9	8	16	10	11	10	8
+ band present								

Table 2. Protein content in seed in diverse male sterile and maintainer lines

Cytoplasmic group	Male sterile line (A)	Protein content mg/g/seed	Male sterile line (B)	Protein content mg/g/seed
A ₁	104 A	9.90	104 B	10.67
A ₂	MS840 A ₂	10.44	840 A ₂ B	11.80
A ₃	SPA ₃ -4A	8.26	SPA ₃ 4B	9.09
A ₄	MSCS 3541 (mal)	9.83	CS 3541 (mal) B	11.13

a protein band with Rm 0.73 was absent in milo and present in other male sterile as well as their maintainer.

In general, the number of polypeptide bands observed in CMS lines were less than that of observed in their respective 'B' lines. The additional bands observed in maintainer could probably be due to expression of specific gene regulated by nucleo cytoplasmic interactions, since the quantitative analysis of protein indicates that, amount of seed protein was low in male

sterile lines as compared to their corresponding maintainer lines (Table 2)

These differences in respect to seed protein have been reported in CMS lines and maintainer lines. The results are in confirmation with the results of Tripathi *et al.* (3) and Senthil and Palanisamy (7) They further observed that protein pattern and some basic similarities and differences among male steriles lines, the milo cytoplasmic sterile CK 60 A and B, Nagpur A and B, pattern differed qualitatively from that of GIA, VZM 2A, M 35-1A and M 35-2A.

References

1. Rao, N.G.P., Tripathi, D.P. and Rana, B.S. 1984. Genetic analysis cytoplasmic system in sorghum. *Indian J. Genet.* **44**:480-496.
2. Kishan, A.G. and Borikar, S.T. 1989. Genetic relationship between some cytoplasmic male sterility system in sorghum. *Euphytica* **42**: 259-269.
3. Tripathi, D.P., Mehta, S.L. and Rao N.G.P. 1983. Soluble proteins and isoenzymes from seeds of diverse male steriles of sorghum (*Sorghum bicolor* (L) Moench). *Theort. Appl. Genet.* **64**:325-331.
4. Lowry, O.H., Rasebrough, N.J., Farr, A.L. and Randall, R.J. . 1951. Protein measurement with the folin pheno reagent. *J. Biol. Chem.* **193** : 265-275.
5. Phul, P.S., Channa, R.S. and Ramak Kumar 1987. Isozyme analysis of some male sterile lines in of sorghum *Sorghum bicolor* (L.) Moench. *Pl. Breed.* **98**:342-345
6. Walker, J.N. 1986. Manual on Techniques in Molecular Biology. Workshop held at TNAU, Coimbatore, **16**.
7. Senthil, N and S. Palnisamy 1995. Fertility restoration studies on diverse cytoosteriles of sorghum. *J. Maharastra Agric. Univ.* **20** :159-160.

Genetic variability studies in grain amaranth (*Amaranthus spp.*)

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Abstract

50 exotic and indigenous genotypes of grain amaranths (*Amaranthus spp.*) were evaluated during *rabi* 2003-04 at AICRP on UUP, Sardarkrushinagar to investigate magnitude of genetic variability. The study revealed that GCV was high for number of branches per plant, days to 50 per cent flowering, plant height, harvest index, grain yield and straw yield. Genetic advance sustained by high heritability was high for number of branches per plant, days to 50 per cent flowering, plant height and harvest index which suggested that there is ample scope of improvement of these traits through selection. Moderate heritability for grain yield indicated that selection through component traits should be practiced for improvement of this character.

Key words: Genetic variability, genetic advance, heritability, component traits.

Introduction

Grain amaranth (*Amaranthus spp.*) is an important pseudocereal which has all the potential to become a valuable food crop. For achieving increased production in grain amaranth, it is essential to evolve high yielding varieties, as very few varieties are available at present. In view of this, an attempt was made to assess the genetic variability present for grain yield, its components as well as seed protein content and its utilization in future breeding programmes.

Material and methods

The experimental material for the present study consisted of 50 diverse genotypes of grain amaranth (*Amaranthus spp.*) sown in randomized block design with 3 replications in 3 environments during winter season of 2003-2004 at All India Co-ordinated Research Project on Underutilized Crops, Regional Research Station, Sardarkrushinagar, Gujarat. The environments were artificially created by three different dates of sowing (E_1 : 1st November 2004, E_2 : 15th November 2004 and E_3 : 1st December 2004). Each genotype was sown in 3 m long single row keeping spacing of 45 cm between rows and 15 cm between plants within rows in all the three environments. Recommended and uniform agronomical practices as well as plant protection measures were followed to raise the crop. Observations were recorded on 5 random plants for each genotype in each environment for grain yield/ plant (g), days to flowering, plant height (cm),

inflorescence length (cm), number of branches/plant, days to maturity, straw yield/ plant (g), harvest index (%) and 1000-seed weight (g). Seed protein (%) was estimated by analyzing seed nitrogen following standard micro-kjeldahl's method and the values were multiplied by 6.25 in each replication and environment.

The mean values obtained were statistically analysed for each environment and pooled over environments. Estimation of phenotypic and genotypic coefficient of variation and heritability in broad sense were made as per method suggested by Burton (1) and Allard (2), respectively. Genetic gain (genetic advance as percentage of mean) was computed using formula suggested by Johnson *et al.* (3).

Results and discussion

The analysis of variance revealed highly significant differences among the genotypes for all the 10 characters studied in individual environments separately and in pooled analysis. Mean, standard error, range, genotypic and phenotypic coefficient of variation, heritability in broad sense and genetic gain analysed for each environment and over pooled basis are shown in Table 1.

Wide range of variability was conspicuous for almost all the characters including grain yield. Genotypic coefficient of variation for majority of traits except grain yield/plant and straw yield/plant were close to the estimates of phenotypic coefficient of variation which

indicated that most of the traits were least influenced by environment.

Highest genotypic and phenotypic coefficient of variation was observed in number of branches/plant and the least in days to maturity (Table 1). The estimates of heritability coupled with genetic gain on the basis of pooled analysis were high for traits such as number of branches/plant, days to flowering, plant height, inflorescence length and harvest index

suggested that these characters could be considered for improvement through selection as they are more likely to be governed by additive genetic action. Moderate heritability and genetic gain were observed for grain yield/plant and straw yield per plant indicating the role of both additive and non-additive genetic effects for these traits. High heritability coupled with low genetic gain were exhibited for protein content, days to maturity and 1000-seed weight which indicated that there is little scope for improvement

Table 1. Mean, standard error (SE ±), range, coefficient of variation (CV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (H), genetic advance as percentage of mean (GA) in grain amaranth over three environments and pooled analysis (P)

Character	E	General Mean	SE±	Range	GCV (%)	PCV (%)	H (%)	GA as % of mean
Grain yield /plant (g)	E ₁	13.47	0.99	5.90 - 24.53	34.54	36.80	88.12	66.81
	E ₂	13.48	1.05	5.17 - 27.71	34.49	37.05	86.65	66.10
	E ₃	10.32	0.73	2.48 - 20.02	45.93	47.54	93.35	91.38
	P	12.42	0.54	6.11 - 19.37	17.55	26.41	44.14	24.02
Days to flowering	E ₁	45.45	0.63	29.33 - 70.00	31.90	31.99	99.43	65.52
	E ₂	49.91	0.61	32.67 - 80.33	29.96	30.03	99.51	61.55
	E ₃	56.13	0.59	39.67 - 79.00	25.78	25.85	99.50	52.98
	P	50.50	0.35	34.00 - 75.78	28.52	28.68	98.83	58.40
Plant height (cm)	E ₁	105.80	6.13	57.17 - 157.23	26.14	27.99	87.17	50.27
	E ₂	108.98	6.65	65.65 - 154.77	26.12	28.18	85.93	49.88
	E ₃	100.86	5.94	60.68 - 141.61	26.30	28.21	86.91	50.50
	P	105.20	3.61	62.83 - 146.33	26.07	26.33	98.00	53.17
Inflorescence Length (cm)	E ₁	71.33	5.09	47.59 - 90.68	14.68	19.20	58.48	23.13
	E ₂	76.50	5.58	33.84 - 106.36	22.28	25.61	75.70	39.93
	E ₃	69.13	4.27	36.58 - 93.58	22.05	24.50	80.97	40.91
	P	72.32	2.89	44.30 - 94.01	18.42	19.42	89.94	35.98
No. of branches /Plant	E ₁	2.89	0.17	4.47 - 7.73	98.42	98.96	98.90	201.73
	E ₂	2.80	0.12	4.13 - 8.07	99.30	99.55	99.49	203.93
	E ₃	2.38	0.08	3.40 - 5.80	99.16	99.34	99.64	203.78
	P	2.69	0.08	4.28 - 6.69	97.44	98.07	98.70	199.25
Days to maturity	E ₁	88.21	0.59	71.00 - 111.67	11.31	11.37	98.95	23.16
	E ₂	92.11	0.75	84.33 - 107.33	7.75	7.88	96.83	15.72
	E ₃	93.39	0.74	86.67 - 100.67	4.90	5.09	92.79	9.73
	P	91.24	0.40	81.22 - 104.33	7.14	7.55	89.37	13.90
Straw yield /Plant (g)	E ₁	68.34	5.19	27.27 - 135.27	33.64	36.12	86.73	64.53
	E ₂	63.91	4.99	33.60 - 100.57	22.93	26.63	74.15	40.67
	E ₃	42.43	2.75	29.06 - 61.54	15.47	19.12	65.49	25.78
	P	58.23	2.57	36.59 - 83.00	16.79	21.57	60.63	26.93
Harvest index(%)	E ₁	16.56	1.19	8.11 - 23.86	18.59	22.36	69.15	31.82
	E ₂	17.73	1.42	5.62 - 27.78	31.32	34.28	83.51	58.94
	E ₃	19.19	1.33	4.20 - 38.85	38.68	40.48	91.27	76.13
	P	17.83	0.75	7.43 - 25.98	24.96	27.69	81.25	46.33
1000-seed weight (g)	E ₁	0.75	0.01	0.51 - 0.98	12.62	12.69	98.90	25.33
	E ₂	0.79	0.01	0.44 - 0.98	13.65	13.95	95.67	27.85
	E ₃	0.69	0.01	0.46 - 0.87	12.29	12.47	97.07	24.95
	P	0.74	0.004	0.47 - 0.90	8.86	10.37	72.88	15.58
Seed protein Content (%)	E ₁	14.54	0.42	11.34 - 17.50	8.91	10.20	76.36	16.02
	E ₂	14.70	0.43	11.94 - 16.84	8.19	9.60	72.86	14.42
	E ₃	14.54	0.38	11.26 - 17.50	9.15	10.24	79.73	16.85
	P	14.59	0.24	11.27 - 17.12	8.64	8.80	96.36	17.47

through selection for these traits due to their non-additive genetic effects. These results were in general in conformation with the findings of Lohithaswa *et al.* (4), Waghmode *et al.* (5), Vyas (6) and Verma *et al.* (7).

While assessing overall position in individual environments separately and over pooled analysis in the present study considering the estimates of genetic parameters like genotypic coefficient of variation, heritability and genetic gain, it is evident that number of branches/plant, days to flowering, plant height, harvest index and inflorescence length are the most important yield attributing characters. Selection of these traits in the segregating generations could be more effective for improving grain yield of grain amaranth.

Acknowledgement

Authors are thankful to Dr. R.V. Singh, Director, NBPGR, New Delhi for providing the grain amaranth germplasm for the investigation.

References

1. **Burton, G.W.** 1952. Quantitative inheritance in grasses. Proceedings of 6th International Grassland Congress, 1:277-283.
2. **Allard, R.W.** 1960. Principles of Plant Breeding. John Wiley and Sons, Inc., New York.
3. **Johnson, H.W., Robinson, H.F. and Comstock, R.E.** 1955. Estimates of genetic and environmental variability in soybean. *Agronomy J.* **46** : 314-318.
4. **Lohithaswa, H.C., Nagaraj J.E., Savithramma, D.L. and Hemareddy, H.B.** 1996. Genetic variability studies in grain amaranth. *Mysore J. of Agric. Sci.* **30** :117-120.
5. **Waghmode, B.D., Patel, S.C., Jadhav, A. and Pawar, S.V.** 1998. Analysis of variability and heritability in amaranthus (*Amaranthus hypochondriacus* L.). *GAU Res. J.* **24** : 92-94.
6. **Vyas, V.H.** 2000. Genetic variability correlation and path analysis in grain amaranth (*Amaranthus paniculatus* L) M.Sc.(Agri)Thesis. Gujarat Agricultural University, Sardarkrushinagar.
7. **Verma, P.K., Deen, M.K., Gupta, S.N. and Sharma, G.D.** 2001. Genetic variation, correlation and path coefficient analysis for seed yield and quality characters in grain amaranth. *Indian J. of Plant Gen. Reso.* **14** : 171 -172.

Genotype-environment interaction in mungbean [*Vigna radiata* (L.) Wilczek]

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Abstract

Genotype x environment interaction and stability parameters of 12 diverse mungbean genotypes were studied at three locations (Sardarkrushinagar, Junagadh and Navsari) over two years viz., Kharif 2002 and 2003. Highly significant variance due to genotypes against pooled deviation for grain yield, days to flowering, days to maturity, plant height, number of effective branches per plant, pod length and test weight revealed the presence of genetic variability for these traits. The G X E (linear) interaction was significant for traits such as yield and days to maturity indicating that phenotypic performance of the genotypes was predictable for these traits. The pooled deviation, a non-linear component was significant for grain yield, days to 50 per cent flowering, days to maturity, plant height and pods per plant. It indicated that both linear and non-linear components of genotype x environment interactions are responsible for the differences in the stability of genotypes observed. The genotypes, GM-9705 (863 kg/ha), GM-9925 (927 kg/ha) and GM-9926 (957 kg/ha) exhibited high mean values for grain yield and non-significant regression coefficient (b_1) approaching unity with non-significant deviation from regression. Parameters in respect of yield attributing traits revealed that GM-9705 for pods/plant, number of effective branches/plant, seeds/pod and pod length, GM-9925 for days to 50 per cent flowering, pods/plant, number of effective branches/plant, seeds/pod and pod length and GM-9926 for days to maturity, pods/plant, number of effective branches/plant and seeds/pod were found stable over environments.

Keywords : Mungbean, GxE interaction, stability.

Introduction

Green gram (*Vigna radiata* (L.) Wilczek) is an important pulse crop thriving well under dryland conditions. Environmental conditions have always been major constrain for stable yield. Yield is a complex character and is multiplicative product of many factors called yield components, which are greatly influenced by environmental fluctuations. It is essential to breed high yielding varieties which perform consistently better under different environmental conditions. The present investigation was taken up to study genotype x environment interaction in 12 diverse mungbean genotypes.

Material and methods

Twelve diverse genotypes of mungbean were evaluated during kharif 2002 and 2003 in randomized block design with four replications at three locations viz., Sardarkrushinagar, Junagadh and Navsari in Gujarat state. The inter and intra-row spacings were

30 cm and 15 cm, respectively. During crop growth period, recommended package of practices were followed at all the locations. Observations were recorded on different agronomical traits viz., grain yield (kg/ha), days to flowering, days to maturity, plant height (cm), pods per plant, number of effective branches per plant, seeds per pod, pod length (cm) and test weight (g). Data were subjected to ANOVA for individual environment and pooled analysis of variance over environments following Eberhart and Russell (1). The significance of stability parameter (b_1) and its deviation from unity was tested by 't' test.

Results and discussion

The results revealed highly significant variance due to genotypes against pooled deviation for grain yield, days to flowering, days to maturity, plant height, number of effective branches per plant, pod length and test weight indicating the presence of genetic variability for these traits (Table 1). Highly significant differences

due to environments were observed for all the traits studied except seeds per pod revealing that the environments were highly variable. Highly significant differences of high magnitude due to environment linear indicated large macro environment differences at three locations and their influence on expression of traits. Genotype x Environments interaction was also found to be significant for all characters except branches per plant. The G X E (linear) interaction was significant for traits such as yield and days to maturity indicating that phenotypic performance of the genotypes was predictable for these traits. The pooled deviation, a non-linear component was significant for seed yield, days to 50 per cent flowering, days to maturity, plant height and pods per plant. It indicated that both linear and non-linear components of genotype x environment interactions were responsible for the differences in the stability of genotypes observed. The linear regression (b_i) is regarded as measure of responsiveness and S^2d_i as measure of stability for classification of genotypes as suggested by Paroda and Hayes (2). A genotype with non-significant S^2d_i and b_i was considered as stable genotype. As revealed from Table 2, in case of grain yield, non-linear portion G X E interaction was found significant in nine genotypes as displayed by significant deviation from regression slope with non-significant regression coefficient. Further three genotypes did not interact with environments as shown by both b_i and S^2d_i being non-significant, therefore prediction of performance was perfect in case of these three genotypes. The genotypes, GM-9705 (863 kg/ha), GM-9925 (927 kg/ha) and GM-9926 (957 kg/ha) exhibited high mean values for grain yield and non-significant regression coefficient (b_i) approaching unity with non-significant deviation from regression. Parameters in respect of yield attributing traits revealed that GM-9705 for pods/plant, number of effective branches/plant, seeds/pod and pod length, GM-9925 for days to 50 per cent flowering, pods/plant, number of effective branches/plant, seeds/pod and pod length, while GM-9926 for days to maturity, pods/plant, number of effective branches/plant and seeds/pod were stable over environments as they expressed non-significant regression coefficient (b_i) approaching unity with non-significant deviation from regression for the respective trait. This indicated that stability observed in these traits have results into the stability of grain yield. The findings are in agreement with the results of Patel et al. (3), Patil and Narkhede (4) and Yadav and Kumar (5).

Table 1. Analysis of variance (mean squares) for stability in mungbean

Source	d.f.	Grain yield (Kg/ha)	Days to flowering	Days to maturity	Plant height (cm)	Pods/plant	Number of effective branches/plant	Seeds /pod	Pod length (cm)	Test weight (g)
Genotypes	11	26310.34**	60.03**	81.48**	306.50**	23.71	0.27**	0.18	0.37**	0.41**
Environments	5	2014521.00**	147.80**	57.97**	676.23**	95.96**	10.20**	0.43	1.12**	0.72**
G X E	55	13477.35	8.85	16.38	39.84	16.74	0.06	0.22	0.04	0.04
Environments (Linear)	1	10072605.00**	739.04**	289.89**	3381.18**	479.84**	51.03**	2.13**	5.62**	3.62**
G X E (Linear)	11	23598.37*	11.39	27.91*	26.91	19.32	0.06	0.26	0.04	0.06
Pooled deviation	48	10034.84**	7.51**	12.39**	39.48**	14.75**	0.05	0.19	0.04	0.04
Pooled error	198	2617.94	0.59	1.01	8.55	3.37	0.04	0.10	0.03	0.01

* ** Significant at 5% and 1% level, respectively

Table 2. Mean and stability parameters for yield and its components in mungbean.

Sr. No.	Genotype	Yield (Kg /ha)			Days to flowering			Days to maturity			Plant height (cm)		
		Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
1	GM-4	944	1.20	12046.41**	37	0.06	7.54**	64	-0.68	30.55**	49	0.53	17.91*
2	GM-9604	872	0.88	8384.60**	46	0.73	13.95**	70	0.12	12.58**	68	0.77	1.61
3	GM-9608	963	1.12	6491.38**	45	1.44	12.97**	76	-0.55	28.64**	73	0.98	18.28*
4	GM-9703	817	1.09	8543.58**	40	0.50	1.68**	78	0.47	11.79**	63	0.84	22.27*
5	GM-9704	770	0.81	6993.27**	45	0.99	8.26**	76	1.57	13.37**	70	0.90	19.52*
6	GM-9705	863	1.04	-1220.00	46	1.44	7.88**	77	0.49	10.88**	68	0.81	19.35*
7	GM-9709	894	0.71	15122.84**	44	1.15	7.02**	76	2.06	7.03**	69	0.91	-9.32
8	GM-9710	811	0.93	5741.27**	47	1.04	3.05**	75	0.79	6.03**	75	1.18	72.83**
9	GM-9717	971	1.23	10101.36**	44	0.80	4.79**	76	1.56	8.07**	66	1.48	24.58**
10	GM-9722	853	0.92	13811.20**	49	0.98	8.99**	77	1.31	6.12**	77	1.65	41.73**
11	GM-9725	927	0.87	1054.57	46	1.33	0.72	76	2.38*	0.42	70	1.07	50.68**
12	GM-9726	957	1.17	2127.41	46	1.53	4.97**	75	1.98*	1.34	69	0.85	56.29**

Sr. No.	Genotype	Pods/plant			Number of effective branches/plant			Seeds/pod			Pod length (cm)			Test weight (g)		
		Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
1	GM-4	21	0.77	22.92**	1.85	1.03	0.12**	11.4	0.73	0.25*	7.7	1.53	-0.02	3.94	0.16	0.12**
2	GM-9604	25	1.69	40.33**	2.52	0.89	-0.09	11.5	2.28	0.34**	7.1	1.20	0.02	3.07	0.69	0.009
3	GM-9608	25	1.20	8.96*	3.00	0.89	0.009	11.6	1.64	0.23*	7.1	1.06	-0.02	3.26	0.95	0.008
4	GM-9703	26	2.53	28.91**	2.75	1.00	0.02	11.2	0.39	0.03	6.9	1.16	-0.00	3.26	1.55	0.01
5	GM-9704	22	0.95	3.87	2.70	1.13	-0.002	11.7	2.24	-0.07	6.8	0.87	-0.01	3.15	1.43*	-0.007
6	GM-9705	25	1.59	4.41	2.90	1.13	0.02	11.5	-1.68	0.16*	7.4	1.17	0.06*	3.37	1.31	0.02*
7	GM-9709	21	1.17	5.55	2.67	0.92	0.004	11.6	1.20	-0.09	7.3	0.94	0.004	3.31	0.48	0.04**
8	GM-9710	21	-0.02	16.55**	2.70	0.97	-0.00	11.3	0.19	0.04	6.9	0.72	-0.02	3.17	1.64*	-0.003
9	GM-9717	22	0.83	-0.53	2.75	1.21	0.01	11.5	2.05	-0.01	7.4	0.78	-0.003	3.47	1.03	0.02*
10	GM-9722	20	0.68	3.08	2.25	0.79	-0.02	11.5	1.94	0.02	7.1	1.32	0.003	3.36	1.18	0.02*
11	GM-9725	21	0.56	-1.41	2.37	0.95	0.03	11.3	1.39	0.02	7.3	0.64	-0.006	3.65	1.06	0.04**
12	GM-9726	22	1.03	-1.32	2.80	1.08	-0.005	11.1	-0.42	0.07	7.3	0.57	0.06*	3.77	0.48	0.03**

*, **Significant at 5% and 1% level, respectively

References

1. Eberhart, S.A and Russell, W.A. 1966. Stability parameters for comparing varieties. *Crop Sci.* 6:36-40.
2. Paroda, R.S and Hayes, J.D. 1971. Investigation of genotypes environment interaction for rate of ear emergence in spring barley. *Heredity* 26:157-176.
3. Patel, M.S., Pathak A.R. and Patel K.M. 1998. Phe-notypic stability for yield and its attributes in clusterbean. *Indian J. of Pulses Res.* 11:25-29.
4. Patil, H.S. and Narkhede. 1995. Stability for 100 seed weight, pods/pant and seed yield in greengram. *Legume Research* 18:41-49.
5. Yadav, I.S and Kumar D. 1983. Association between stability parameters of productive traits in blackgram. *Madras J. of Agric.* 70: 331-333.

Stability performance of mothbean [*Vigna aconifolia* (Jacq.) Marechal] genotypes for yield in Gujarat

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Abstract

Ten advance breeding lines were evaluated at three locations in Gujarat state viz., Sardarkrushinagar, Radhanpur and Kothara during *kharif-2003* in randomized block design. The stability analysis was carried out for seed yield and yield attributing characters. Genotype and genotype x environment (G x E) interactions were significant for all the traits under study except for test weight. Linear and non-linear component of G x E interaction were also significant for most of the traits. Genotypes GMO 9704 ($\bar{X} = 614$ kg/ha, $b_i = 1.5$ and $S^2d_i = -0.003$), GMO 9713 ($\bar{X} = 559$ kg/ha, $b_i = 1.2$ and $S^2d_i = -0.004$) and GMO 9004 ($\bar{X} = 465$ kg/ha, $b_i = 1.01$ and $S^2d_i = -0.004$) had high grain yield with unit regression and least deviation from regression were categorized as most stable genotypes for yield. The genotype GMO-9713 has been released for Gujarat state during 2004 as Gujarat Moth-2.

Key words : Mothbean, *Vigna aconifolia* (Jacq.) Marechal, stability.

Introduction

Mothbean [*Vigna aconifolia* (Jacq.) Marechal] is an important crop of arid regions of India particularly, Rajasthan, Gujarat and Haryana. This crop is mostly grown in Gujarat as sole or intercropped with bajra for grain as well as fodder purpose. For selecting stable genotypes with higher yield potential, investigations are needed to study the effect and magnitude of genotypes x environment interactions, which would ultimately help in stabilizing the production from season to season. Keeping these facts in view, the present investigation was carried out to study stability analysis for grain yield and its components in mothbean.

Material and methods

Ten advance breeding lines were evaluated at different locations of Gujarat state viz., Sardarkrushinagar, Radhanpur and Kothara during *kharif-2003* in randomized block design with four replications. The inter and intra-row spacing were 45 cm and 10 cm respectively. During crop growth period, the recommended package of practices were followed at all the locations. Observations were recorded on different agronomical traits viz., grain yield (kg/ha), days to 50 % flowering, days to maturity, plant height (cm), number of effective branches/plant, pods/

plant, pod length (cm), seeds/pods and test weight (g). Data were subjected to ANOVA for individual environments and pooled analysis of variance over environments following an Eberhart and Russell (1). The significance of stability parameter (b_i) and its deviation from unity S^2d_i was tested by 't' test.

Results and discussion

The results revealed highly significant variance due to genotypes against pooled deviation for grain yield and all the yield components studied indicating the presence of genetic variability for these traits (Table 1). Highly significant differences due to environments for all the traits studied revealed that the locations were highly variable. Highly significant differences of high magnitude due to environment (linear) for all the traits studied indicated large macro environmental differences and their influence on expression of traits. The G x E (linear) interaction was significant for traits such as days to flowering, days to maturity, plant height and seeds/pod indicating that phenotypic performance of the genotypes was predictable for these traits. The pooled deviation, a non-linear component was significant for grain yield, days to flowering, days to maturity, plant height, seeds/pod and test weight. Thus both linear and non-linear components of genotype x environment interactions were responsible for the differences in the stability of genotypes observed. The linear

regression (b) is regarded as a measure of responsiveness and S^2d as a measure of stability for classification of genotypes as suggested by Paroda and Hayes (2). A genotype with non-significant S^2d and b was considered as stable genotype. As revealed from Table 2, for grain yield, non-linear portion of $G \times E$ interaction was found significant in three genotypes, as displayed by significant deviation from regression slope with non-significant regression coefficient. Further seven genotypes did not interact with environments as shown by both b and S^2d being non-significant. Thus prediction of performance was perfect in case of these seven genotypes. The genotypes, GMO-9704 (614 kg/ha), GMO-9713 (559 kg/ha), and GMO-9004 (465 kg/ha), exhibited high mean values for grain yield and non-significant regression coefficient (b) approaching unity with non-significant deviation from regression. Stability for seed yield in mothbean has also been reported by Henry (3), Henry and Dauley (4), Henry and Dauley (5), Saini et al. (6), Sharma (7) and Thangavellu (8). The genotype GMO-9713 has been recommended for release for Gujarat state during 2004 as Gujarat Moth-2 by State seed committee. Parameters in respect of yield attributing traits revealed that GMO-9704 for days to maturity, plant height, branches/plant and pod length; GMO-9713 for plant height, pods/plant, pod length and test weight; GMO-9004 for plant height, branches/plant, pod length and test weight were stable over environments as they expressed non-significant regression coefficient (b) approaching unity with non-significant deviation from regression for the respective traits. This indicated that the stability observed in these traits is reflected in the stability for grain yield. Therefore, the chances for the selection of stable genotypes could be strengthened by selection for stability of yield components.

Table 1. Analysis of variance (mean squares) for stability for different characters

Source	d.f.	Seed yield	Days to flowering	Days to maturity	Plant height (cm)	Branches per plant	Pod per plant	Pod length (cm)	Seeds/pods	Test weight (g)
Genotypes	9	0.087*	120.663**	146.617**	10.501*	3.861**	134.990**	0.129*	0.044**	0.080**
Environment	2	1.440**	112.980**	479.134**	2403.805**	69.358**	14302.914**	0.147**	13.534**	0.149**
GXE	18	0.023*	17.264*	39.126*	13.448*	1.567**	43.247*	0.054*	0.011*	0.013
Environment (linear)	1	2.280**	225.959**	958.269**	4807.609**	138.717**	28605.828*	0.293*	27.068**	0.297*
GXE (linear)	9	0.025	26.598**	26.260**	5.496*	1.060	55.520	0.028	0.021*	0.014
Pooled deviation	10	0.018*	7.137*	46.794*	19.260*	1.866	27.877	0.071*	0.0001	0.010*
Pooled error	81	0.004	2.105	14.872	1.672	0.063	2.318	0.017	0.008	0.005

Table 2. Mean and stability parameters for yield and its components in mothbean

Sr. No.	Genotype	Yield (Kg /ha)			Days to flowering			Days to maturity			Plant height (cm)			Branches/plant		
		Mean	b _i	S ² d _i	Mean	b _i	S ² d _i	Mean	b _i	S ² d _i	Mean	b _i	S ² d _i	Mean	b _i	S ² d _i
1.	GMO-1	278	0.514	0.112**	73	0.296	22.07	103	1.29	19.51*	63	1.085	-0.34	5.55	0.740	3.293
2.	GMO-9703	409	1.094	0.007	68	-1.530*	-0.98	92	0.44	-0.09	61	1.029	24.50*	7.11	1.244	0.140
3.	GMO-9713	539	1.249	-0.004	63	1.439*	3.67	85	0.46	-14.55*	58	0.810	3.29	7.50	1.157	2.806
4.	GMO-9704	614	1.566	-0.003	59	1.652*	6.41	88	1.05	-8.60	57	0.831	-1.51	7.66	1.357	0.689
5.	GMO-9004	465	1.010	-0.004	61	1.572*	-1.80	86	0.77	25.89*	59	0.998	2.93	7.79	1.306	2.549
6.	GMO-9105	472	1.170	0.019**	78	1.692	6.68	89	0.37	-8.68	60	1.004	16.49*	7.61	1.187	3.057
7.	GMO-9114	368	1.001	-0.0001	73	1.760	3.19	98	1.00	47.00	62	1.126	-0.81	6.18	0.847	0.289
8.	GMO-9118	309	0.871	-0.001	77	1.700	-0.90	100	0.98	17.210	60	0.982	133.95*	5.83	0.839	1.043
9.	GMO-9125	273	0.728	0.014*	75	1.429	11.89*	90	1.92	243.16*	60	1.018	-1.39	5.01	0.691	1.775
10.	GMO-9701	324	0.797	0.004	75	-0.010	0.05	102	1.69	-1.65	63	1.117	-1.24	4.98	0.632	2.45**
11.	Mean	407	.	.	69	.	.	98	.	.	60	.	.	6.52	.	.
12.	S.E.m.±	66.78	0.25	.	1.88	0.56	.	4.83	4.83	.	3.10	0.20	.	0.97	0.37	.

Contd....

Sr. No.	Genotype	Pods/plant			Pod length (cm)			Seeds/pod			Test weight (g)		
		Mean	b _i	S ² d _i	Mean	b _i	S ² d _i	Mean	b _i	S ² d _i	Mean	b _i	S ² d _i
1.	GMO-1	47.80	0.916	0.820	4.1	1.174	0.173*	5.18	0.794	-0.007	2.38	0.233	-0.005
2.	GMO-9703	56.70	1.060	25.252*	4.3	2.529	0.110	5.47	1.030*	-0.007	2.67	1.509	0.008
3.	GMO-9713	61.31	1.136	10.368	4.4	1.841	0.001	5.48	0.993*	-0.008	2.79	1.433	-0.003
4.	GMO-9704	61.13	1.169	33.053*	4.4	1.549	-0.004	5.49	1.067*	-0.007	2.87	1.934*	0.025
5.	GMO-9004	58.48	1.120	67.706*	4.2	-0.034	0.040	5.54	1.104*	-0.007	2.68	1.478	0.032
6.	GMO-9105	58.15	1.154	46.414*	4.0	1.442	0.245	5.38	1.079*	-0.008	2.76	-0.348	-0.003
7.	GMO-9114	46.63	0.889	23.874*	3.8	1.491	-0.006	5.30	0.931	-0.007	2.46	0.468	0.010
8.	GMO-9118	46.19	0.880	10.614	3.9	-0.626	-0.009	5.29	0.993	-0.007	2.48	1.200	-0.002
9.	GMO-9125	46.34	0.845	23.377*	4.0	-0.047	-0.016	5.26	1.017	-0.007	2.51	0.931	-0.004
10.	GMO-9701	46.57	0.832	14.107*	3.9	0.682	0.000	5.27	0.993	-0.008	2.50	1.162	-0.005
11.	Mean	52.93	.	.	4.1	.	.	5.36	.	.	2.61	.	.
12.	S.E.m.±	3.73	9.87	.	0.19	1.55	.	0.002	0.01	.	0.071	0.58	.

*, ** Significant at 5% and 1% level, respectively

References

1. Eberhart, S.A and Russell, W.A. 1966. Stability parameters for comparing varieties. *Crop Sci.* **6**: 36-40.
2. Paroda, R.S. and Hayes, J.D. 1971. Investigation of genotypes environment interaction for rate of ear emergence in spring barley. *Heredity* **26**:157-176.
3. Henry, A. 1995. Phenotypic stability in Mothbean for seed yield on drylands of Western Rajasthan. *Forage Res.* **21**:58-61.
4. Henry, A. and Dauley, H.S. 1983a. Genotype x environmental interactions for seed yield in mothbean. *Indian J. Agric. Sci.* **53**:469-470.
5. Henry, A. and Dauley, H.S. 1983b. Genotype x environmental interactions of induced mutants in mothbean. *Madras Agric. J.* **76**:705-708.
6. Saini, M.L., Malik, J.S., Solanki, K.R. and Singh, J.V. 1983. V x E interactions for green fodder yield in mothbean. *Indian J. Agric. Sci.* **53**:83-84.
7. Sharma, R.C. 1998. Stability in Mothbean (*Vigna aconitifolia*). *Indian J. Agric. Sci.* **68**:130-131.
8. Thangavellu, M. 1982. Correlation, path and stability analysis in Mothbean [*Vigna aconitifolia* (Jacq.) Marechal]. M.Sc. Thesis, H.A.U. Hissar.

Combining ability analysis in sorghum [*Sorghum bicolor* L. (Moench)] for yield and its attributing traits

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Abstract

The present study was carried out to estimate the general and specific combining ability of parents and hybrids respectively for yield and its attributes in sorghum. Ten elite genotypes of sorghum were used as parents and were mated in diallel fashion excluding reciprocals. The observations recorded were plant height, flag leaf area, panicle length, primaries per panicle, grain yield per plant and test weight. ANOVA revealed significant differences among genotypes, parents and hybrids. The GCA variances were predominant for all the characters under study except test weight. The results indicated that the yield and its attributing traits were governed by additive gene action. Parent SR 1571 exhibited higher GCA effects for most of the characters hence it could be used for yield improvement. The high GCA effects were associated with higher mean performance. Considering the SCA effects, crosses SR 770 x SPY 1022 and GMRP 9 x SR 1571 recorded higher SCA effects for yield and its related characters. The crosses with higher SCA effects involve atleast one or both parents with high GCA. Such crosses may be exploited to fix high yielding characters in advanced generations. In rare cases both parents with poor GCA also produced hybrids with higher SCA effects. In such cases cyclic or biparental breeding programme might be useful.

Key words: Sorghum, general combining ability, specific combining ability.

Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) is an important rainfed crop for dryland area. Sorghum provides staple food for the people. In Gujarat, sorghum is considered as poor farmer's crop. Cultivation of sorghum on poor fertile soil, low cost crop management, rainfed cultivation, diseases and pest attack, least preference as food, lack of superior lines in hybridization programme are the main reasons which led to lower production of sorghum.

Choice of parents which had good potentiality for yield and its related characters is the primary necessity in breeding programme. Information on relative importance of general and specific combining ability is of immense use in the development of an efficient breeding programme. It not only helps to identify the parents and crosses which are likely to give the maximum improvements for the characters under consideration but also provides means of understanding the nature of gene action involved in it.

The present study was, therefore, conducted to estimate the general and specific combining ability of parents and hybrids respectively for yield and its attributing traits.

Material and methods

Ten homozygous lines of grain sorghum were used as parents in this hybridization programme. The lines were SR 770, SR 833, SPY 1388, SPY 1022, CSV 15, GMRP 9, GMRP 27, SR 1571, SR 1718 and GJ 38. The crossing programme was adopted using diallel mating design at Main Sorghum Research Station, Navsari Agricultural University, Surat. The parental lines and their resultant 45 F_1 's were evaluated with GJ 41 as standard check at Main Sorghum Research Station, Surat. The trial was conducted in a randomized block design with three replications. The recommended agricultural practices were adopted to raise the crop.

The observations recorded were plant height (cm), flag

leaf area (sq. cm), panicle length (cm), primaries per panicle, grain yield per plant (g) and test weight (g). Analysis of data for general and specific combining ability was carried out following Griffing's (1) method II, Model I (Fixed effect model).

Results and discussion

The analysis of variance for combining ability of yield and its attributing traits are presented in Table 1. The ANOVA revealed that the differences due to genotypes were highly significant for all the characters under study. The same trend was observed for parents and hybrids. The results indicated that there was sufficient variability exist among genotypes, parents and hybrids for all the traits under evaluation. The variances due to general combining ability and specific combining ability were highly significant for all the characters under study except test weight which was indication of importance of additive and non-additive variances in the inheritance of the traits. Similar findings had been reported by number of other workers (2, 3, 4, 5, 6, 7, 8, 9, 10, 11). The GCA variances were higher as compared to SCA variances for flag leaf area, panicle length, number of primaries per panicle, grain yield per plant and test weight. These results suggested that the traits under study having higher GCA variances were governed by additive gene action. The results were in agreement with the earlier results of Poor and Rezai (12), Shakoor and Qureshi (13), Patil (14), Ravindrababu *et al.* (15), Gaikwad *et al.* (16) and Tiwari *et al.* (17). Due to predominance of additive gene action, direct selection is effective in the improvement of such traits. Only plant height exhibited higher SCA effects, which was indication of the presence of dominance gene action in the trait.

The estimates of general combining ability effects are presented in Table 2. Considering the plant height, parent GJ 38 exhibited highest negative GCA effect which was desirable for dwarfness. GJ 38 was followed by SR1571 and SR1718. For flag leaf area SR 1571, SR 770, SPY 1022 and GMRP 9 observed promising in respect of GCA effects as well as mean performance. For panicle length, the GCA effect was higher for SR 1571, GMRP 9 and GMRP 27. The parents with high GCA also get higher rank for mean values. For primaries per panicle, parents SR 1718, SR 1571 and GMRP 27 exhibited higher GCA effects.

While, parents SPY 1022, GMRP 9, SR 1571, SR 770 and GMRP 27 recorded higher GCA effects for the grain yield per plant. While for test weight, only two parents SR 1571 and SR 770 were observed significantly promising for GCA effects.

In most of cases, higher GCA was associated with higher mean values, which indicated that selection based on per se performance is also effective. This trait is matched with the earlier findings of Patel (18) and Wadikar *et al.* (19).

Looking to the overall situation for GCA effects, parent SR 1571 observed promising, as it had exhibited higher GCA effects for most of the characters accompanied with high mean. So, one can use SR 1571 as one of the parent in future sorghum breeding programme and can achieve the target of developing higher yielding grain sorghum varieties.

High GCA effects mostly contribute additive gene effects or additive x additive interaction effects and represents fixable portion of genetic variance. Parents with high GCA offer the best possibilities of exploitation for the development of improved lines with enhanced yielding ability. It is suggested that population involving these lines in a multiple crossing programme may be developed for isolating desirable recombinations.

The details of top ten crosses for SCA effect is presented in Table 3. For plant height, highest negative and significant effect was recorded by cross GMRP 9 x SR 1571 followed by SPY 1388 x SPY 1022, SR 770 x SR 1718 and CSV 15 x GMRP 9. While for flag leaf area, crosses SR 833 x GMRP 27, SR 770 x SPY 1022, SPY 1022 x GMRP 27, SPY 1022 x SR 1718 and GMRP 9 x SR 1571 were top five significant specific crosses. Panicle length is also one of the yield attributing character. For this trait, crosses SPY 1388 x SR 1571, SR 833 x GJ 38, SR 770 x SPY 1022, SPY 1388 x SR 1718 and GMRP 9 x SR 1571 observed most promising. These crosses also exhibited high mean values for the respective traits. While for primaries per panicle, the cross SPY 1388 x SR 1571 recorded highest significant SCA effects which was followed by SPY 1388 x CSV 15, SR 770 x SPY 1022, CSV 15 x GMRP 9 and SR 1571 x SR 1718. Crosses with higher SCA effects also registered higher mean values for the trait.

Table 1. Analysis of variance for combining ability in sorghum for yield and its attributing traits in sorghum

Source of variation	d.f.	Plant height (cm)	Flag leaf area (Sq. cm)	Panicle length (cm)	No. of primaries /panicle	Grain yield/plant (g)	Test weight (g)
Replication	2	367.807	3.950	0.533	19.063	25.013	0.010
Genotypes	54	3123.992**	22614.290	38.138**	174.474**	3284.505	0.432**
Parents	9	1844.654*	9764.822**	62.512**	108.059*	257.420**	0.523**
Hybrids	44	2464.102**	23816.840**	33.016**	188.305**	3766.279**	0.409**
P. vs hybrids	1	43673.172	85347.282	44.123	163.666	9330.219	0.620
GCA	9	833.573**	11072.679**	27.893**	102.846**	1729.454	0.225
SCA	45	1082.882**	6831.180**	9.677**	49.220**	967.911**	0.128
Error	108	159.577	224.304	2.170	10.014	15.131	0.019
σ^2		56.166	904.031	2.143	7.736	142.860	0.017
σ^2		923.305	6606.877	7.506	39.207	952.780	0.109
S.E.M $\pm$		1.703	2.019	0.199	0.427	0.525	0.019

* = Significant at 5% ** = Significant at 1 %

Table 2. Estimates of general combining ability effects of parents for yield and its attributing characters in sorghum

Parents	Plant height (cm)	Flag leaf area (Sq. cm)	Panicle length (cm)	No. of primaries /panicle	Grain yield/plant (g)	Test weight (g)
SR770	12.061** (238.37)	25.0267 (243.93)	-6.880** (24.60)	-1.093 (44.40)	9.497 (60.20)	0.140 (2.9)
SR833	1.788 (233.83)	6.031 (150.60)	-1.205** (21.13)	-2.593** (47.40)	-4.862** (36.60)	0.007 (2.7)
SPY 1388	-2.695 (223.33)	-23.644** (183.30)	-1.641** (21.33)	1.090 (46.40)	-11.553* (43.80)	-0.102** (2.7)
SPY 1022	4.861 (239.73)	21.809** (242.00)	-0.436 (28.20)	-2.635** (50.60)	13.363** (58.80)	0.090** (3.0)
CSV 15	2.869 (237.30)	-39.669** (123.13)	-0.288 (25.23)	1.907* (43.60)	-15.153** (43.50)	-0.227** (2.5)
GMRP9	12.033** (267.57)	17.951** (117.30)	1.856 (29.60)	-0.702 (41.40)	10.880** (38.80)	0.007 (2.0)
GMRP27	-2.609 (258.53)	-10.555** (87.13)	1.673** (36.40)	2.423** (63.20)	9.472** (58.00)	-0.002 (1.8)
SR1571	-10.442** (212.30)	42.398** (200.33)	2.426** (30.50)	3.148** (49.80)	9.113** (47.00)	0.198 (3.0)
SR1718	-6.001 (204.67)	12.173** (242.50)	0.359 (27.10)	3.698** (49.60)	-2.162** (52.30)	0.073 (2.4)
GJ38	-11.864** (184.43)	-51.519** (153.67)	-1.863** (25.17)	-5.243** (46.40)	-18.595* (36.00)	-0.185** (2.9)
S.E(g) $\pm$	3.460	4.102	0.403	0.867	1.065	0.0378
S.E(g-g) $\pm$	5.157	6.114	0.601	1.292	1.588	0.056
Parental mean	230.00	174.390	26.93	48.28	47.47	2.6

* = Significant at 5% ** = Significant at 1 %

Figures in parenthesis indicated the mean performance of parents

Table 3. Details of top ten crosses in respect of specific combining ability effects for yield and its attributing traits in sorghum

Plant height			Flag leaf area		
Cross	SCA	Mean	Cross	SCA	Mean
GMRP9/SR1571	-82.818**	180.67	SR833xGMRP27	134.221**	362.33
SPY1388xSPY1022	-55.603**	141.97	SR770xSPY1022	122.730**	392.20
SR770xSR1718	-43.055**	158.50	SPY1022xGMRP27	112.877**	346.77
CSY15xGMPP9	-41.296**	169.10	SPY1022xSR1718	104.713**	361.33
GMRP9xGMPR27	-31.252	173.67	GMRP9xSR1571	98.316**	381.30
SR770xGMRP27	-29.946	175.00	SPY1022xSR1571	86.224**	373.07
SR833xGMRP9	-29.582	179.73	CSV15xGJ38	86.419**	373.07
SR833xGMRP27	-28.541	166.13	SR833xSR1571	84.469**	355.53
SPY1022xGMRP27	-28.413	169.33	SPY1388xCSV15	84.444**	243.77
SPY1388xGJ38	-25.535	156.60	GMRP9xSR1718	81.541**	334.30
S.E.(S _y)±	10.431	--		12.37	--
S.E.(S _a -S _{ik})±	17.104	--		20.28	--
F ₁ Mean		187.83			233.36

Cont...

Grain yield/plant			Test weight		
Cross	SCA	Mean	Cross	SCA	Mean
SR833xGMRP27	54.168**	122.20	SR770xSPV1022	0.660**	3.6
SPY1022xSR1718	51.677**	126.30	GMRP9xSR1718	0.500**	3.3
GMRP9xSR1571	50.395**	133.80	GMRP9xSR1571	0.475*	3.4
SR770xSPV1022	49.218**	136.50	SR833xGMRP9	0.467*	3.2
SPY1022xSR1571	42.702**	128.60	SPY1388xGMRP27	0.383*	3.0
SR770xSR1571	42.568**	126.40	SR770xGMRP27	0.342	3.2
SR770xSR1571	42.568**	126.40	SPY1022xSR1571	0.292	3.3
GMRP9xSR1718	36.160**	108.30	SR833xSPV1388	0.275	2.9
GMRP27.GJ38	36.202*	89.50	GMRO27xGJ38	0.264	2.8
CSY15xGJ38	29.627**	59.30	CSY15xGMRP27	0.208	2.7
S.E.(S _y)±	32.11	--		0.114	--
S.E.(S _a -S _{ik})±	52.67	--		0.187	--
F ₁ Mean		66.96			2.75

Cont...

Panicle length			Primaries/penicle		
Cross	SCA	Mean	Cross	SCA	Mean
SPY 1388 x SR1571	5.819**	32.43	SPV1388xSR1571	15.969**	70.60
SR833xGJ38	5.405**	28.17	SPV1388xCSV15	14.611**	68.00
SR770xSPV1022	4.286*	28.80	SR770xSPV1022	12.436**	59.10
SPY1388xSR1718	3.786	28.33	CSV15xGMRP9	11.602*	63.20
GMRP9xSR1571	3.622	33.73	SR1571xSR1718	10.761*	68.00
SPY1388xCSY15	3.466	27.37	SPV1388xSR1718	9.619*	64.80
SR770xSR1718	3.491	28.80	CSV15xSR1718	7.402	63.40
SR833xGMRP9	1.719	28.20	GMFP9xGJ38	4.752	49.20
GMRP27xGJ38	1.694	27.33	SR770xSR833	3.494	50.20
CSV16xSR1718	1.600	27.50	GMRP9xSR1571	3.761	56.60
S.E.(S _y)±	1.357	--		26.13	--
S.E.(S _a -S _{ik})±	1.995	--		42.85	--
F ₁ Mean		25.59			50.86

In respect of grain yield per plant, the crosses SR 833 x GMRP 27 stood first (54.168) followed by SPY 1022 x SR 1718, GMRP 9 x SR 1571, SR 770 x SPY 1022 and SPY 1022 x SR 1571. For test weight, the cross SR 770 x SPY 1022 (0.650) recorded highest significant and positive SCA effects and was followed by GMRP 9 x SR 1718, GMRP 9 x SR 1571, SR 833 x GMRP 9 and SPY 1388 x GMRP 27. These crosses are observed promising in respect of mean values also. From overall performance, crosses SR 770 x SPY 1022 and GMRP 9 x SR 1571 exhibited higher SCA

effects for yield and all the yield attributing characters except plant height. It is interesting that the parent SR 1571 exhibited higher GCA effects for most of the traits under study. Hence, these crosses could be exploited to fix the high yield characters in advanced generations. Reciprocal recurrent selection method may be used to handle the crosses with high SCA effects (20). This indicated that additive or additive x dominance type of gene interaction was involved in the inheritance of these traits. Similar findings have been reported by Patil and Bapat (21).

References

1. Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing systems. *Aust. J. of Biol. Sci.* **9**:463-493.
2. Amsalu, A. A. and Bapat, D. R. 1990. Diallel analysis of combining ability in sorghum. *J. of Maharashtra Agric. Uni.* **15** : 302-305.
3. Patel, R. H., Desai, K. B., Desai, M. S. and Patel, K.G. 1990. Combining ability in grain sorghum. *Madras Agric. J.* **77**: 528-530.
4. Mehtre, S. P. and Borikar, S.T. 1992. Combining ability studies involving Maldandi cytoplasm in sorghum. *J. of Maharashtra Agric. Uni.* **17** : 247-249.
5. Senthil, N. and Palanisamy, S. 1994. Combining ability studies involving diverse cytoosteriles of sorghum. *Annals of Agric. Res.* **15** :339-343
6. Pillai, M. A., Rangaswamy, P., Nandarajan, N., Vanniarajn, C. and Ramlingam, J. 1995. Combining ability analysis for panicle characters in sorghum. *Indian J. Agric. Sci.* **29**: 98-102.
7. Naik, B. M. 1996. Heterosis and combining ability in fodder sorghum (*Sorghum bicolor* (L.) Moench) unpublished M.Sc.(Agri) Thesis. Gujarat Agricultural University, Sardarkrushinagar.
8. Bhadouriya, N. S. and Saxena, M. K. 1997. Combining ability studies in sorghum through diallel analysis. *Crop Res.* **14**: 253-256.
9. Chhimpi, B. G. 1998. Stability analysis in sorghum (*Sorghum bicolor* (L.) Moench.), Ph.D. Thesis. GAU, Sardarkrushinagar.
10. Bhavsar, V. V. and Borikar, S.T. 2002. Combining ability studies in sorghum involving diverse cytoosteriles. *J. of Maharashtra Agric. Uni.* **27**: 35-37.
11. Rafiq, S. M., Thete, R. Y., Madhusudhana, R. and Umakanth, A. V. 2002. Combining ability studies for grain yield and its components in post rainy season where sorghum grown in medium deep and shallow soils. *International Sorghum and Millet Newsletter* **43**:33-37.
12. Poor, S. N. and Rezai, A. 1997. Estimates of genetic parameters for grain yield and related traits in sorghum. *Indian J. Agric. Sci.* **27** : 77-87.
13. Shakoar, A. and Qureshi, A. S. 1999. Genetic effects and heritability for early maturing non senescence traits in *Sorghum bicolor* (L.) Moench. *Sarhad J. of Agric.* **15** : 569-581.
14. Patil, D. G. 2000. Heterosis and estimation of genetic parameters for resistance to midge in sorghum. Unpublished M.Sc. (Agri.) Thesis. GAU, Sardarkrushinagar.
15. Ravindrababu, Y., Pathak, A. R. and Tank, C. J. 2001. Studies on combining ability for yield and yield attributes in sorghum (*Sorghum bicolor* (L.) Moench). *Crop Res.* **22** : 274-277.
16. Gaikwad, N. J., Jhete, R.Y., Kanawade, D. G., Patil, J.V. and Kute, N.S. 2002. Selection of parents based on combining ability in sorghum. *Indian J. of Agric. Res.* **36**: 141 -144.
17. Tiwari, D. K., Gupta, R. S. and Mishra, R. 2003. Study of heterotic response for yield and its components in grain sorghum (*Sorghum bicolor* (L.) Moench). *Plant Archi.* **3** : 255-257.

18. **Patel, R. H.** 1980. Heterosis, combining ability and stability performance in sorghum. M.Sc. (Agri.) Thesis. GAU, Sardarkrushinagar.
19. **Wadikar, P. B., Ambekar, S. S., Jawanjal, S. S. and Aher, G.Y.** 2006. Line x Tester analysis for yield and yield contributing traits in *kharif* sorghum. *J. of Maharashtra Agric. Uni.* **31**: 73-76.
20. **Maunder, A. B.** 1972. Objectives and approaches to grain and forage sorghum improvement in the Americas. In sorghum in seventies. (Rao, N.G.P and House, L.R. Ed.) Oxford and IBH Co. Ltd., New Delhi.
21. **Patil, F. B. and Bapat, D. R.** 1991. Heterosis in forage sorghum and its relationship with combining ability. *J. Maharashtra Agric. Uni.* **16** : 329-332.

Stability analysis in cowpea [*Vigna unguiculata* (L.) Walp.]

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Abstract

Stability analysis was carried out for 11 diverse genotypes of cowpea grown at 3 locations (Sardarkrushinagar, Anand and Navsari) over two years. Highly significant variance due to genotypes against pooled deviation for presence of genetic variability for these traits. The G X E (linear) interaction was significant for traits such as grain yield and plant height indicating that phenotypic performance of the genotypes was predictable for these traits. The pooled deviation, a non-linear component was significant for grain yield, days to flowering, days to maturity, plant height, pod length and test weight. It indicated that both linear and non-linear components of genotype x environment interactions were responsible for the differences in the stability of genotypes observed. The genotypes, GC-9714 (859 kg/ha), GC 9732 (775 kg/ha), GC 9210 (735 kg/ha), GC 9708 (681 kg/ha) and GC 4 (584 kg/ha), exhibited high mean values for grain yield and non-significant regression coefficient (b_1) approaching unity with non-significant deviation from regression. Parameters in respect of yield attributing traits revealed that GC 9714 for pods per plant, pod length, number of effective branches/ plant, seeds per pod and test weight; GC 9732 for plant height, pods/plant, number of effective branches/ plant and seeds/pod, GC 9210 for days to flowering, days to maturity, plant height, pod length, number of effective branches/plant and test weight; GC 9708 for days to flowering, plant height, pods/plant, pod length, number of effective branches per plant and seed per pod and GC 4 for plant height, pod length, number of effective branches/plant and test weight; were stable over environments.

Key words : Stability analysis, cowpea, environment interaction.

Introduction

Cowpea [*Vigna unguiculata* (L.) Walp.] is an important grain legume suitable for cultivation under arid and semi arid agro climatic conditions. Yield is a complex character and is multiplicative product of many factors called yield components which are greatly influenced by environmental fluctuation. Environmental conditions have always been major constrain for stable yield. It is essential to breed high yielding varieties which perform consistently better under different environmental conditions. Therefore, the present investigation was taken up to study genotype x environment interaction in 11 advance cowpea genotypes.

Material and methods

Eleven advance genotypes of cowpea were grown at 3 locations, Sardarkrushinagar, Anand and Navsari over two years, summer 2002 and 2003 in randomized block design with four replications. The inter and intra-row spacing were 45 cm and 10 cm, respectively. During crop growth period, the recommended package of practices was followed at all the locations. Observations were recorded on different agronomical traits viz., grain yield (kg/ha), days to 50 % flowering, days to maturity, plant height (cm),

pods per plant, pod length (cm), number of effective branches per plant, seeds per pods and test weight (g). Data were subjected to ANOVA for individual environments and pooled analysis of variance over environments following Eberhart and Russell (1). The significance of stability parameter (b_1) and its deviation from unity was tested by 't' test.

Results and discussion

The results revealed highly significant variance due to genotypes against pooled deviation for grain yield, plant height, pods/plant, pod length, number of effective branches/plant and test weight revealing the presence of genetic variability for these traits (Table 1). Highly significant differences due to environments were observed for all the traits studied except pod length and seeds per pod indicating that the locations were highly variable. Highly significant differences of high magnitude due to environment linear for all the traits studied except seeds per pod indicated large macro environment differences at three locations and their influence on expression of traits. The G X E (linear) interaction was significant for traits such as grain yield and plant height indicating that phenotypic performance of the genotypes were predictable for these traits. The pooled deviation, a non-linear component was significant for grain yield, days to flowering, days to

maturity, plant height, pod length and test weight. It indicated that both linear and non-linear components of genotype x environment interactions were responsible for the differences in the stability of genotypes observed.

The linear regression (b_1) is regarded as measure of responsiveness and S^2d_1 as measure of stability for classification of genotypes as suggested by Paroda and Hayes (2). A genotype with non-significant S^2d_1 and b_1 was considered as stable genotype. As revealed from Table 2 all the genotypes did not interact with environments as shown by both b_1 and S^2d_1 being non-significant, therefore prediction of performance was perfect in case of all the genotypes. The genotypes, GC 9714 (859 kg/ha), GC 9732 (775 kg/ha), GC 9210 (735 kg/ha), GC 9708 (681 kg/ha) and GC 4 (584 kg/ha), exhibited high mean values for grain yield and non-significant regression coefficient (b_1) approaching unity with non-significant deviation from regression. Parameters in respect of yield attributing traits revealed that GC 9714 for pods/plant, pod length, number of effective branches/plant, seeds/pod and test weight; GC 9732 for plant height, pods/plant, number of effective branches/plant and seeds/pod, GC 9210 for days to flowering, days to maturity, plant height, pod length, number of effective branches/plant and test weight; GC 9708 for days to flowering, plant height, pods/plant, pod length, number of effective branches/plant and seed per pod and GC 4 for plant height, pod length, number of effective branches /plant and test weight were stable over environments, as they expressed non-significant regression coefficient (b_1) approaching unity with nonsignificant deviation from regression for the respective traits. This indicated that because of the stability observed in these traits may results in to the stability of grain yield of plant. Therefore, the chances for the selection of stable genotypes could be strengthened by selection for stability of yield components.

Table 1. Analysis of variance (mean squares) for stability in cowpea

Source	d.f.	Grain yield (Kg/ha)	Days to 50% flowering	Days to maturity	Plant height (cm)	Pods/plant	Pod length (cm)	Number of effective branches/ plant	Seeds/ pods	Test weight (g)
Genotypes	10	108657.43**	6.27	12.05	171.48**	10.33**	1.36**	0.28**	1.02	15.77**
Environments	5	891037.50**	325.43**	80.43**	4374.23**	529.62**	0.89	13.34**	1.11	18.96**
GXE	50	33105.83	5.63	7.19	171.82	7.18	0.37	0.05	0.93	0.41
Environments (I)	1	1782075.00**	650.86**	160.87**	8748.47**	1059.23**	1.78*	26.68**	2.22	37.91**
GXE(I)	10	44126.78**	3.78	4.69	253.86*	10.20	0.22	0.05	0.91	0.51
Pooled deviation	40	20077.17**	6.79**	4.81**	81.62**	3.79	0.46**	0.05	0.87	0.30**
Polled error	180	6329.64	0.53	0.31	4.87	2.91	0.11	0.03	0.13	0.02

* ** Significant at 5% and 1% level, respectively

Table 2. Mean and stability parameters for yield and its components in cowpea

Sr. No.	Genotype	Yield (Kg /ha)			Days to 50 % flowering			Days to maturity			Plant height (cm)		
		Mean	b _i	S ² d _i	Mean	b _i	S ² d _i	Mean	b _i	S ² d _i	Mean	b _i	S ² d _i
1	GC-8929	665	1.22	165099.0	49	0.83	9.71**	71	0.60	15.44**	46	0.55	60.17**
2	GC-8956	577	0.83	-9257.0	48	0.77	0.98	73	0.93	-0.53	45	0.63	52.35**
3	GC-9040	208	0.16*	-6056.0	49	1.19	15.29**	74	0.73	28.44*	56	1.08	-3.09
4	GC-9210	735	1.40	5034.6	47	0.88	0.32	70	1.50	0.51	56	0.83	-1.68
5	GC-9211	643	1.29	-3700.0	48	0.90	0.058	70	0.25	10.09**	49	0.68	4.30
6	GC-9708	681	0.60	-5978.2	47	0.99	-0.30	71	1.77	1.80*	52	0.80	1.03
7	GC-9714	859	1.80	-5998.2	46	0.89	2.23*	70	1.43	4.91**	49	0.42	93.32**
8	GC-9732	775	1.48	10692.2	47	0.74	5.99**	59	0.64	4.16**	61	1.01	-1.82
9	TGC-99-1	370	1.17	6102.4	52	1.59	16.43**	75	1.13	7.21**	50	1.84	44.64**
10	GC-3	437	0.88	2689.4	48	1.25	15.80**	72	0.82	11.77*	70	2.27	591.44**
11	GC-4	584	0.92	-5431.8	47	0.96	2.03*	73	1.30	7.10**	45	0.89	5.21

Contd....

Sr. No.	Genotype	Pods/plant			Pod length (cm)			Number of effective branches/plant			Seeds/pod			Test weight (g)		
		Mean	b _i	S ² d _i	Mean	b _i	S ² d _i	Mean	b _i	S ² d _i	Mean	b _i	S ² d _i	Mean	b _i	S ² d _i
1	GC-8929	16	0.57	13.11*	11.3	0.87	0.06	2.6	0.75	0.01	9.7	3.17	0.40	14.6	1.53	0.01
2	GC-8956	12	0.71	-2.10	11.4	0.13	-0.06	2.5	0.97	0.08	9.5	3.60	0.03	14.6	1.44	0.09*
3	GC-9040	12	0.64*	-3.10	12.0	0.26	-0.55*	3.1	0.80*	-0.03	9.7	2.22	0.97**	15.1	0.57	1.29**
4	GC-9210	17	1.54*	-3.13	10.7	1.94	-0.10	2.7	1.09	-0.03	10.0	-2.29	3.27**	9.9	0.66	0.05
5	GC-9211	13	0.57	0.74	10.9	-1.14	-0.01	2.4	0.93	0.03	9.1	2.07	-0.14	10.9	0.89	0.31**
6	GC-9708	13	0.98	2.03	11.2	1.54	-0.06	2.4	0.92	0.02	9.9	0.42	0.19	10.2	0.75	0.16*
7	GC-9714	11	0.80	1.62	10.4	0.87	-0.07	2.1	1.15	0.001	9.9	2.62	0.04	8.9	1.25	-0.01
8	GC-9732	15	1.16	0.33	11.4	2.52	2.73**	2.2	1.13	-0.02	10.3	1.54	1.19**	11.8	0.90	0.19**
9	TGC-99-1	13	0.95	1.27	12.7	-0.26	0.39**	2.6	1.06	0.19*	11.2	0.90	1.58**	13.9	1.51	0.88**
10	GC-3	16	1.42	-0.61	11.2	2.47	0.19	2.7	1.21	0.003	10.9	-2.17*	-0.14	10.6	1.06	-0.03
11	GC-4	15	1.34*	-3.14	12.2	1.78	0.20	2.2	0.98	0.007	10.1	-0.40	1.53**	14.4	0.45	-0.0005

*, ** Significant at 5% and 1% level, respectively

References

1. Eberhart, S.A and Russell, W.A. 1966. Stability parameters for comparing varieties. *Crop Sci.* **6**: 36-40.
2. Paroda, R.S and Hayes, J.D. 1971. Investigation of genotypes environment interaction for rate of ear emergence in spring barley. *Heredity* **26** :157-176.

Association analysis between yield and contributing characters in cowpea (*Vigna unguiculata* (L) Walp.)

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Abstract

Association between seed yield and its ten contributing characters in cowpea (*Vigna unguiculata* (L) Walp.) was studied using field experimental data of thirty six treatment combinations comprising of four levels of date of sowing and three levels of each varieties and irrigation. Seed yield per plant exhibited significant positive association with all contributing characters except trifoliage leaves and reproductive period and accounted for ninety four per cent of the total variation. There was high positive direct effects of dry matter, plant height and pod length on seed yield per plants

Key words : Correlation, coefficient of determination, path analysis, cowpea.

Introduction

Crop yield is a complex quantitative trait governed by large number of genes and greatly influenced by many contributing characters. Therefore, it is always of interest to know the contribution of such characters on yield and interrelationship among themselves. Cow-pea (*Vigna unguiculata* (L) Walp.) is one of the important legume crops of India. It is grown as grain, vegetable and fodder crop in all the seasons for which such information is inadequate. Hence, the present investigation was taken up to obtain information on association between yield and its components and direct and indirect effects.

Material and methods

The field experiment was conducted at the Seed Technology Farm Gujarat Agricultural University, Sardarkrushinagar during *rabi* season of the two consecutive years viz., summer 1999 and summer 2000 to ascertain the interrelationship between yield and its component characters of cowpea. Thirty six treatment combinations comprising of four levels of date of sowing and three levels each of irrigations and varieties were tried using RBD with four replications. The crop was raised with a spacing of 45 cm between rows and 10 cm within rows. All the recommended practices were followed during the crop growth. The observations were recorded on five

randomly selected plants from each plot. Besides seed yield (Y), plant height at 60 DAS (X_1), number of trifoliage leaves per plant at 60 DAS (X_2), number of primary branches per plant (X_3), dry matter per plant (X_4), number of pods per plant (X_5), number of seeds per pod (X_6), pod length (X_7), 100-seed weight (test weight) (X_8), fodder yield gm per plant (X_9) and reproductive period (X_{10}) were studied. The correlation and regression analysis (1) and path coefficient analysis (2) were carried out.

Results and discussion

Analysis of variance revealed that there were significant differences among the treatments almost for all the characters. The correlation matrix for seed yield and its ten contributing characters is given in Table 1. All the characters were positively associated with seed yield except reproductive period. Seed yield was significantly and highly associated with pod length (0.888), dry matter (0.87), number of seeds per pod (0.84), number of pods per plant (0.838), number of primary branches (0.817), fodder weight (0.805), plant height (0.785) and 100 seed weight (0.538). The trifoliage leaves (0.193) and reproductive period (-0.020) had non significant and negative association with seed yield respectively. All the contributing characters were also positively correlated among themselves except reproductive period suggesting that selection for these traits would be effective for

improvement in seed yield. Ram and Singh (3), Sawant (4) and Bhopal Singh *et al.* (5) also found positive correlation between grain yield and its components in cowpea.

When all the contributing characters were regressed with seed yield, the total variation accounted by them was 94 per cent. The regression coefficients (b), their standard error and test of significance ('t' values) for all these characters are shown in Table 2. The results revealed that the contribution of different characters were not of the same magnitude. The assess direct and indirect contribution of each character towards seed yield, path coefficient analysis was done and the same

is given in Table 3. The results of path analysis indicated that all the characters exhibited positive direct effect towards seed yield except trifoliage leaves (-0.266), 100-seed weight (-0.257) and fodder weight (-0.135). The dry matter per plant had the highest positive direct effect (0.644) followed by plant height (0.375), pod length (0.363), number of primary branches (0.050), number of seeds per pods (0.021) and reproductive period (0.060). Thus, the selection pressure on these traits may lead to an overall increase in seed yield. These results are in greement with earlier reported by Ram and Singh (3), Sawant (4) and Bhopal Singh (5) for majority of the characters. Trifoliage leaves (-0.266) and 100-seed weight (-0.266)

Table 1. Correlation coefficient among yield and its ten contributing characters in cowpea.

Characters	Y	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉
X ₁	0.785									
X ₂	0.193	0.478								
X ₃	0.817	0.117	0.593							
X ₄	0.871	0.395	0.686	0.892						
X ₅	0.838	0.226	0.767	0.789	0.829					
X ₆	0.841	0.024	0.667	0.748	0.692	0.715				
X ₇	0.888	0.384	0.712	0.798	0.890	0.742	0.788			
X ₈	0.538	0.169	0.358	0.808	0.758	0.560	0.622	0.640		
X ₉	0.805	0.511	0.877	0.773	0.855	0.821	0.660	0.825	0.634	
X ₁₀	-0.020	-0.162	-0.051	-0.028	-0.056	-0.014	-0.002	-0.012	0.278	0.013

Legend : All estimates are significant at 5% level
 X₁: Plant height in cm
 X₂: Number of trifoliage leaves per plant
 X₃: Number of primary branches per plant
 X₄: Dry matter gm per plant
 X₅: Number of pods per plant

X₆: Number of seeds per pod
 X₇: Pod length
 X₈: 100-seed weight (test weight) g
 X₉: Fodder yield g/plant
 X₁₀: Reproductive period
 Y: Seed yield g/plant

Table 2. Regression coefficient, their standard error and coefficient of determination (R²).

Characters	Regression coefficient	standard error	t' value	R ² per cent
x ₁	0.1236	0.0383	3.23	
X ₂	0.1313	0.0448	2.93	
X ₃	0.0626	0.2065	0.30	
X ₄	0.3404*	0.1004	3.39	
x ₅	0.0040	0.0484'	0.08	
X ₆	0.0463	0.2494	0.19	94.41
X ₇	0.8245	0.3133	2.63	
x ₈	-0.0137	0.0062	-2.20	
X ₉	-0.0658	0.0806	-0.82	
X ₁₀	0.0611	0.0594	1.03	

showed highest negative direct effect followed by fodder yield (-0.135). The path analysis also revealed a low residual effect of (0.236) which indicated the adequacy of the characters chosen for the study.

The results thus lead to the conclusion that plant height (X₂), number of primary branches per plant (X₃), dry matter weight (X₄), number of pods per plant (X₅), number of seeds per pod (X₆) and pod length (X₇) had positive direct effects as well as high significant positive association with seed yield per plant are the most influential characters towards seed yield. Hence, it would be rewarding to pay emphasis on these traits in selection programme for improving seed yield of cowpea.

Table 3. Direct and Indirect effects for ten contributing characters

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	Correlation with seed yield
X_1	-0.127	0.375	0.030	0.442	0.014	0.007	0.258	-0.092	-0.012	-0.003	0.785
X_2	-0.266	0.179	0.006	0.254	0.002	0.001	0.139	-0.043	-0.069	-0.010	0.193
X_3	-0.031	0.222	0.050	0.575	0.007	0.016	0.290	-0.207	-0.105	0.002	0.817
X_4	-0.105	0.257	0.044	0.644	0.008	0.015	0.323	-0.195	-0.116	-0.003	0.871
X_5	-0.060	0.287	0.039	0.534	0.009	0.015	0.269	-0.144	-0.111	-0.001	0.838
X_6	-0.006	0.250	0.037	0.445	0.007	0.021	0.285	-0.108	-0.089	0.000	0.841
X_7	-0.102	0.267	0.040	0.573	0.007	0.017	0.363	-0.164	-0.112	0.001	0.888
X_8	-0.045	0.134	0.040	0.488	0.005	0.009	0.232	-0.257	-0.086	0.017	0.538
X_9	-0.136	0.328	0.039	0.551	0.008	0.014	0.299	-0.163	-0.135	0.001	0.805
X_{10}	0.043	-0.019	0.001	-0.036	0.001	0.000	0.004	-0.071	-0.002	0.060	-0.020

 $R^2 = 94.41$

Residual effect = 0.236

References

1. **Montgomery, D.C. and Peck, E.A.** 1982. Introduction to linear regression analysis. John Wiley and Sons, New York.
2. **Dewey, D. R and Lu, K.H.** 1959. A correlation and path analysis of components of crested wheat grass seed production. *Agronomy J.* **51** : 515-518.
3. **Ram, D. and Singh, K.P.** 1996. Correlation and path coefficient analysis of certain morphological characters in cowpea. *Haryana J. Hort. Sci.* **25**: 148-152.
4. **Sawant, D. S.** 1994. Association and path analysis in cowpea. *Annals of Agri. Res.* **15** : 134-139.
5. **Bhopal Singh, Bagade, A.B., Patel, D.U. and Naik, M.R.** 2004. Correlation and path analysis in cowpea. *Indian J. Pulses Res.* **17**: 84-85.

Effect of row spacing and fertilization on growth and yield of clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] under rainfed conditions

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Abstract

A field experiment was conducted at Main Pulses Research Station, Gujarat Agricultural University, Sardarkrushinagar during rainy seasons of 2000 to 2002 on effect of row spacings (30, 45 and 60 cm) and fertilization (15 N + 30 P₂O₅, 20 N + 40 P₂O₅, 25 N + 50 P₂O₅ kg/ha and control) on growth and yield of clusterbean. Results revealed that significantly highest seed yield (496 kg/ha) was obtained when clusterbean was sown at 60 cm row spacing and it was 28 and 13 per cent higher over 30 cm and 45 cm row spacings respectively. Application of 25 N + 50 P₂O₅ kg per ha recorded significantly higher seed (518 kg/ha) and straw (1233 kg/ha) yields because of significantly higher values of number of pods per plant, number of seeds per pod, 100-seed weight, number of branches per plant and plant height.

Keywords : clusterbean, row spacing, fertilization.

Introduction

Clusterbean [*Cyamopsis tetragonoloba* (L.)Taub.] occupies an important place in the national economy, especially, among dryland crops grown in the arid and semi-arid regions of the country. Despite its diversified uses as industrial crop, very little research efforts have so far been made on the agronomic aspects influencing its growth and yield. It is grown as feed, fodder green manuring and vegetable. Atwal and Sidhu (1) reported that application of nitrogen in small doses improved nodulation, growth and nitrogen fixation in clusterbean. It has been reported by Malik (2) that application of phosphorus enhances the growth and yield of clusterbean. Row spacing is an important non-monetary factor influencing yield. As there is paucity of information on the effect of row spacing and fertilization on clusterbean in North Gujarat, the present study was conducted.

Material and methods

The field experiment was conducted during *kharif* sea-son from 2000 to 2002 at Main Pulses Research Station, Gujarat Agricultural University, Sardarkrushinagar on sandy loam soil having 0.29% organic carbon, 42 kg/ha available phosphorus, 291 kg/ha available potassium and 7.1 pH. Treatments included three row spacings (30, 45 and 60 cm) as main plot and four doses of fertilizers (15 N + 30 P₂O₅,

20 N + 40 P₂O₅ and 25 N + 50 P₂O₅ kg/ha and control) as sub-plot in a split plot design with four replications. All the requisite quantity of N and P were applied as basal on 18th, 5th and 1st July in 2000, 2001 and 2002 at the time of sowing, respectively. The clusterbean variety Gujarat Guar-1 was used in the study. A common seed rate of 15 kg/ha was used. The rainfall received during crop seasons was 398.6 mm in 13 rainy days during 2000, 570.7 mm in 30 rainy days during 2001 and 206.5 mm in 16 rainy days during 2002. Other agronomic practices were carried out as and when required as per the recommendation.

Results and discussion

Effect of row spacing

Seed yield of clusterbean (Table. 1) was significantly influenced by different row spacing during 2001, 2002 and in pooled but was non significant during 2000. With increase in row spacing, the seed yield of clusterbean significantly increased during 2001, 2002 and in pooled data. The crop sown at 60 cm row spacing produced significantly higher seed yield than that sown at 30 cm during 2001 and 2002 but was at par with 45 cm row spacing during 2002. In pooled analysis, 60 cm row spacing recorded significantly highest seed yield while significantly lowest seed yield was recorded when crop sown at 30 cm. Intermediate response with respect to seed yield was observed when the crop was sown at 45 cm row spacing.

The increase in seed yield with 60 cm row spacing was 28 and 13 per cent higher over 30 and 45 cm row spacings, respectively. The number of pods per plant and seeds per pod contributed towards the increase in seed yield. The yield attributes viz., pods per plant and seeds per pod were significantly higher when the crop was sown at 60 cm row spacing. However, 100-seed weight and number of branches per plant were not significantly influenced by different row spacings. Malik *et al.* (3) reported that branched variety clusterbean No. 2 performed better under wider row spacing of 60 cm than narrow row spacing of 20 cm but on the contrary better performance of clusterbean was reported at 30 cm row spacing by Kackar *et al.* (4) on light textured loamy sand soil of Bikaner.

As far as straw yield is concern, 30 cm row spacing produced significantly higher straw yield than that produced by 45 cm and 60 cm row spacings during 2001. During 2000, 2002 and in pooled data, it was not significant. Similar trend was observed in growth characters viz., number of branches per plant and plant height.

Effect of fertilization

Application of 25 N + 50 P₂O₅ kg/ha recorded significantly higher seed yield than application of 20N+40 P₂O₅ kg/ha and 15 N + 30 P₂O₅ kg/ha as well as no fertilization but was at par with 20 N + 40 P₂O₅ kg/ha during 2001 and 2002. In pooled data, all fertilization treatments differ significantly among themselves. Application of 25 N + 50 P₂O₅ kg/ha recorded significantly highest seed yield which was 44, 29 and 7 per cent higher over control, 15 N + 30 P₂O₅ kg/ha and 20 N + 40 P₂O₅ kg/ha, respectively. The improvement in seed yield could be attributed to the combined effect of significantly higher number of pods per plant, seeds per pod, 100-seed weight and number of branches per plant. Dahiya *et al.* (5) reported that application of fertilizer doses increased the seed yield of clusterbean under rainfed conditions.

Application of 25 N + 50 P₂O₅ kg/ha recorded significantly higher straw yield as compared to application of 15 N + 30 P₂O₅ kg/ha and without fertilization but was at par with 20 N + 40 P₂O₅ kg/ha during all individual years and in pooled data. Plant height was significantly higher with the application of 25 N + 50 P₂O₅ kg/ha which resulted in higher straw yield.

Table 1. Effect of different row spacings and fertilization on seed and straw yields, growth and yield attributing characters of clusterbean

Treatments	Seed yield(kg/ha)				Straw yield (kg/ha)				No. of pods per plant	Seeds per pod	100-seed weight (g)	No. of branches per plant	Plant height (cm)
	2000	2001	2002	pooled	2000	2001	2002	pooled					
Row spacing													
30 cm	495	376	288	387	1043	1530	746	1106	13.2	7.7	2.77	1.2	64.9
45 cm	544	397	383	441	1192	1343	720	1085	16.8	7.9	2.82	1.4	64.8
60 cm	559	517	410	496	1128	1296	654	1026	21.1	8.2	2.91	2.1	67.8
S. Em. ±	28	18	12	12	65	48	32	55	0.5	0.1	0.03	0.2	3.4
C.D.at 5%	NS	62	40	35	NS	166	NS	NS	1.4	0.3	NS	NS	NS
CV%	21.1	16.6	12.9	18.4	23.1	16.8	18.3	18.7	18.3	9.6	4.94	20.4	11.3
Fertilizer doses													
15 N + 30 P ₂ O ₅ kg/ha	481	409	316	402	979	1412	682	1024	15.3	7.7	2.79	1.3	65.8
20 N + 40 P ₂ O ₅ kg/ha	571	469	416	485	1242	1468	740	1150	17.9	8.1	2.87	1.7	66.4
25 N + 50 P ₂ O ₅ kg/ha	629	479	446	518	1310	1591	798	1233	20.1	8.4	2.99	1.9	69.9
Control	449	364	264	360	953	1088	607	883	14.8	7.6	2.69	1.3	61.3
S. Em±	20	18	10	9	40	62	23	51	0.6	0.1	0.02	0.1	0.9
C.D.at 5%	57	52	30	27	116	181	67	176	1.7	0.3	0.06	0.2	2.4
CV%	12.7	14.4	10.0	12.9	12.3	15.5	11.2	14.4	17.9	7.7	4.39	17.1	8.0
Interaction													
S. Em±	34	31	18	16	70	108	40	45	1.0	0.2	0.06	0.1	1.5
C.D.at 5%	NS												

The interaction effect between row spacing and fertilization was found non significant on seed yield.

The study indicated that clusterbean crop requires 60 cm row spacing with 25 N + 50 P₂O₅ kg/ha for improving its seed and straw yields as well as its growth and yield attributes under rainfed condition of North Gujarat.

References

1. **Atwal, A.S. and Sidhu, G.S.** 1964. Legume in the nitrogen economy of soil. Fixation and excretion of nitrogen by Indian legumes under controlled conditions in sand culture. *Indian J. Agric., Sci.* **34**:139-145.
2. **Malik, A.C.** 1978. Effect of levels of phosphorus and spacing on growth, yield and gum production of clusterbean varieties. M.Sc. (Agri.) Thesis. Haryana Agricultural University, Hissar.
3. **Mallik, A.C., Dahliya, D.R., Singh, D.P. and Malik, D.S.** 1981. Yield and quality of two clusterbean cultivars as influenced by inter row spacings and phosphorus application. *Haryana Agric. Uni. J. Res.* **10** : 198-201.
4. **Kackar, N.L., Daulay, H.S. and Singh, P.P.** 1984. Effect of inter and intra row spacings on grain yield of rainfed clusterbean. *Annals of Arid Zone* **23** : 1-5.
5. **Dahliya, S.S., Hooda, I.S., Gupta, S.C., Faroda, A.S. and Mundra, M.C.** 1996. Response of economics of fertilizer application in clusterbean under rainfed conditions. *Indian J. Pulses Res.* **9** : 31-33.

Productivity of greengram based relay cropping system in dryland agriculture

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Abstract

A field experiment was conducted during *Kharif* season of 1997 to 1999 on loamy sand soil at Gujarat Agricultural University, Sardarkrushinagar to explore the possibility of relay cropping in greengram with castor sown as a relay crop in greengram with different row ratios and both crops sown as sole crops. Greengram sown at onset of monsoon and castor taken as a relay crop in greengram in 2:1 rows ratio gave higher greengram equivalent yield, gross returns and land equivalent ratio, while these parameters were minimum in case of sole cropping of greengram and castor.

Key words: Relay cropping, land equivalent ratio, equivalent yield, monetary returns, dryland agriculture.

Introduction

The beneficial effects of intercropping in increasing and stabilizing the returns per unit area are well known Rahman *et al.* (1). In this region, major crops are taken as sole crop or mix crop. The yields from these cropping systems are low due to aberrant weather condition and erratic and uneven distribution of rainfall. As there is hardly any scope for increasing the area under cultivation, it is advisable to adopt relay/inter cropping systems. Greengram being a short duration crop, after harvest of the crop, land is practically left fallow and late season moisture/rainfall can not be properly used. To study the feasibility of growing castor as a relay crop in greengram for efficient utilization of moisture and land and to generate some additional return from the same unit area of land under dryland agriculture, the present experiment was conducted.

Material and methods

A field experiment was conducted during *Kharif* season of 1997 to 1999 at Regional Research Station, Gujarat Agricultural University, Sardarkrushinagar. The soil of the experimental plot was loamy sand in texture having low organic carbon. The experiment was laid out in randomized block design with six treatments viz., greengram sole at 45 x 10 cm, castor sole at 90 x 60 cm under normal

sowing, castor sole at 90 x 60 cm under late sown condition, castor as a relay crop in greengram in 2:1, 3:1 and 4:1 row ratios with four replications. Castor was taken as a relay crop in greengram before one month of harvest of greengram depending upon availability of soil moisture. Greengram variety K-851 and castor GCH-4 were used for sowing. The rainfall received during cropping seasons were 800.3, 692.5 and 224.8 mm during 1997, 1998 and 1999, respectively. Greengram equivalent yield and benefit: cost ratio were worked out on the basis of prevailing market prices. Land equivalent ration (LER) was worked out with the help of formulae suggested by Rahman *et al.* (1).

Results and discussion

Greengram equivalent yield

The greengram equivalent yield differed significantly with different relay cropping system in pooled results (Table 1). In terms of greengram equivalent yield, significantly higher greengram equivalent yield (1166 kg ha⁻¹) was obtained with castor as relay crop in greengram in ratio of 2:1. It was statistically at par with castor as relay crop in greengram in the 3:1 and 4:1 row ratios. The lowest greengram equivalent yield (643 kg ha⁻¹) was recorded with castor sown as a sole crop under late sown condition. Yield advantage ranging from 240 to 366 kg ha⁻¹ was observed by adopting relay cropping system over sole crop of

Table 1. Greengram equivalent yield of different treatments

Cropping system	Greengram equivalent yield kg ha ⁻¹				Yield advantage over sole crop of greengram
	1997-98	1998-99	1999-2000	Pooled	
T ₁	430	1157	812	800	
T ₂	868	1434	989	1097	+297
T ₃	756	596	577	643	-157
T ₄	949	1496	1052	1165	+365
T ₅	774	1414	918	1035	+235
T ₆	794	1377	949	1040	+240
CD at 5%	175	150	109	225	

green gram. On the basis of the study, it was emphasized that an additional production of castor can be realized through relay cropping. This might be due to no competition of moisture between two crops with the relay cropping system. These results are in conformity with Yadavandra *et al.* (2) and Reddy and Jagannadham (3).

Land equivalent ratio

The planting of castor as a relay crop in greengram in 2:1, 3:1 and 4:1 row ratios recorded the higher LER ranging from 1.46 to 1.65 as compared to sole cropping system. This suggest that planting pattern was more efficient utilizing natural resources over sole cropping resulting in higher production per unit area.

Economics

The economics of different treatments presented in Table 2 revealed that the highest cost of cultivation was incurred with relay cropping system followed by sole crop of castor and greengram owing to higher input due to double cropping system. The higher gross

Table 2. Monetary returns and land equivalent ratio of different treatments. (3 years pooled data)

Cropping system	Greengram equivalent yield kg ha ⁻¹	Monetary returns Rs. ha ⁻¹	LER
T ₁	800	13600	1.00
T ₂	1097	18649	1.00
T ₃	643	10931	1.00
T ₄	1166	19822	1.65
T ₅	1035	17599	1.46
T ₆	1040	17680	1.47
CD at 5%	225	4521	

returns was recorded with relay cropping of castor in greengram in 2:1 ratio (Rs. 19822 ha⁻¹) followed by castor sown as a sole crop under timely sown condition (Rs.18649 ha⁻¹). The lowest gross returns was obtained with castor sown as a sole crop under late sown condition (Rs.10931 ha⁻¹).

References

1. Rahman, A., Sinha, K.P., Singh, Y.P, Ratey, A., Bhagat, A.K. and Singh, R.K. 1982. Effect of intercropping pulses, oilseeds and tuber crops in maize on yield and net return. *Indian J. Agron.* 27:1-6
2. Yadavendra, J.P., Patel, A.R. and Shah, R.M. 1989. Relay inter cropping of pigeonpea in spreading groundnut. *Legume Res.* 12:123-124.
3. Reddy, G.K. and Jagannadham, A.1996. Production potential of groundnut based relay cropping systems in dryland agriculture. *J.of Maharashtra Agri. Uni.* 21:311 -312

Response of potato varieties to irrigation and nitrogen levels on graded tuber yield

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Abstract

Field trials were conducted during *rabi* season of 1994 and 1995 at Regional Research Station, Sardarkrushinagar to determine the yield response of potato varieties (*Kufri Badshah* and IPS C-3) to nitrogen levels (180, 220 and 260 kg/ha) and irrigation levels (1.0, 1.25, 1.50 and 1.75 IW/CPE ratio). The results showed that variety *Kufri Badshah* recorded significant increase in tuber yield upto 260 kg/ha, while TSP-3 increased only upto 220 kg/ha. The tuber yield of potato increased significantly upto irrigation at 1.50 IW/CPE ratio.

Keywords : Potato, irrigation, nitrogen levels

Introduction

Potato (*Solanum tuberosum* L) is grown in North Gujarat during *rabi* season under assured irrigation. The potato has sparse and shallow root system and nearly 70 per cent of the total water used by the crop is from the upper 30 cm soil layer. To obtain potential yield, the total available soil moisture should not be depleted by more than 30 to 50 per cent. Potato grown under irrigated conditions responded well to nitrogen. As the potato crop has to buildup large reserve food in short time, the nitrogen requirement is also high. Therefore present study was undertaken to investigate the irrigation water and nitrogen requirements of two potato varieties.

Material and methods

Field experiments were conducted during *rabi* seasons of 1994 and 1995 on loamy sand soil at Regional Research Station, Gujarat Agricultural University, Sardarkrushmagar. The treatments included four levels of irrigation based on IW/CPE ratio of 1.0, 1.25, 1.50 and 1.75 related to main plots and six treatment combinations of varieties (*Kufri Badshah* and TPS C-3) and nitrogen levels (180, 220 and 260 kg/ha) were assigned at random to subplots in split plot design with four replications. The recommended dose of P_2O_5 (110 kg/ha) and K_2O (220 kg/ha) were applied to all the plots at the time of planting. The half

dose of nitrogen was applied as basal in the form of ammonium sulphate, while remaining dose of nitrogen was applied in the form of urea after 30 DAP as per treatments. The irrigation levels were superimposed after complete crop emergence. *Kufri Badshah* was raised from cutting of seed tuber while TPS C-3 was raised from tuberlets in which whole tubers were used as planting material. The recommended package of practices were followed during the course of experiments. The produce of each plot was graded into different grades i.e. large (above 75 g), medium (25-75 g) and small (below 25 g) size and weighed separately.

Results and discussion

Varietal difference existed in the yielding ability of potato tubers (Table-1). *Kufri Badshah* recorded significantly higher total tuber yield (219.10 q/ha) as compared to TPS C-3 (208.38 q/ha) during both years as well as in pooled results. The increase in tuber yield of *Kufri Badshah* over TPS C-3 was observed by 13.79 q/ha more on pooled basis. The varieties also exhibited differences in the yield of different grades of potato tubers. The higher portion of small and medium size tubers was observed in TPS C-3 as compared to *Kufri Badshah*. While, higher proportion of large size tuber yield was produced under *Kufri Badshah* than TPS C-3. The higher total tuber yield recorded with *Kufri Badshah* might be due to its higher

yielding ability of tuber than TPS C-3 as a result of better extracting ability of nutrients and water from the soil. Similar results were recorded by Khurana and Bhatia (1) and Nandekar (2).

Tuber yield of potato was significantly influenced by irrigation. Total tuber yield increased significantly with increase in irrigation level up to 1.5 IW/CPE ratio during both the years as well as in pooled results (Table 1). It shows that irrigation at 1.75 IW/CPE ratio did not show perceptible change in the tuber yield. Adequate supply of irrigation water at higher level of irrigation maintained proper soil moisture condition, right from the time of tuber initiation, almost to the tuber gets matured, resulted in higher total tuber yield. Samudar Dan and Thind (3) and Chandra and Bhatnagar (4) observed similar results.

Irrigation scheduled at lower level produced higher portion of medium size tuber yield. Higher portion of large size tuber recorded at higher level of irrigation as it maintains proper soil moisture condition for developing the tubers. These findings are in accordance with Khalak and Kumaraswamy (5)

Application of nitrogen increased tuber yield significantly with each increase in the level of nitrogen during both the years and in pooled results. Significantly highest (232.43 kg/ha) total tuber yield recorded with 260 kg N/ha. Low status of nitrogen in the soil of experimental site cause greater response of potato at higher level of nitrogen as it is an essential constituent of divers type of metabolically active compound, without which the plant can not attain growth and development. Trehan and Grewal (6) and Shanmugusundaram and Sayitri (7) also reported higher yield with higher level of nitrogen application. The maximum proportion of small tubers was recorded with 180 kg N/ha while more or less equal proportion of medium and large size tuber obtained under 220 and 260 kg N/ha application. These results were substantiated by Gupta (8).

Kufri Badshah produced significantly higher large and medium size tuber yield at 260 kg N/ha than 220 and 180 kg N/ha TPS C-3 recorded higher small tuber yields at all the levefof nitrogen (Table 2). Total tuber yield increased significantly upto 260 kg N/ha in Kufri Badshah while that of only upto 220 kg N/ha in TPS C-3 due to its genetic make up in responding to fertilizer application. Similar type of positive interaction between variety and nitrogen was also reported by Kushwah et al. (9).

Table 1. Effect of irrigation and nitrogen levels on graded tuber yield of potato cultivars

Treatments	Tuber grades (q/ha)											
	Large size			Medium size			Small size			Total		
	1994-95	1995-96	Pooled	1994-95	1995-96	Pooled	1994-95	1995-96	Pooled	1994-95	1995-96	Pooled
IW:CPE ratio												
1.00	60.14	49.80	54.97	113.94	92.66	103.30	24.81	23.59	24.19	198.44	164.48	181.44
1.25	66.27	61.38	63.82	120.05	103.14	111.59	30.08	26.98	28.53	213.95	191.20	202.57
1.50	81.83	71.46	76.65	127.79	118.26	123.02	30.80	29.38	30.09	240.41	219.15	229.88
1.75	86.45	77.17	81.81	128.46	117.04	122.75	32.20	28.95	30.58	243.19	223.13	233.16
CD 5 %	5.93	7.68	4.51	7.75	13.54	7.25	2.50	3.03	1.82	12.27	23.33	12.12
Varieties												
Kufri Basshah	83.87	75.54	79.71	119.55	107.63	113.59	27.33	25.52	26.42	229.43	208.78	219.10
TPS C-3	63.46	54.37	58.92	125.56	107.92	116.74	31.60	28.93	30.27	218.55	198.20	208.38
CD 5 %	3.11	3.35	2.26	5.13	NS	NS	1.85	0.92	1.02	8.74	6.86	6.73
Nitrogen Levels												
180 kg/ha	65.78	58.41	62.11	108.85	95.14	102.00	27.54	24.42	25.98	199.73	176.58	188.16
220kg/ha	73.75	65.25	69.50	126.50	108.65	117.57	29.01	28.61	28.81	226.92	202.36	214.64
260kg/ha	81.48	71.19	76.34	132.33	119.51	125.94	31.86	28.64	30.25	245.33	219.53	232.43
CD 5 %	3.81	4.10	2.77	6.29	4.65	3.87	2.28	1.12	1.25	10.70	8.40	5.50

Table 2. Interaction effect of varieties, nitrogen and irrigation on tuber grades

Treatments	Nitrogen levels (kg/ha)			Irrigation levels (IW/CPE ratio)			
	180	220	260	1.00	1.25	1.50	1.75
Large size tuber yield							
K. Badshah	69.33	79.15	90.53	62.57	73.63	89.39	93.24
TPS C-3	54.81	59.85	62.08	47.37	51.01	63.90	70.37
CD (0.05)		3.92			4.52		
Medium size tuber yield							
K. Badshah	96.29	115.50	128.98	104.29	112.54	119.09	118.45
TPS C-3	107.70	119.64	122.89	102.31	110.65	125.96	127.05
CD (0.05)		5.98			6.32		
Small size tuber yield							
K. Badshah	24.46	26.19	28.62	22.44	26.59	22.57	29.11
TPS C-3	27.50	31.43	31.88	25.96	30.47	32.60	32.04
CD (0.05)		NS			NS		
Total tuber yield							
K. Badshah	188.90	220.44	246.99	183.30	212.76	236.05	240.80
TPS C-3	188.07	210.93	214.77	175.64	192.13	222.47	229.46
CD (0.05)		9.52			NS		

Table 3. Interaction effect of irrigation and nitrogen on tuber grades

Nitrogen levels (kg/ha)	Irrigation levels (IW/CPE ratio)			
	1.00	1.25	1.50	1.75
Large size tuber yield (q/ha)				
180	54.69	57.42	64.81	71.49
220	53.75	66.00	76.30	81.96
260	56.49	68.05	88.84	91.97
CD (0.05)		5.54		
Medium size tuber yield (q/ha)				
180	86.41	96.18	113.72	111.67
220	107.62	114.53	124.32	123.80
260	115.85	124.07	131.02	132.78
CD (0.05)		NS		
Small size tuber yield (q/ha)				
180	20.96	25.48	27.56	29.92
220	24.58	29.17	31.21	30.28
260	27.06	30.94	31.49	31.52
CD (0.05)		NS		

Significantly higher yield of large tuber was observed in *Kufri Badshah* at all the levels of irrigation whereas medium tuber yield was recorded in TPS C-3 at 1.50 and 1.75 IW/CPE ratio (Table 2). It might be due to the size of the tubers produced under varieties is governed by variability. No significant difference was observed due to interaction effect of irrigation and variety in producing small tuber and total tuber yield.

Application of 260 kg N/ha at irrigation level 1.50 and 1.75 IW/CPE ratios recorded significantly the highest large size tuber yield than rest of the combinations except 220 kg N/ha applied with 1.75 IW/CPE ratio (Table 3). Under adequate soil moisture condition, efficiency of applied nitrogenous fertilizer might have increased, which result into higher production of large size tuber yield. Though, no interaction effect was observed due to irrigation and nitrogen with respect to medium and small size tuber yield.

References

1. **Khurana, S. C. and Bhatia, A. G.** 1994. Performance of TPS families at Hissar. *J. Indian Potato Assoc.* **21** : 243-246.
2. **Nandekar, D. N.; Sharma, R. C. and Dubey, K. C.** 1995. Yield performance and economics of potato production through TPS. *J. Indian Potato Assoc.* **22** : 23-25.
3. **Samudar Dan and Thind S. S.** 2005. Role of FYM, potassium and irrigation levels on potato tuber quality in Typic ustipsments soil. *Potato J.* **32** : 85-88.
4. **Chandra, S. and Bhatnagar, V. K.** 1996. Effect on irrigation on spring potato. *Indian J. Agric. Sci.* **66** : 485-486.
5. **Khalak, A. and Kumaraswamy, A. S.** 1993. Weed bio-mass in relation to irrigation and mulching and economics of mulching potato crop under conditions of acute water scarcity. *J. Indian Potato Assoc.* **20** : 185-189.
6. **Trehan, S. P. and Grewal, J. S.** 1995. Response of promising potato hybrid J. H. 222 to NPK fertilizers. *Indian J. Agric. Res.* **29** : 103-108.
7. **Shanmugasundaram R. and Savitri P.** 2000. Effect of various N levels with organic and amendments on N content, uptake, on yield of potato in western ghats of TN. *Indian Potato Assoc.* **27** : 127-131.
8. **Gupta, A.** 1992. Response of potato to nitrogen and phosphorus fertilization. *Indian J. Agron.* **31** : 309-311.
9. **Kushwah, V. S.; Singh, K. and Grewal, J. S.** 1989. Response of potato varieties to nitrogen in alluvial soil of Patna. *J. Indian Potato Assoc.* **16** : 77-80.

Yield and quality of potato (*Solanum tuberosum* L.) as influenced by different organic manures, inorganic fertilizers and fertilizer sources in a potato pearlmillet cropping system

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Abstract

A field experiment was conducted during 2002-03 and 2003-04 to evaluate the effect of different organic manures, inorganic fertilizers and fertilizer sources on potato (*Solanum tuberosum* L.). Twenty four treatment combinations comprised of four treatments of organic manures viz., FYM, Biogas slurry, Nadeb compost and no organic manure, three levels of inorganic fertilizers viz., 125, 100 and 75 per cent of RDF and two fertilizer sources viz., sulphur containing fertilizers and sulphur free fertilizers were studied in split split plot design with four replications keeping organic manures in main plots, inorganic fertilizers in sub plots and sources in sub sub plots. Among the organic manures, FYM @ 25 t ha⁻¹ produced 4.9, 10.0 and 41.3 per cent higher tuber yield over application of BGS @ 12.5 t ha⁻¹, NC 12.5 t ha⁻¹ and no organic manure, respectively. Application of 125 per cent of RDF significantly increased the total tuber yield to the tune of 26.49 and 72.00 per cent over 100 and 75 per cent of RDF, respectively. Sulphur containing fertilizers had their significant influence on tuber yield. Integrated use of FYM @ 25 t ha⁻¹ + 125 per cent of RDF (220:110:220 kg NPK ha⁻¹) through sulphur containing fertilizers produced significantly the maximum values of yield attributes, total tubers yield and protein content of potato and also secured maximum net realization of Rs.1,24, 715 ha⁻¹ with 2.86 BCR.

Keywords : Potato, tuber yield, organic manures, inorganic fertilizers, sulphur.

Introduction

Potato responds extremely well to the application of both organic manures and inorganic fertilizers. Normally recommended rates of inorganic fertilizers are sub-optimal in intensive cropping system and also in case of potato. Among the major nutrients, sulphur is now recognized as fourth major plant nutrient. (1), which is essential for growth and development of the plant. Deficiency of sulphur in soils and plants are becoming increasingly important and has been reported from 130 districts of India including Banaskantha district of Gujarat (2). Sulphur is, therefore, now very much a part of balanced fertilization. Because of sulphur deficient areas; applying pure inorganic fertilizers only can not ensure high yields unless sulphur is applied. In Banaskantha district (Gujarat), dynamic cultivation of potato-pearl millet crop sequence is pre-dominantly observed. Keeping in view, the declining yields, soil degradation and quality awareness of consumers, this investigation was undertaken to study the effect of

organic manures, inorganic fertilizer and fertilizers' sources on growth, yield and quality of potato in a potato-pearlmillet cropping system.

Material and methods

A field experiment was conducted on a loamy sand soil at the Demonstration Farm of Krishi Vigyan Kendra, Gujarat Agricultural University, Deesa (24° 14' North latitude and 72° 12' East Longitude with an elevation of 136.4 metres above the mean sea level) during 2002-03 and 2003-04. The soil was slightly alkaline in reaction (pH 8.2) having 0.33 per cent organic matter and 192, 26.7 and 453 kg ha⁻¹ available nitrogen, phosphorus and potash, respectively. Twenty four treatment combinations comprised of four treatments of organic manures viz., FYM @ 25 t ha⁻¹, Biogas slurry @ 12.5 t ha⁻¹, Nadeb compost @ 12.5 t ha⁻¹ and no organic manure; three treatments of inorganic fertilizers viz., 125 per cent, 100 per cent and 75 per cent of RDF (110:220 kg NP ha⁻¹) and two treatments of fertilizers' sources viz., sulphur

containing fertilizers and sulphur free fertilizers were tested in split split plot design with four replications, keeping organic manures in main plots, inorganic fertilizer in sub plots and sources of fertilizers in sub sub plots. Potash was applied as a common source (275 kg/ha) from muriate of potash. Potato 'Kufri Badshah' was sown on 21st and 17th November in the respective years.

Results and discussion

Yield and yield attributes

Application of organic manures showed significant variation in total tubers yield (Table 2). Application of organic manures viz., FYM, BGS and Nadep compost enhanced the tuber yield significantly over no organic manures. Among the organic manures, FYM @ 25 t ha⁻¹ produced 4.9, 10.0 and 41.3 per cent higher tuber yield over application of BGS @ 12.5 t ha⁻¹, NC 12.5 t ha⁻¹ and no organic manure,

respectively. This increase in yield could be attributed to the yield contributing parameters viz., number of tubers per plant, tuber yield per plant and size of tubers (Table 1). All yield attributing parameters showed remarkable increase with the application of FYM @ 25 t ha⁻¹ than other organic manurial treatments. This might be due to improvement in the physical, chemical and biological properties of soil with the addition of organic manures. Mondal *et al.* (3) also reported that FYM increases fertilizer use efficiency of the added nutrients to a considerable extent. These results are also in agreement with those reported by Krishnamurthy *et al.* (4).

Increasing rates of inorganic fertilizers remarkably influenced the total tuber yield (Table 2). Application of 125 per cent of RDF significantly increased the total tubers yield to the tune of 26.49 and 72.00 per cent over 100 and 75 per cent of RDF. This increase in yield is due to increase in different yield attributes viz.,

Table 1. Quality and yield attributes of potato as influenced by different organic manures, inorganic fertilizers and fertilizers sources

Treatment	Yield attributes (mean of two years)					Protein content (per cent) (on dry wt. basis)
	Number of tubers per plant	Tubers yield (g) per plant	Gradewise tubers yield (q ha ⁻¹)			
			'A' grade	'B' grade	'C' grade	
Organic manures						
M ₁ (FYM @ 25 t ha ⁻¹)	4.84	337.31	93.00	126.20	26.46	10.47
M ₂ (Biogas slurry@ 12.5 t ha ⁻¹)	4.68	326.42	87.71	121.46	25.08	10.16
M ₃ (Nadep compost@ 12.5 t ha ⁻¹)	4.59	318.85	82.46	117.27	23.74	10.09
M ₄ (No organic manure)	4.03	263.17	58.89	96.40	18.23	9.69
S.Em ±	0.09	3.69	1.42	1.38	1.08	0.05
C.D. at 5 per cent	0.39	10.96	4.21	4.09	4.85	0.15
C.V. per cent	5.36	8.21	12.20	8.26	8.06	3.38
Inorganic fertilizers						
D ₁ (125 per cent of RDF)	5.03	366.84	107.29	139.55	30.53	10.78
D ₂ (100 per cent of RDF)	4.52	310.95	81.02	115.62	22.68	10.22
D ₃ (75 per cent of RDF)	4.05	256.52	53.23	90.82	16.92	9.31
S.Em ±	0.03	2.75	1.50	4.40	2.30	0.04
C.D. at 5 per cent	0.09	7.62	4.16	26.78	NS	0.12
C.V. per cent	5.55	7.06	14.89	9.19	9.14	3.56
Sources of fertilizers						
S ₁ (Sulphur containing)	4.65	325.02	87.27	121.81	25.20	10.14
S ₂ (Sulphur free)	4.41	297.85	73.76	108.85	21.56	10.07
S.E.m ±	0.03	1.24	0.73	3.67	0.67	0.03
C.D. at 5 per cent	0.07	3.44	2.01	NS	NS	NS
C.V. per cent	5.34	3.90	8.83	6.14	7.07	2.76

number of tubers per plant, tubers yield per plant and size of tuber (A and B grade) with the application of 125 per cent of RDF. This increase in yield may be due to better assimilation of carbohydrates and their translocation to the tubers, which ultimately helped in the enlargement of tuber size and weight of tuber as reported by Singh *et al.* (5). Higher dose of nutrient application enhances the uptake of nutrients which ultimately results in higher tuber yield as reported by Mondal *et al.* (3). These results are also concomitant to those reported by Singh *et al.* (6).

Sulphur containing fertilizers significantly increased the total tuber yield (Table 2). All yield attributing parameters except 'B' and 'C' grade tubers, yield increased significantly with sulphur containing fertilizers over sulphur free fertilizers. It might be due to sulphur, the fourth major nutrient, which increases root growth (7) and ultimately increasing tuberization.

Sulphur involves in the formation of chlorophyll that enhances photosynthesis. Thus, more photosynthates translocate towards potato tubers and consequently increase the tubers yield. These results are in line with the findings of Cheltri and Thapa (8).

Protein content

Application of organic manures viz., FYM, BGS and Nadep compost had significant effect on protein content over no application of organic manure (Table 1). Among organic manures, FYM @ 25 t ha⁻¹ increased protein content to the tune of 3.0, 3.08 and 8.0 per cent over BGS @ 12.5 t ha⁻¹, NC @ 12.5 t ha⁻¹ and without organic manure, respectively. Organic manures helped in producing hormones and vitamins like substances, which have beneficial effects on the quality of potato tubers (9). These results are in line with those reported by Hassandokht and Kashi (10).

Table 2. Yield and economics of potato as influenced by different organic manures, inorganic fertilizers and fertilizers sources

Treatment	Total tubers yield (q ha ⁻¹)			Average cost (Rs.ha ⁻¹)	Net realization (Rs.ha ⁻¹)	Benefit : cost ratio
	2002-03	2003-04	Pooled			
Organic manures						
M ₁ (FYM @ 25 t ha ⁻¹)	213.40	277.98	245.66	62,228	79,044	2.27
M ₂ (Biogas slurry @ 12.5 t ha ⁻¹)	203.07	265.53	234.30	62,228	72,495	2.16
M ₃ (Nadep compost @ 12.5 t ha ⁻¹)	193.59	253.21	223.40	62,228	66,227	2.06
M ₄ (No organic manure)	144.30	203.43	173.87	55,811	44,164	1.79
S.E.m ±	3.04	3.34	2.26			
C.D. at 5 per cent	9.72	10.69	6.71			
C.V. per cent	7.90	6.55	7.14			
Inorganic fertilizers						
D ₁ (125 per cent of RDF)	245.08	309.66	277.37	62,824	96,664	2.54
D ₂ (100 per cent of RDF)	188.90	249.68	219.28	60,625	65,461	2.08
D ₃ (75 per cent of RDF)	131.79	190.78	161.29	58,976	33,766	1.57
S.E.m ±	2.89	3.04	2.10			
C.D. at 5 per cent	8.42	8.85	5.81			
C.V. per cent	8.67	6.88	7.65			
Sources of fertilizers						
S ₁ (Sulphur containing)	202.62	266.04	234.33	62,777	71,963	2.15
S ₂ (Sulphur free)	174.55	234.03	204.29	58,471	58,996	2.01
S.E.m ±	1.02	1.78	1.02			
C.D. at 5 per cent	2.84	4.92	2.84			
C.V. per cent	3.76	4.92	4.58			

Protein content in potato tubers increased significantly with 125 per cent of RDF over 100 and 75 per cent of RDF (Table 1). The magnitude of increase was to the tune of 7.4 and 15.8 per cent over 100 and 75 per cent of RDF. Nitrogen is an essential constituent of protein and chlorophyll (7). Hence, with increasing rates of RDF, the rate of nitrogen uptake was also increased which might be responsible for successive increase in protein content. These results are in conformity with those reported by Hassandokht and Kashi (10). Sources of fertilizers failed to exert their significant influence on protein content of potato.

Economics

From Table 2, it is seen that application of FYM secured maximum net realization of Rs. 79,044 ha⁻¹ with 2.27 BCR, followed by BGS @ 12.5 t ha⁻¹ (Rs. 72,495 ha⁻¹ and 2.16, respectively). In case of inorganic fertilizer, application of 125 % of RDF registered highest net realization of Rs. 96,664 ha⁻¹ with 2.54 BCR. In case of sources of fertilizer, sulphur-containing fertilizers recorded maximum net realization of Rs. 71,963 ha⁻¹ with 2.15 BCR. Looking to the integration, application of FYM @ 25 t ha⁻¹ + 125 % of RDF through sulphur containing fertilizer secured maximum net realization of Rs. 1,24,715 ha⁻¹ with 2.86 BCR (Table 3).

Table 3. Economics of different Treatment combinations for potato (on pooled data basis)

Treatment combinations	Mean Tubers yield (qha ⁻¹)	Gross realization (Rs. ha ⁻¹)	Cost of production (Rs. ha ⁻¹)	Net realization (Rs. ha ⁻¹)	Benefit : cost ratio
M ₁ D ₁ S ₁	333.62	1,91,832	67,117	1,24,715	2.86
M ₁ D ₁ S ₂	291.53	1,67,630	61,737	1,05,893	2.72
M ₁ D ₂ S ₁	260.69	1,49,897	64,380	85,517	2.33
M ₁ D ₂ S ₂	228.16	1,31,192	60,076	71,116	2.18
M ₁ D ₃ S ₁	196.06	1,12,735	61,643	51,092	1.83
M ₁ D ₃ S ₂	164.06	94,335	58,415	35,920	1.61
M ₂ D ₁ S ₂	315.81	1,81,591	67,117	1,14,474	2.70
M ₂ D ₁ S ₂	279.81	1,60,891	61,737	99,154	2.61
M ₂ D ₂ S ₁	251.68	1,44,716	64,380	80,336	2.25
M ₂ D ₂ S ₂	218.84	1,25,833	60,076	65,757	2.09
M ₂ D ₃ S ₁	186.30	1,07,123	61,643	45,480	1.74
M ₂ D ₃ S ₂	153.37	88,188	58,415	29,773	1.51
M ₃ D ₁ S ₁	300.36	1,72,707	67,117	1,05,590	2.57
M ₃ D ₁ S ₂	263.04	1,51,248	61,737	89,511	2.45
M ₃ D ₂ S ₁	239.25	1,37,569	64,380	73,189	2.14
M ₃ D ₂ S ₂	212.37	1,22,113	60,076	62,037	2.03
M ₃ D ₃ S ₁	180.33	1,03,690	61,643	42,047	1.68
M ₃ D ₃ S ₂	145.05	83,404	58,415	24,989	1.43
M ₄ D ₁ S ₁	234.04	1,34,573	60,705	73,868	2.22
M ₄ D ₁ S ₂	200.74	1,15,426	55,325	60,101	2.09
M ₄ D ₂ S ₁	171.64	98,693	57,968	40,725	1.70
M ₄ D ₂ S ₂	171.66	98,705	53,664	45,041	1.84
M ₄ D ₃ S ₁	142.23	81,782	55,231	26,551	1.48
M ₄ D ₃ S ₂	122.88	70,656	51,973	18,683	1.36

Selling price of tubers: Rs. 5.5 kg⁻¹ during 2002-03, Rs. 6.0 kg⁻¹ during 2003-04

References

1. **Tandon, H.L.S. and Mssick, D.L.** 2002. Practical Sulphur Guide. Washington D C, USA. pp.1 -19.
2. **Tandon, H.L.S.** 1995. Sulphur deficiencies in soils and crops. Their significance and management. Sulphur fertilizers for Indian Agriculture. A Guide Book, pp.1.
3. **Mondal, S.S., Chettri M., Sarkar, S. and Mondal, T.K.** 1993. Integrated nutrient management with sulphur bearing fertilizer, FYM and crop residues in relation to growth and yield of potato. *J. of the Indian Potato Assoc.* **20** :139-143.
4. **Krishnamurthy, N., Pandey, S.K. and Singh, B.P.** 2002. Integrated nutrient supply and management for potato production in Alfisols. *Potato Global Research and Development* **2** :856.
5. **Singh, D., Singh J. and Verma, S.K.** 1997. Response of potato to N and K application under Faizabad Location. *J. of the Indian Potato Assoc.* **24**:40-43.
6. **Singh, S.K., Lal, S.S. and Dua, V.K.** 2005. Effect of integrated nutrient management on potato and its residual effect on succeeding moong crop. *Potato J.* **32**:243.
7. **Yawalkar, K.S., Agrawal, J.P. and Bokde, S.** 1981. General principles of plant nutrition. *Manures and Fertilizers* pp.1-26
8. **Chettri, M and Thapa, U.** 2002. Response of potato to different sources of potassium with or without farmyard manure in new alluvial zone of West Bengal. *Haryana J. of Horti. Sci.* **31** :253-255.
9. **Singh, S., Kumar, V. and Yadav, S.S.** 1988. Organic manure the only cure for better crop and soil health. *Farmer and Parliament* **23**:20-30.
10. **Hassandokht, M.R. and Kashi, A.** 2000. Effect of farmyard manure and nitrogen application on the quantity and quality of potato crop. *Seed and Plant.* **15**:323-330.

Scheduling of irrigation in okra under drip and surface irrigation system

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Abstract

A field experiment was carried out during 1998-99 and 1999-2000 at Plasticulture Development Centre, Regional research Station, S.D.Agricultural University, Sardarkrushinagar on loamy sand soil to study the scheduling of irrigation in okra (*Abelmoschus esculentus* (L) Moench) under drip and surface irrigation system. The experiment was laid out in randomized block design with four replications. Treatments consisted of four levels of drip (0.4, 0.6, 0.8 and 1.0 PEF) and four levels of surface irrigation method (0.4, 0.6, 0.8 and 1.0 IW/CPE ratio with 50 mm depth). Crop was sown in paired row system (30 cm between row, 60 cm between two paired rows and 25 cm within row) and lateral lines were laid out in middle of pair with 50 cm dripper distance, having 4 Lph dripper discharge. The results revealed that okra crop irrigated through drip at 1.0 PEF gave significantly higher fruit yield (8656 kg ha⁻¹) as compared to rest of the treatments, but it was at par with 0.8 PEF (8379 kg ha⁻¹). Application of irrigation at 0.4 PEF through drip recorded the lowest fruit yield (7216 kg ha⁻¹), however 55 per cent of water was saved, which helps to increase the additional area of 1.22 ha with Rs. 15104/- additional income than surface method and it was at par with surface irrigation method (1.0 IW/CPE 50 mm depth).

Keywords: Drip irrigation, surface method, water use efficiency, water saving, okra, fruit yield.

Introduction

Okra (*Abelmoschus esculentus* (L) Moench) is an important vegetable crop of North Gujarat. Weather condition, soil type, fertility levels, pre-cultivation status etc. influence the response of okra to water. The available moisture storage capacity of the soil of this region is very low and water is one of the critical inputs for the crop production. Hence, the conventional method of irrigation to crop is not efficient. Large quantity of water (50 to 60 %) is wasted through conveyance, evaporation, field application and distribution losses (1). Maximizing water use efficiency is of prime concern and drip irrigation can play a vital role to do so. Drip irrigation is an efficient method to increase crop yield (2,3). Limited scientific information is available on drip irrigation system in okra under this situation. Therefore, the present field experiment was carried out with a view to find out the most suitable and economical method of irrigation in okra.

Material and methods

The experiment was conducted during summer seasons of 1998-99 and 1999-2000 at Plasticulture

Development Centre, Regional Research Station, S.D.Agricultural University, Sardarkrushinagar on loamy sand soil with pH 7.8, organic carbon 0.22 %, available nitrogen 158 kg ha⁻¹, available phosphorus 49 kg ha⁻¹ and available potash 240 kg ha⁻¹. The soil had 85.2 % sand, 7.0% silt, 7.6 % clay, 8.94 % field capacity, 2.53 % permanent wilting point and 1.6 g/ cc bulk density.

Eight treatments comprised of two irrigation methods (drip and surface) and four levels of irrigation in each method (0.4, 0.6, 0.8 and 1.0 PEF on alternate day for drip and 0.4, 0.6, 0.8 and 1.0 IW/CPE ratio with 50 mm depth for surface) arranged in randomized block design with four replications.

The crop was sown on 18th and 19th February during 1999 and 2000, respectively, with a spacing of 30:60 x 25 cm as paired rows and lateral lines were laid out in the middle of two rows of pair (90 cm apart) with 50 cm distance of drippers on each line having 4 Lph discharge of water. The system was operated at 1.2 kg cm². presser on alternate day. Surface irrigation was applied as check basin method. Cumulative pan evaporation was taken as the sum of the daily pan

evaporation from USWB Class-A. Irrigation water was measured in surface method by parshall flume installed in the field channel. Fertilizer dose of 75 - 37.5 - 37.5 kg NPK ha⁻¹, was applied and cumulative fruit yield was recorded for statistical analysis. Water use efficiency, water saving and economics were also computed.

Results and discussion

Fruit Yield

It is seen from the Table-1 that irrigation applied through drip system at 1.0 PEF produced significantly higher fruit yield (8656 kg ha⁻¹) as compared to rest of the treatments, but it was statistically at par with 0.8 PEF of drip (8379 kg ha⁻¹). The results further revealed that the fruit yield obtained from 0.6 and 0.8 PEF were also at par with each other. In comparison to both the methods at each level of moisture regimes, drip performed better than surface method of irrigation. It is interesting to note that the fruit yield obtained at 1.0 IW/CPE ratio by surface method was statistically at par even with 0.4 PEF by drip method of irrigation. Similar results were also observed in brinjal (4) and tomato (5).

The drip system proved its superiority in producing higher fruit yield of okra by providing a favourable soil moisture availability for crop growth (6)

Water Use Efficiency and Water Saving

Maximum water use efficiency (WUE) was observed in treatment 0.4 PEF through drip. (14.58 kg ha mm⁻¹), while minimum (7.0 kg ha mm⁻¹) was recorded with 1.0 IW/CPE ratio in surface irrigation method (Table 1). This indicated that WUE was found higher under drip irrigation system than surface method. This could be described to the minimum water loss through deep percolation, run off and soil surface evaporation. This is in conformity with the findings of Nair *et al.* (7). The extent of water saving with drip at 0.4, 0.6, 0.8 and 1.0 PEF over surface method (1.0 IW/ CPE) was 55, 39, 24 and 8 percent, respectively. These results are also in the line with the findings of Jadhav and Jain (8).

Economics

The highest net profit of Rs. 19430 ha⁻¹ was realized under surface irrigation with 1.0 IW/CPE ratio (Table 2). However, drip irrigation at 0.4 PEF produced at par yield with surface method (1.0 IW/CPE) and about 55 per cent water can be saved in drip method at 0.4 PEF, considering the additional area (1.22 ha), that can be covered with the same quantity of water. It is estimated that about Rs.15104 additional income can be obtained under 0.4 PEF. This finding confirms the results of Khistariya (9).

Table 1. Fruit yield, water use efficiency and water saving as influenced by method of irrigation in okra

Treatment	Fruit yield kg ha ⁻¹			WUE	Water Saving %	Percent yield increase
	1998-99	1999-2000	Pooled			
Drip Method						
D ₁ : 0.4 PEF	7088	7344	7216	14.58	55	-
D ₂ : 0.6 PEF	7982	7763	7873	11.80	39	2.17
D ₃ : 0.8 PEF	8430	8328	8379	9.99	24	8.73
D ₄ : 1.0 PEF	8583	8729	8656	8.55	8	13.27
Surface Method						
S ₁ : 0.4 IW/CPE	6344	5278	5811	11.07	52	-
S ₂ : 0.6 IW/CPE	6574	6492	6533	9.13	35	-
S ₃ : 0.8 IW/CPE	7770	7330	7550	8.32	35	-
S ₄ : 1.0 IW/CPE	7954	7459	7706	7.00	17	-
CD at 5 %	800	1300	700			

Table 2. Relative economics of different irrigation treatment in okra

Sr. No.	Particulars	Drip method (PEF)				Surface method (IW/CPE)	
		0.4	0.6	0.8	1.0	0.8	1.0
1.	Fixed cost						
2.	Variable cost	12400	12400	12400	12400	-	-
3.	Total cost	11300	12500	13300	14000	17900	19100
4.	Fruit yield(kg ha ⁻¹)	23700	24900	25700	26400	17900	19100
5.	Total income	7216	7873	8379	8656	7500	7706
6.	Net Profit	36080	39365	41895	43280	37500	38530
7.	Water apply(mm)	12380	14465	16195	16880	19600	19430
8.	Additional area over 1.0 IW/CPE(ha)	495	667	839	1012	907	1100
9.	Additional Net Profit	1.22	0.65	0.31	0.08	0.20	-
10.	Total Net Profit	15104	9402	5020	1350	3920	-
		27484	23867	21215	18230	23520	-

Selling Price : 5.0 Rs/Kg Fruit

References

1. **Suttal S.B., Jadhav S.S. and Takte R.U.** 1990. Responses of chilli crop to drip irrigation. Proceeding of International Agricultural Engineering Conference. pp. 815-818.
2. **Patel J.C., Malavia D.D. and Vyas M.N.** 1990. Comparative evaluation of irrigation system for summer groundnut. Proc. XI. International Congress on the Use of Plastic in Agriculture, New Delhi. February-March 1990. pp.31-34.
3. **Singh, S.S. and Kaushal M.P.** 1991. Fresh and saline water irrigation through drip and furrow method. *International J. Trop. Agric.* **9** : 194-202.
4. **Anonymous**, 1989. Study of drip irrigation method in brinjal. In water management research in Gujarat. Published by Water Management Project, G.A.U. Navsari. pp.37-38.
5. **Bogle C.R., Hartz J.K. and Nunez.** 1989. Comparisons of sub-surface trickle and furrow irrigation on plastic mulch and bare soil for tomato production. *J. of Am. Soc. Horti. Soc.* **114**: 40-43.
6. **Shelke O.K., Vaishnava, V.S. Jadhav G.S. and Oza S.R.** 1990. Optimization of irrigation water and nitrogen to cotton through drip irrigation system. *Indian J. Agron.* **44** : 624-33.
7. **Nair M.K., Sairam C.V and Gopalsundaram M.** 1995. Competitiveness through cost production and higher productivity in coconut. *Indian Coconut J.* **24** :6-13.
8. **Jadhav V.B. and Jain R.N.** 1987. Comparative Study of various irrigation methods for cabbage. B.Tech.(Agri.Engg) Thesis. MPAU, Rahuri.
9. **Khaistariya P.B.** 1993. Performance of drip and surface method of irrigation along with organic mulch in eggplant. M.Sc.(Agri.) Thesis. GAU, Sardarkrushinagar.

Response of summer mungbean to date of sowing and levels of fertilizers

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Abstract

A field experiment was conducted to study the response of summer mungbean to dates of sowing and levels of fertilizers in split plot design with three replications at Main Pulses Research Station, GAU, Sardarkrushinagar. There were 27 treatment combinations, comprising three different dates of sowing assigned in main plots (15th February, 1st March and 15th March) and three levels each of nitrogen (10, 20 and 30 kg N / ha) and phosphorus (20, 40 and 60 kg P₂O₅ / ha) assigned in sub plots. Results revealed that maximum yield of mungbean and net realization was recorded when it was sown on 1st March as compared to early (15th February) and late (15th March) sowing. The effect of nitrogen on yield was not observed in two out of three years as well as in pooled analysis. Application of 40 kg P₂O₅ / ha gave significantly higher yield over 20 kg P₂O₅ / ha but was at par with 60 kg P₂O₅ / ha. This level also registered higher net profit as well as NICER.

Keywords : Summer mungbean, date of sowing.

Introduction

Mungbean (*Vigna radiata* (L) Wilczek) is an important pulse crop in Gujarat. Recently, high yielding variety of mungbean suitable for summer has been evolved, which requires evaluation under different agro-climatic conditions. The time of sowing is an important non-monetary input to achieve synchronous maturity and higher productivity of summer mungbean. Nitrogen and phosphorus also play an important role in production of mungbean. Since information on the nutrients aspects under varying planting time in summer seasons is scanty, present experiment was carried out to evaluate the performance of mungbean under different dates, nitrogen and phosphorus levels during summer season.

Material and methods

A field experiment was carried out at Main Pulses Research Station, Gujarat Agricultural University, Sardarkrushinagar, Gujarat during summer seasons of 1995 to 1997. The soil had an average 197 kg/ha available nitrogen, 47 kg/ha available phosphorus and 211 kg/ha available potash with soil pH 7.1. Twenty seven treatment combinations comprising, three planting dates (Main plot : 15th February, 1st March,

and 15th March) and three levels of nitrogen (10, 20 and 30 kg/ha) and phosphorus (20, 40 and 60 kg/ha) in sub plot were tested in split plot design replicating thrice. The mungbean variety GM-3 was sown at 30 cm row to row distance with 25 kg/ha seed rate. Entire dose of N and P as per treatments was applied as basal at the time of sowing. Post planting operations viz. thinning, irrigation and interculturing etc. were done as per need of crop.

Results and discussion

Effect of date of sowing

The grain yield differences due to sowing dates exhibited significant effect during two years of investigation out of three years and in pooled (Table 1). The crop sown on 1st March recorded significantly higher grain yield as compared to crop sown 15th February and 15th March during 1995 and 1996 but were at par with 15th March sowing in 1997 and pooled analysis. The higher yield in 1st March sowing may be owing to favourable environment at the time of growth, fruiting and maturity. The results confirm the findings of Chovatia *et al.* (1) and Saini and Jaiswal (2). Lower yields in early sowing and late sowing might be attributed to the unfavorable temperature during crop season *i.e.* low temperature

at sowing time in 15th February (minimum 8.7 - 10.2 °C) and high temperature at grain filling in 15th March sowing (maximum 40.9- 43.2 °C).

Effect of nitrogen

The differences in grain yield of summer mungbean GM-3 due to various levels of nitrogen were significant during first year of investigation only (Table 1). It can be seen from the first year and pooled data that the grain yield increased significantly and numerically with increasing in the levels of nitrogen respectively. The highest grain yield of 1002 kg/ha was obtained with the application of 30 kg nitrogen/ha in pooled analysis. This is in accordance with the finding of Patel et al. (3).

Effect of phosphorus

Application of phosphorus significantly increased the grain yield of summer mungbean in two out of three years and in pooled analysis (Table 1). The results revealed that increased in phosphorus levels upto 60 kg/ha resulted in corresponding higher yield of

summer mungbean. Application of 40 and 60 kg phosphorus/ha gave significantly higher yield over 20 kg P_2O_5 /ha during 1995, 1996 and in pooled. However, the differences in grain yield due to 40 and 60 kg P_2O_5 /ha were not significant. (3).

Interaction effect

The interaction effect between NP, DN, DP and DNP were not significant during the individual years and pooled, except DN interaction in the year of 1997. Application of 20 kg N/ha in 1st March sowing (D_2N_2) gave significantly higher grain yield over application of nitrogen to early sowing being at par with D_3N_1 .

Economics

The results shown in Table 2 indicated that among sowing dates maximum yield and net profit (1096 kg/ha Rs.9510/ha) was observed by 1st March sowing. In case of nitrogen levels, application of 30 kg N/ha gave the maximum net ICBR of 4.70. Among levels of phosphorus, 40 kg P_2O_5 /ha recorded maximum net profit of Rs.7942/ha with Net ICBR of 2.46.

Table 1. Grain yield (kg/ha) as influenced by date of sowing, nitrogen and phosphorus fertilization

Treatment		1995	1996	1997	Pooled
Date of sowing:					
D_1	15 th February	344	587	1297	742
D_2	1 st March	679	1124	1482	1096
D_3	15 th March	534	1074	1462	1023
	S. Em ±	27.1	76.1	69.1	35.4
	C.D at 5%	109.0	298.0	NS	109.85
	C.V (%)	18.1	14.4	12.4	15.5
Levels of Nitrogen (Kg/ha)					
N_1	10	444	884	1407	910
N_2	20	516	955	1378	948
N_3	30	607	947	1457	1003
	S. Em ±	18.1	23.0	28.8	23.6
	C.D at 5%	45.0	NS	NS	NS
	C.V (%)	17.5	12.9	10.6	12.8
Levels of phosphorus (kg/ha)					
P_1	20	435	891	1322	883
P_2	40	553	951	1457	988
P_3	60	562	943	1463	991
	S. Em ±	18.1	23.0	28.8	13.6
	C.D at 5%	45.0	NS	81.3	37.6
	C.V (%)	17.5	12.9	10.6	12.8

Table 2. Economics of the treatments

Treatment		Yield (kg/ha)	Total income (Rs./ha)	Expenditure (Rs./ha)	Net Realization (Rs./ha)	Net ICBR
Date of sowing:						
D ₁	15 th February	742	11130	6930	4200	--
D ₂	1 st March	1096	16440	6930	9510	--
D ₃	15 th March	1023	15345	6930	8615	--
Levels of Nitrogen (Kg/ha)						
N ₁	10	910	13650	6778	6872	-
N ₂	20	948	14220	6863	7357	6.20
N ₃	30	1003	15045	6948	8097	4.70
Levels of phosphorus (kg/ha)						
P ₁	20	883	13245	6513	6732	--
P ₂	40	988	14805	6863	7942	2.46
P ₃	60	991	14865	7213	7652	0.31

References

1. Chovatia, P.K., Ahlawat, R.P.S and Trivedi, S.J. 1992. Growth and yield of summer greengram (*phaseolus radiatus*) as affected by different date of sowing, rhizobium inoculation and levels of phosphorus. *Indian J. Agron.* **38** : 492-494.
2. Saini, S. S. and Jaiswal, V. P. 1991. Response of summer greengram to date of planting. *Indian J. Agron.* **36**: 427-428.
3. Patel, R.G., Patel, M. P., Patel H. C. and Patel R. B. 1984. Effect of graded levels of nitrogen and phosphorus on growth, yield and economics of summer mungbean. *Indian J. Agron.* **29** : 291-294.

Maximizing castor yield through irrigation and nitrogen management strategies under different plant geometry

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Abstract

An experiment was conducted on loamy sand soil of Sardarkrushinagar during 1996-97 and 1997-98 in order to maximize castor yield through irrigation and nitrogen management strategies under different plant geometry. Higher values of yield attributing characters were recorded under wider spacing (120 cm x 90 cm) but higher total yield of castor produced under closer spacing as it maintained double plant population. Irrigation at 1.2 PEF through drip produced significantly highest castor yield. Though, 0.8 PEF through drip recorded similar yield of castor as produced in surface method of irrigation. Nitrogen castor was obtained with 50 kg N/ha applied through drip as produced at 100 kg N/ha in surface method applied as band application. Castor crop sown at closer spacing (90cm x 60cm) and irrigated at 1.2 UPE through drip as well as fertilizer with 150 kg N/ha (30 kg basal and 120 kg in equal split at monthly interval) produced maximum yield of castor. Though irrigation at 0.8 PEF and 50 kg N/ha through drip harvested similar yields as obtained in surface method of irrigation with 100 kg N/ha as band application.

Keywords : Castor, irrigation, drip, spacing.

Introduction

Castor (*Ricinus communis* L.) is an important non-edible oilseed crop of North Gujarat grown as rainfed as well as irrigated under assured irrigation facilities. Potential crop production can be obtained if its nitrogen and water requirements is provided through proper method during growth period. Loamy sand soil responds very well to nitrogen and irrigation management. Water losses through seepage and evaporation in surface method are high in arid and semi-arid region. To minimise these losses and to maximize yield, irrigation and nitrogen should be provided judiciously through suitable method at optimum rate. Crop geometry also becomes an important factor in crop production under adequate supply of moisture and nutrients.

Material and methods

A field experiment was conducted on loamy sand soil of Regional Research Station, Gujarat Agricultural University, Sardarkrushinagar during 1996-97 and 1997-98. The soil was poor in organic carbon, medium in available phosphorus and high in available

potash. The soil had 85.2 % sand, 7% silt and 7.6 % clay with 8.9 % FC and 2.3 % PWP (-15 bar). The treatments comprised of two spacing i.e. 120 cm x 90 cm and 90 cm x 60 cm and four levels of irrigation wherein 0.8, 1.0 and 1.2 PEF for drip and recommended irrigation schedule (0.8 IW:CPE ratio) for surface method (Check basin method) and three levels of nitrogen i.e. 50, 100 and 150 kg/ha. The experiment was laid out in split plot design with spacing in main plot, irrigation levels in sub-plot and nitrogen levels in sub-sub plot with four replications.

Full dose of phosphorus (50 kg/ha) and 30 kg N/ha were applied as basal in form of DAP and Urea. Remaining nitrogen of each level was applied through drip system in seven split at monthly interval starting from 30 DAS in the form of urea in drip irrigated plots. In case of check basin method of irrigation, equal quantity of urea according to treatment was applied as band application at same day.

Drip system was laid out in such a way that each plant received irrigation water through one dripper having 4 LPH discharge rate in 90 cm x 60 cm and 8 LPH in 120 cm x 90 cm to apply equal amount of

water in both the spacings. The crop was sown in middle of August. The regular irrigation scheduled started after cessation of rainy season. In drip system, the numbers of hours for operation ranged from 0.5 to 2.0 depending on value of daily USDA Class-A pan evaporimeter.

Results and discussion

Plant geometry

The variation in plant geometry resulted in significant difference in yield and yield attributes (Table 1). The plant under wider spacing (120 cm x 90 cm) had significantly higher number of primary branches and capsules per main spikes than close spaced plants. Effective spike length did not differ due to spacing, however, longer spike recorded under wider spacing. Significantly taller plants were produced in closer spacing as a result of competition among plants for light. Higher plant competition and mutual shading might have resulted in reduction of capsules per spike and secondary branches. The effect indicate that at higher plant population, the assimilates supply for an

individual plant may be insufficient to sustain numerous vegetative and reproductive sinks.

Decrease in row and plant spacing was found beneficial in increasing yield significantly by 14 per cent. The reduction in yield attributes under narrow spacing both in row and plant, may be ascribed to comparatively poor growth and development of individual plants, owing to competition for growth resources like space, nutrients, sunlight, moisture etc. The improvement in yield attributes at wider spacing was not reflected by total yield because of higher productivity per plant under wider spacing (413 g plant⁻¹) could not compensate for increased number of plants per unit area under closer spacing. Narkhede (1) also observed similar results in cotton.

Irrigation

Irrigation at 1.2 PEF produced the tallest plant along with maximum length of main spike, which was at par with 1.0 PEF. Significantly highest numbers of primary branches and castor yield per plant was also recorded with 1.2 PEF under drip system. Irrigation scheduling

Table 1. Effect of different levels of nitrogen under drip and surface method of irrigation on yield and yield attributes of castor

Treatments	Plant height (cm)	Main spike length (cm)	Effective spike length (cm)	No. of primary branches per plant	No. of capsules per main spike	Castor yield per plant (g)	Test weight (g)	Castor yield (kg/ha)
Plant Geometry (cm)								
90 x 60	75.0	59.8	47.1	4.43	47.9	240	30.702	4354
120 x 90	64.0	62.6	49.5	6.80	56.3	413	29.835	3750
CD (0.05%)	8.3	NS	NS	0.50	10.5	39	0.692	450
Irrigation Drip method								
0.8 PEF	68.2	60.1	45.6	5.27	51.2	320	30.141	3959
1.0 PEF	71.5	61.6	50.3	5.71	53.0	323	30.854	4096
1.2 PEF	75.6	62.7	51.2	6.32	54.8	357	30.673	4444
Surface method								
0.8 IW:CPE	62.9	60.4	46.1	5.15	40.4	303	29.406	3728
CD(0.05%)	5.3	NS	NS	0.42	3.5	16.0	0.501	181
Nitrogen (kg/ha)								
50	64.9	58.1	45.1	5.3	48.5	285	29.348	3554
100	69.4	61.7	48.1	5.7	51.8	328	30.258	4090
150	74.2	63.8	51.7	5.8	56.0	365	31.202	4527
CD(0.05%)	4.6	2.4	2.3	0.36	3.0	14	0.434	156
S x F								19.48

at 0.8 IW:CPE ratio through surface method recorded lower values of all the yield attributing characters and was at par with 0.8 PEF through drip system except yield per plant. Better availability of soil moisture through out the growth period in the root zone under drip method is responsible for higher values of yield attributing characters in castor as compared to surface method of irrigation. The results corroborate the findings of Patel *et al.*(2) Significant response of irrigation on yield attributes reflected in castor yield. Significantly the highest castor yield of 4444 kg ha⁻¹ was obtained at 1.2 PEF in drip method that was 16.1 per cent higher than 0.8 IW:CPE ratio in surface method. Drip irrigation at 0.8 and 1.0 PEF produced 3959 and 4096 kg ha⁻¹ castor yield, respectively, wherein 0.8 PEF was at par with surface method while 1.0 PEF showed its significant superiority over surface method by 8.96 per cent on pooled basis.

Table 2. Effect of different levels of nitrogen under drip and surface method of irrigation on castor yield (kg/ha)

Nitrogen (kg/ha)	1996-97	1997-98	Mean
Drip method			
50	3946	3352	3649
100	4440	3946	4193
150	5051	4267	4656
Surface method			
50	3434	3104	3269
100	4027	3532	3779
150	4314	3961	4137

Nitrogen

Application of 150 kg N/ha resulted in significant increase in all the yield attributing characters as well as castor yield except main spike length and number of primary branches per plant as compared to 100 kg N/ha (Table 1). Nitrogen applied through drip @ 150 kg/ha produced the highest castor yield (4656 kgj ha) which was 11.15 and 18.84 per cent higher than that of applied at 100 and 50 kg N/ha in surface method, respectively. Similar yield of castor was recorded at 50 kg N/ha when applied through drip and 100 kg N/ha applied as band application in surface method of irrigation (Table 2). It indicates that 50 kg N/ha can be saved when nitrogen was supplied to crop through drip system as fertigation. Similar results were also observed by Shelke *et al.*(3) in cotton.

References

1. Narkhede, W.N., Bharad, G.M. and Kohale, S.K. 1996. Effect of plant density and drip irrigation on pre-monsoon cotton. *Indian J. Agron.* **41** : 127-131.
2. Patel, B.D, Maliwal, G.L., Dudhatra, N.P., Kaswala, P.U., Raman, S. and Patel, M.L. 1998. Effect of drip irrigation levels on yield and water expense efficiency of castor. *GAU Res. J.* **24** : 86-88.
3. Shelke, D.K., Vaishnava, G.S., Jadhav, G.S. and Oza, S.R. 1999. Optimizing of irrigation water and nitrogen in cotton (*Gossypium* species) through drip irrigation system. *Indian J. Agron.* **44** : 629-633.

Economics and nutrient uptake by crop and weeds in chickpea as influenced by different fertilizers and weed management practices

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Abstract

A field experiment was carried out at College Agronomy Farm, Anand Agricultural University, Anand during *rabi* seasons of the years 2003-04 and 2004-05 to study the economics and nutrient uptake by crop and weeds in chickpea as influenced by different fertilizers and weed management practices. The results indicated that uptake of nitrogen, phosphorous and potash by seeds and straw were higher under IC+HW at 20 and 40 DAS and also recorded minimum uptake of nitrogen, phosphorous and potash by weeds. The said treatment also registered the highest additional income over control of Rs. 18714 ha⁻¹, while application of oxadiargyl @ 0.075 kg ha⁻¹ (W₃) recorded the highest ICBR values of 1:17.89.

Key words : weed mangement, chickpea, nutrient uptake.

Introduction

Chickpea (*Cicer arietinum* L.) commonly known, as gram or Bengal gram is the most important *rabi* pulse crop, occupies first position among the pulses grown in India. It is grown in an area of 123.4 thousand hectares, producing 77.7 thousand tonnes with average productivity of 817 kg ha⁻¹ in Gujarat (1). Chickpea is a poor competitor to weeds because of slow growth rate and limited leaf area development at early stages of crop growth and establishment. Weeds affect growth, yield and quality of crop plants and reduce soil fertility, available soil moisture, and nutrients and also compete for space and sunlight with the crop plants. Considerable yield losses in chickpea recorded to the extent of 88 per cent if weeds are not controlled at critical growth period of crop with weed competition (2) Beside this, fertilizers also played significant role in boosting up the production of pulses.

Material and methods

An experiment was conducted on loamy sand soil of the Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand for two consecutive *rabi* seasons of the year 2003-04 and 2004-05. The soil was sandy loam in texture having

low in available nitrogen and medium in available phosphorus and high in potassium with pH 7.7. Twenty treatments comprising of all combinations of four fertilizer treatments (F₀: Control, F₁: 5 t ha⁻¹ FYM, F₂: 1.5 kg ha⁻¹ Mo and F₃: 5 t ha⁻¹ FYM + 1.5 kg ha⁻¹ Mo) with five weed management practices (W₁: fluchloralin @ 1.0 kg ha⁻¹, W₂: pendimethalin @ 0.75 kg ha⁻¹, W₃: oxadiargyl @ 0.075 kg ha⁻¹, W₄: IC+HW at 20 and 40 DAS and W₅: weedy check) were tested in a factorial randomized block design with four replications. The seeds of Gujarat Gram-1 were dibbled manually at 30 cm between two rows @ 60 kg seed/ha during the month of November in both the years. All the herbicides were applied as pre-emergence using Knapsack sprayer fitted with flat fan nozzle by mixing in 500 L of water/ha as per treatment. After sowing of the seed immediately a light irrigation was given to the crop for uniform germination and next day the herbicide was spray as per the treatment. Full dose of phosphorus and nitrogen through diammonium phosphate and urea were applied at the time of sowing. In general, weather conditions were favourable for plant growth and no severe pest and diseases noticed during both the years of experimentation. The package of recommended practices was adopted to maintain the crop. The observations of weed density and their dry matter were taken randomly from 1.0 m² quadrat from net plot area at 3 spots from each

treatment and data were transformed to square root before their statistical analysis.

Results and discussion

Effect on nutrient uptake

Different fertilizer treatment showed significant influenced on nutrient uptake by crop. Significantly highest N, P and K uptake by chickpea seed and straw and the lowest uptake by weeds was noticed under application of 5 t ha⁻¹ FYM + 1.5 kg ha⁻¹ Mo. Further, treatment of 5 t ha⁻¹ FYM (F₁) also recorded significantly higher nitrogen uptake by seed and straw as compared to treatment of 1.5 kg ha⁻¹ Mo and control. Fertilizer treatment did not show significant influenced on nutrient uptake by weeds. Whereas, twice hand weeding and interculturing carried out at 20 and 40 DAS recorded maximum uptake of N, P and K by chickpea seeds and straw closely followed by application of oxadiargyl at 0.075 kg ha⁻¹. The said treatment also recorded minimum uptake of N, P and K by weeds. Application of pendimethalin @ 0.75 kg ha⁻¹ and application of fluchloralin @ 1.0 kg ha⁻¹ both

were at par with each other, but found significantly superior over weedy check treatment. Significantly the lowest nitrogen uptake by chickpea seed was recorded under weedy check treatment.

Economics

The higher additional income over control (Rs. 2454 ha⁻¹) with the highest ICBR (1:2.05) and net ICBR (1:1.05) was recorded under 5 t ha⁻¹ FYM closely followed by 5 t ha⁻¹ FYM + 1.5 kg ha⁻¹ Mo. The lowest additional income over control was noticed under application of 1.5 kg ha⁻¹ Mo (Rs. 170 ha⁻¹) with the ICBR value of 1:0.04 and negative net ICBR. Whereas, application of oxadiargyl @ 0.075 kg ha⁻¹ (was recorded the higher ICBR values of 1:17.89 and net ICBR 1:16.89 followed by higher additional income over control of Rs. 18714 ha⁻¹ with the ICBR value of 1:10.51 and net ICBR 1:9.51 was observed under IC + HW at 20 and 40 DAS (W₄). However, pendimethalin @ 0.75 kg ha⁻¹ recorded higher additional income over control (Rs. 17827 ha⁻¹) as compared to fluchloralin @ 1.0 kg ha⁻¹. Similarly, Dungarwal (3) also observed higher net return under pendimethalin application.

Table 1. Effect of fertilizers and weed management practices on nutrient uptake by crop and weeds
(Mean of two years)

Treatment	Nutrient uptake by grains (kg/ha)			Nutrient uptake by stover (kg/ha)			Nutrient uptake by weeds (kg/ha)		
	N	P	K	N	P	K	N	P	K
Fertilizers									
F ₀ : Control	30.12	5.06	6.07	7.20	3.59	3.55	3.32	1.89	8.39
F ₁ : 1.5 t ha ⁻¹ FYM	34.87	5.83	7.01	7.90	4.05	4.02	3.48	1.99	8.94
F ₂ : 1.5 kg ha ⁻¹ Mo	30.56	5.17	6.26	7.23	3.68	3.70	3.37	1.94	8.77
F ₃ : 5 t ha ⁻¹ FYM+1.5 kg ha ⁻¹ Mo	35.85	5.88	7.14	8.51	4.11	4.09	3.18	1.98	8.48
S.Em. ±	0.66	0.11	0.13	0.17	0.07	0.07	0.15	0.09	0.38
C.D. (P=0.05)	1.86	0.32	0.35	0.47	0.19	0.20	NS	NS	NS
Weed management practices									
W ₁ : Fluchloralin@ 1.0 kg ha ⁻¹	37.59	6.24	7.49	8.50	4.24	4.22	3.45	2.00	8.75
W ₂ : Pendimethalin @ 0.75 kg ha ⁻¹	38.76	6.44	7.74	9.01	4.48	4.51	2.66	1.56	6.85
W ₃ : Oxadiargyl @ 0.075 kg ha ⁻¹	40.11	6.60	7.93	9.07	4.50	4.46	2.16	1.18	5.20
W ₄ : IC+HW at 20 & 40 DAS	40.82	6.65	8.16	9.21	4.59	4.56	1.68	0.98	4.29
W ₅ : Weedy check	6.96	1.49	1.78	2.76	1.49	1.46	6.88	4.05	18.13
S.Em. ±	0.74	0.13	0.14	0.19	0.08	0.08	0.46	0.27	1.23
C. D. (P=0.05)	2.08	0.35	0.39	0.52	0.22	0.22	1.79	1.07	4.81
Interaction F X W	NS	NS	NS	Sig.	NS	NS	NS	NS	NS
C. V. (%)	12.78	13.00	11.96	13.69	11.33	11.70	27.71	27.68	28.10

Table 2. Economics as influenced by fertilizers and weed management practices

Treatment	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Total income (Rs.ha ⁻¹)	Total cost of cultivation (Rs.ha ⁻¹)	Additional cost over control (Rs.ha ⁻¹)	Additional income over control (Rs.ha ⁻¹)	ICBR	Net ICBR
Fertilizers								
F ₀ : Control	1080	1362	18924	7954	10970	—	—	—
F ₁ : 1.5 t ha ⁻¹ FYM	1226	1494	21378	9154	12224	2454	1:2.05	1:1.05
F ₂ : 1.5 kg ha ⁻¹ Mo	1092	1357	19094	12481	6631	170	1:0.04	1: -ve
F ₃ : 5 t ha ⁻¹ FYM+1.5 kg ha ⁻¹ Mo	1224	1482	21324	13581	7743	2400	1:0.43	1: -ve
Weed management practices								
W ₁ : Fluchloralin@ 1.0 kg ha ⁻¹	1319	1581	22947	9112	13835	17156	1:14.82	1:13.82
W ₂ : Pendimethalin @ 0.75 kg ha ⁻¹	1354	1654	23618	9474	14144	17827	1:11.73	1:10.73
W ₃ : Oxadiargyl @ 0.075 kg ha ⁻¹	1383	1649	24043	8974	15069	18252	1:17.89	1:16.89
W ₄ : IC+HW at 20 & 40 DAS	1409	1685	24505	9734	14771	18714	1:10.51	1:09.51
W ₅ : Weedy check	0313	0548	5791	7954	—	—	—	—

Selling price of chickpea seed Rs. 15 kg⁻¹Selling price of chickpea straw Rs. 02 kg⁻¹**References**

1. Rathod P.S. 2002. Techniques and management of field crop production. Agrobios (India) Jodhpur. pp. 317-318
2. Bhalla C.S., Kurchania, S.P. and Paradkar, N.R. 1998. Herbicidal weed control in chickpea (*Cicer arietinum* L.). *World Weeds* 5 : 121-124.
3. Dungarwal H.S., Chaplor P.C. and Nagda B.L. 2002. Chemical weed control in chickpea (*Cicer arietinum* L.) *Indian J. Weed Sci.* 34 : 208-212.

Phosphorus management in pearl millet-mustard cropping sequence under North Gujarat conditions

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Abstract

A field experiment was conducted during six consecutive years from 1997-98 to 2002-03 to study the effect of levels of phosphorus and its application frequencies on pearl millet - mustard cropping sequence at Main Cropping System Research Station, Gujarat Agricultural University, Sardarkrushinagar. The soil of experimental site was loamy sand having 21 kg/ha available phosphorus. The results indicated that application of phosphorus & 60 kg/ha to both the crops each year recorded significantly higher yields of both the crops as compared to lower levels as well as others modes of application. These treatments also secured maximum net realization and BCR values.

Keywords: Pearl millet-mustard Cropping sequence, Phosphorus management.

Introduction

Pearl millet - mustard is the most popular crop sequence of North Gujarat. Among the production constraint for pearl millet and mustard, imbalanced and inadequate nutrition is considered one of the important factors especially under areas having light textured soil of North Gujarat. Requirement of phosphorus of both the crops is high. Phosphorus fertilization is of prime importance need for normal growth and development of the plants due its vital role in vital role in physiological and metabolic process of the plant (1). The status of available phosphorus in the soils of this area is low to medium. Phosphorus use efficiency for most of the crops seldom exceeds 30 per cent. Phosphorus management in cropping system is differing than single crop. Therefore, it is prime need to find out the phosphorus requirement for pearl millet- mustard sequence. Keeping in view the above facts, present investigation was carried out under All India Co ordinated research project on Cropping System to evaluate production potential and economical viability of different cropping sequences.

Material and methods

A field investigation was carried out in split plot design with four replications at Cropping system Research Centre, Gujarat Agricultural University, Sardarkrushinagar during six consecutive years from

1997-98 to 2002-03 to study the effect of phosphorus levels and its application frequency to increase phosphorous efficiency in pearl millet- mustard cropping sequence. The texture of experimental field was loamy sand having 7.8 pH, 0.44% OC, 188 kg/ha available N, 21 kg/ha available P and 253 kg/ha available K. Three levels of phosphorus (20, 40 and 60 kg/ P_2O_5 / ha) as main plot and six phases of its applications (A_1 - *kharif* and *rabi* both the crops each year, A_2 - only *kharif* crop each year, A_3 - only *rabi* crop each year, A_4 - alternate year to only *kharif*, A_5 - alternate year to only *rabi*, A_6 - alternate year to both *kharif* and *rabi*) as sub-plot treatments. Full dose of phosphorus was applied as basal to both the crops. Recommended package of practices were adopted for growing both the crops.

Results and discussion

Effect of levels of phosphorus

The data presented in Table 1 indicated that the grain yields of pearl millet and mustard were significantly increased with increase in phosphorus application from 20 to 60 kg P_2O_5 /ha in all the individual years as well as in pooled analysis. Application of 60 kg P_2O_5 /ha recorded significantly highest yield of both the crops. The mean pearl millet equivalent yield (PMYE) was maximum with application of 60 kg P_2O_5 /ha. The grain yield of pearl millet with 60 kg P_2O_5 /ha increased

The results further indicated that the effect of phases of phosphorus on yield of pearl millet and mustard was significant in all the year of study as well as in pooled results. Application of phosphorus to both the crops every year gave higher yield of both pearl millet and mustard as well as in term of pearl millet equivalent. These results are in conformity with the earliar reports (3).

The figures presented in Table 2 indicated that the highest gross, net monetary return and BCR was recorded with 60 kg P₂O₅/ha. Among different phases, application of phosphorus to both the crops in each season gave higher net return and BCR value over rest of the phases.

From the six years results, it is concluded that for getting higher yield as well as net monetary return from pearl millet-mustard cropping system, grown in light textured soil of North Gujarat Agro-climatic condition, both the crops are fertilized with 60 kg P_2O_5 /ha each year along with their recommended doses of nitrogen.

Table 1. Grain yield of pearl millet and mustard (kg/ha) as influenced by levels of phosphorus and its phases of application

Treatments	Grain yield (kg/ha)														
	1997-98		1998-99		1999-2000		2000-01		2001-02		2002-03		Pooled		PMEY
	P.M.*	Mustard	P.M.*	Mustard	P.M.*	Mustard	P.M.*	Mustard	P.M.*	Mustard	P.M.*	Mustard	P.M.*	Mustard	
Main plot treatments — Levels of P_2O_5 (kg/ha)															
$P_1 = 20$	973	1755	799	1660	1621	1544	1207	1486	1314	1465	1476	1544	1202	1576	6057
$P_2 = 40$	910	1986	978	1772	1794	1777	1434	1736	1522	1757	1686	1742	1387	1795	6904
$P_3 = 60$	1100	2307	1304	2003	2029	1997	1599	1908	1594	1861	1774	1817	1562	1982	7688
S. Em. ±	51	37	41	34	29	25	34	23	25	42	36	44	24	24	—
C.D. (5%)	177	130	144	119	102	86	119	79	88	146	123	150	75	76	—
C.V. (%)	26.9	9.1	19.8	9.3	7.9	6.8	12.9	6.5	8.4	12.2	10.6	12.6	13.8	9.6	—
Sub plot treatments — phases of P application															
A_1 = Both crops each year	1111	2185	1410	2182	2116	2096	1662	2178	1639	2010	1881	1668	1637	2103	8137
A_2 = Only Kharif each year	1062	1824	1145	1753	1942	1688	1462	1653	1542	1639	1702	1633	1476	1699	6727
A_3 = Only Rabi each year	735	2057	873	1830	1748	1788	1432	1823	1514	1769	1643	1768	1324	1839	7008
A_4 = Alternate year only kharif	1046	1855	858	1657	1688	1554	1272	1428	1349	1479	1492	1571	1284	1591	6202
A_5 = Alternate year only rabi	623	2043	932	1707	1552	1642	1258	1484	1369	1556	1520	1559	1198	1665	6344
A_6 = Alternate year both kharif and rabi	1031	2130	944	1741	1841	1867	1395	1693	1449	1715	1633	1708	1382	1809	6973
S. Em. ±	62	68	38	62	61	51	73	49	65	93	71	63	36	27	—
C.D. (5%)	175	194	107	177	174	146	207	140	185	266	200	177	106	75	—
C.V. (%)	22.9	11.7	12.7	11.8	11.7	10.0	17.8	9.9	15.2	19.0	14.9	12.8	15.9	12.8	—
PM=pearlmillet															

Table 2. Economics of different treatments

Treatments	Av. Grain yield (kg/ha)		P. M. fodder (kg/ha)	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	BCR
	P. M.*	Mustard					
Levels of P ₂ O ₅ (kg/ha)							
P ₁ = 20	1202	1576	2758	36161	16376	19785	2.21
P ₂ = 40	1387	1795	3045	41188	16680	24508	2.47
P ₃ = 60	1562	1982	3365	45650	16986	28664	2.69
Phases of P application							
A ₁ = Both crops each year	1637	2103	3404	48158	17288	30870	2.78
A ₂ = Only <i>kharif</i> each year	1476	1699	3160	40161	16680	23481	2.41
A ₃ = Only <i>rabi</i> each year	1324	1839	2990	41535	16680	24855	2.49
A ₄ = Alternate year only <i>kharif</i>	1284	1591	2909	37018	16376	20643	2.26
A ₅ = Alternate year only <i>rabi</i>	1198	1665	2771	37665	16376	21289	2.30
A ₆ = Alternate year both <i>kharif and rabi</i>	1382	1809	3091	41445	16680	24765	2.48

*PM=pearlmillet

References

1. Mehta, Y. K., Shaktavat, M. S. and Singh, S. M. 2005. Influence of sulture, phosphorus and farm yard manure on yield attributed and yield of maize (*Zea mays*) in southern Rajasthan conditions. *Indian J. Agron.* **50** : 203-205.
2. Kumpawat, B. S. and Rathore, S. S. 1995. Response of maize (*Zea mays*) - wheat (*Triticum aestivum*) cropping sequence to fertilizer application. *Indian J. Agron.* **40** : 26-29.
3. Annual Report 2003. Annual Report of cropping system Research PDCSR, Modipuram. pp.93.

Bio-efficacy of various insecticidal treatments against chickpea pod borer [*Helicoverpa armigera* (Hubner) Hardwick] in lucerne seed production

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Abstract

Various insecticides were tested for the control of lucerne pod borer, *H. armigera* in lucerne seed production. Among various treatments, endosulfan 0.07 per cent was found significantly superior over the rest of the treatments in controlling the larval population and it was at par with quinalphos 0.05 per cent in increasing the seed yield. Polytrin C 0.044, chlorpyrifos 0.05 and cypermethrin 0.01 per cent were at par with each other in controlling the pest as well as increasing the seed-yield. Considering the economics of the insecticides, all the treatments gave appreciable NICBR (Net Incremental Cost Benefit Ratio). The chronological order of various insecticidal treatments based on Net Incremental Cost Benefit Ratio was : quinalphos 0.05 per cent (1:36.64) > chlorpyrifos 0.05 per cent (1:33.87) > cypermethrin 0.01 per cent (1:31.09) > endosulfan 0.07 per cent (1:28.95) > NSKS 5 per cent (1:18.37) > Gronim 0.0005 per cent (1:18.20) > Polytrin C 0.044 per cent (1:16.83) > profenophos 0.05 per cent (1:14.46) > HaNPV 250 LU (1:07.44). However, the highest NICBR was recorded in the treatments of quinalphos 0.05 per cent followed by chlorpyrifos 0.05, cypermethrin 0.01, endosulfan 0.07 and NSKS 5 per cent.

Keywords : Bio-efficacy, *Helicoverpa armigera*, lucerne, seed production.

Introduction

Lucerne (*Medicago sativa* Linnaeus) is one of the important perennial forage legume crops of India, which is also known as the "Queen of cultivated fodder crops" or "Green gold". It provides good quality nutritious fodder and also improves the soil fertility. The crop provides a continuous supply of green fodder for 3-4 years from the same field under favourable soil and climatic conditions. It has world wide distribution and mainly cultivated in USA, USSR, Australia, Argentina, France, New Zealand, Bulgaria and India. In India, it is mainly cultivated in Gujarat, Haryana, Punjab, Madhya Pradesh, Uttar Pradesh and Maharashtra. In Gujarat, cultivation of lucerne is mostly confined to Saurashtra as well as north and middle Gujarat covering about 62,000 ha. (1). Gujarat is the leading state in lucerne seed production and its supply to Rajasthan and other states of India.

The crop suffers from the attack of aphid (*Therioaphis maculata* Buckton), gram pod borer [*Helicoverpa armigera* (Hubner)] and leaf eating caterpillar (*Spodoptera litura* Fabricius), whereas leaf hopper (*Amrasca biguttula biguttula* Ishida) and alfalfa weevil (*Hypera postica* Gyllenhal) are minor pests.

H. armigera is considered as one of the major lepidopterous pests in lucerne seed production. During summer months, it survives on lucerne crop cultivated for seed production purpose in absence of other host crops in the field (2). Different insect-pests caused loss in lucerne seed yield up to 16.49 per cent in Gujarat (3).

Material and methods

With a view to test the efficacy of different insecticides against *H. armigera* in lucerne cultivated for seed production, a field experiment was conducted at Forage Research Farm, Gujarat Agricultural University during rabi-summer season of the year 2002 to 2003. Ten treatments including control were tried in randomized block design with three replications. Lucerne variety Anand-2 was sown at 25 cm between two rows having gross and net plot size of 4.5x3.5 m and 4x3 m, respectively. All the recommended agronomical practices were followed for raising the crop. The insecticidal treatments were given twice, first at 50 % flowering and second at 50 % podding which were applied with the help of knapsack sprayer and quantity of spray solution was @ 750 lit. per hectare. Observations on number of larvae were

recorded from one square meter area in each plot before 24 hours and 1,3,5 and 7 days after each spray. The data on larval number was subjected to statistical analysis after square root transformation.

Seed yield from each treated plot was also recorded separately and subjected to statistical analysis. Economics and effectiveness of the treatments were worked out.

Results and discussion

Effectiveness of different conventional insecticides, botanicals and NPV were evaluated against *H. armigera* in lucerne cultivated for seed production.

Effect of different insecticides on larval population based on pooled over periods and sprays

It is evident from the pooled data of first spray (Table 1) that all the insecticidal treatments were significantly superior over control. A close perusal of the data on larval population of *H. armigera* in different treatments indicated that endosulfan 0.07 and quinalphos 0.05 per cent were found significantly more effective in reducing the larval population over rest of the treatments. Polytrin C 0.044 and chlorpyrifos 0.05 per cent were closely followed by quinalphos 0.05 per cent. Cypermethrin 0.01 per cent was at par with Polytrin C 0.044 per cent. Profenophos 0.05 per cent was next best treatment but, was at par with Gronim 0.0005 per cent. It was further revealed that HaNPV 250 LU and NSKS 5 per cent were found to be the least effective treatments.

Pooled data of second spray revealed that all the insecticidal treatments proved significantly superior in controlling pest population over control. The plots treated with endosulfan 0.07 and quinalphos 0.05 per cent were found to be most effective treatment in controlling the larval population. Polytrin C 0.044 per cent and quinalphos 0.05 per cent were at par with each other. Polytrin C 0.044, cypermethrin 0.01, and chlorpyrifos 0.05 per cent were next effective treatments and also at par with each other, whereas profenophos 0.05 and Gronim 0.0005 per cent were at par with each other. The remaining insecticidal treatments were less effective in controlling the larval population.

Thus, on the basis of pooled data of two sprays, it can be concluded that among different insecticidal treatments, endosulfan 0.07, quinalphos 0.05, Polytrin

C 0.044, chlorpyrifos 0.05, cypermethrin 0.01 and profenophos 0.05 per cent were proved to be most effective in controlling this pest under field conditions, whereas Gronim 0.0005 per cent, HaNPV 250 LU and NSKS 5 per cent were proved less effective in controlling this pest.

Seed yield

The data (Table 1) on seed yield (kg/ha) revealed that all the insecticidal treatments recorded significantly higher seed yield over control. Among the various treatments under test, the plots treated with endosulfan 0.07 per cent gave the highest seed yield (530.56 kg/ha) and it was at par with quinalphos 0.05 (506.94 kg/ha) and Polytrin C 0.044 percent (454.17 kg/ha). Among the remaining treatments, chlorpyrifos 0.05 (412.50 kg/ha), cypermethrin 0.01 (391.67 kg/ha), profenophos 0.05 (383.33 kg/ha) and Gronim 0.0005 per cent (372.22 kg/ha) were at par with each other, whereas chlorpyrifos 0.05 (412.50 kg/ha) was at par with Polytrin C 0.044 (454.17 kg/ha). These treatments were found next effective in increasing the yield as compared to endosulfan 0.07 and quinalphos 0.05 per cent. The treatments of HaNPV 250 LU (347.22 kg/ha) and NSKS 5 percent (327.78 kg/ha) showed lower yield and proved to be less effective, however these treatments were superior over control. Thus, on the basis of seed-yield, the treatments can be arranged as :endosulfan 0.07 per cent (530.56 kg/ha) > quinalphos 0.05 per cent (506.94 kg/ha) > Polytrin C 0.044 per cent (454.17 kg/ha) > chlorpyrifos 0.05 per cent (412.50 kg/ha) > cypermethrin 0.01 percent (391.67 kg/ha) > profenophos 0.05 per cent (383.33 kg/ha) > Gronim 0.0005 per cent (372.22 kg/ha) > HaNPV 250 LU (347.22 kg/ha) > NSKS 5 per cent (327.78 kg/ha) > control (water spray) (205.56 kg/ha).

Different workers have tested number of insecticides against *H. armigera* on different crops. Mishra and Saxena (4) reported that two applications of endosulfan 0.07 and quinalphos 0.05 per cent proved effective in reducing the damage to pods of chickpea. Bapodra (5) reported that endosulfan 0.07 per cent.

Incremental Cost Benefit Ratio (ICBR)

To know the economics of different insecticidal treatments, ICBR was worked out on the basis of seed yield and the details are presented in Table 2. The chronological order of various insecticidal treatments based on Net Incremental Cost Benefit Ratio was:

Table 1. Efficacy of different insecticides, botanicals and NPV against *H. armigera* in lucerne seed production (Pooled over periods and sprays)

Treatment	Number of larvae / sq. meter area				Seed-yield (kg/ha)
	Before spray	I spray	II spray	Pooled	
Endosulfan 0.07 %	2.70 ^a (6.79)	1.21 ^f (0.96)	1.19 ^f (0.92)	1.20 ^g (0.94)	530.56 ^a
Cypermethrin 0.01%	2.58 ^a (6.16)	1.66 ^d (2.25)	1.63 ^d (2.16)	1.65 ^e (2.22)	391.67 ^{bc}
Chlorpyrifos 0.05%	2.54 ^a (5.95)	1.63 ^{de} (2.16)	1.65 ^d (2.22)	1.64 ^e (2.19)	412.50 ^{bc}
Polytrin C 0.044%	2.57 ^a (6.10)	1.63 ^{de} (2.16)	1.58 ^{de} (2.00)	1.61 ^e (2.09)	454.17 ^{ab}
Quinalphos 0.05%	2.61 ^a (6.31)	1.44 ^{ef} (1.57)	1.42 ^{ef} (1.52)	1.43 ^f (1.54)	506.94 ^a
Profenophos 0.05%	2.62 ^a (6.36)	1.92 ^c (3.19)	1.90 ^c (3.11)	1.91 ^d (3.15)	383.33 ^{bc}
HaNPV250LU	2.59 ^a (6.21)	2.14 ^b (4.08)	2.14 ^b (4.08)	2.14 ^{bc} (4.08)	347.22 ^c
NSKS 5 %	2.64 ^a (6.45)	2.18 ^b (4.25)	2.18 ^b (4.25)	2.18 ^b (4.25)	327.78 ^c
Gronim 0.0005%	2.70 ^a (6.79)	2.05 ^b (3.70)	2.03 ^{bc} (3.62)	2.04 ^c (3.66)	372.22 ^{bc}
Control (Water spray)	2.67 ^a (6.63)	2.71 ^a (6.84)	2.84 ^a (7.56)	2.77 ^a (7.17)	205.56 ^d
Mean	2.62 (6.36)	1.86 (2.96)	1.86 (2.96)	1.86 (2.96)	393.19
S.Em ±	0.10	0.07	0.07	0.05	33.64
T x P	0.16	0.15	0.17	0.11	99.94
C.V. %	10.62	13.99	13.59	13.79	14.82

Note: 1. Figures in the parentheses are retransformed and those outside are $\sqrt{x \pm 0.5}$ transformed values

2. Figures with letter (s) in common do not differ significantly by DNMRT

Table 2. Details of incremental cost benefit ratio (ICBR) for different insecticidal treatments

Insecticide	Quantity of insecticide (l/kg/ha)	Total cost of treatments (kg/ha) including labour charges for two application (Rs/ha)	Yield (kg/ha)	Gross realization (Rs/ha)	Net profit (Rs/ha)	Profit over control (Rs/ha)	ICBR	Net ICBR
Endosulfan	3	1050	530.56	53056	52006	31450	1:29.95	1:28.95
Cypermethrin	0.750	562.50	391.67	39167	38605	18049	1:32.09	1:31.09
Chlorpyrifos	1.5	585	412.50	41250	40665	20109	1:34.37	1:33.37
Polytrin C	1.5	1320	454.17	45417	44097	23541	1:17.83	1:16.83
Quinalphos	1.5	780	506.94	50694	49914	29358	1:37.64	1:36.64
Profenophos	1.5	1080	383.33	38333	37253	16697	1:15.46	1:14.46
HaNPV	0.500	1500	347.22	34722	33222	12666	1:08.44	1:07.44
NSKS	75	600	327.78	32778	32178	11622	1:19.37	1:18.37
Gronim	0.750	825	372.22	37222	36397	15841	1:19.20	1:18.20
Control (Water Spray)	-	-	205.56	20556	-	-	-	-

quinalphos 0.05 per cent (1:36.64) > chlorpyrifos 0.05 per cent (1:33.87) > cypermethrin 0.01 percent (1:31.09) > endosulfan 0.07 per cent (1:28.95) > NSKS 5 per cent (1:18.37) > Gronim 0.0005 per cent (1:18.20) > Polytrin C 0.044 per cent (1:16.83) > profenophos 0.05 per cent (1:14.46) > HaNPV 250 LU (1:07.44). Thus, from the view point of NICER in various treatments, the maximum NICBR was gained in the treatment of quinalphos 0.05 per cent (1:36.64) followed by chlorpyrifos 0.05 per cent (1:33.87). Lower NICBR was gained in the treatment of profenophos 0.05 per cent (1:14.46) and HaNPV 250 LU (1:07.44). Thus, the treatment of quinalphos 25 EC @ 0.05 per cent at 50% flowering and 50% podding stage can be recommended to the farmer as it gave the highest NICBR and gave protection against this pest.

References

1. Hazra, C. A. 1995. Forages Resources. In: Advances in Forage Production Technology. ICAR, New Delhi. pp. 2-7.
2. Yadav, D. N., Patel, R. C. and Patel, D. S. 1986. Seasonal abundance of *H. armigera* (Lepi-doptera : Noctuidae) on different host plants at Anand (Gujarat). *GAU Res. J.* 11 : 32-35.
3. Patel, C. C., Patel, J. R., Patel, T. D., Patel, S. A., Yadavendra, J.P., Patel, M.R. and Vaishnav, P. R. 2003. Assessment of loss in yield of lucerne seed due to different pests. National Symposium on Sustainability, Advancement and Future Thrust areas of Research on Forages. CCS HAU, Hisar, Haryana. March 5-6, 2003.
4. Mishra, R. N. and Saxena, H. P. 1981. Search for safer insecticides while controlling pod borer in chickpea, *Cicer arietinum* L. *Int. Chickpea Newsletter* 5:12-13.
5. Bapodra, J. G. 1988. Biometrical analysis, biology, population dynamics and chemical control of *H. armigera* (Hubner) under Junagadh condition. Ph. D. Thesis. GAU, Sardarkrushinagar.

Efficacy of native insect pathogens against *Plutella xylostella* and *Helicoverpa armigera* on cabbage

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Abstract

Bioefficacy of three native insect pathogens viz. *Bacillus thuringiensis* (Berliner) (GAU TOB 1), *Heterorhabditis* sp. (GAU A02) and *Metarrhizium anisopliae* var. *anisopliae* (Metschnikoff) Sorokin (GAU Ma) for microbial control of Diamond back moth (*Plutella xylostella* Linn.) and head borer (*Helicoverpa armigera* (Hub)) on cabbage (*Brassica oleracea* var. *capitata* L.). All the treatments were tested in CRD with 4 replications in micro plot (1 m x 1 m) under net house conditions during the year 2003 and 2004. The larval mortality was recorded at 24 hrs intervals up to 12 days. Results exhibited that treatments of insect pathogens like bacteria, fungus and nematodes remained significantly superior over control. Maximum larval mortality was in *B. thuringiensis* (65.0 and 67.50%) followed by *Heterorhabditis* (42.50 and 42.0%) and *M. anisopliae* (30.0 and 35.0%) of *P. xylostella* and *H. armigera*, respectively. But Endosulfan being a chemical insecticide quickly reduced population of insects. Study indicated that laboratory augmented native insect pathogens were found very effective in suppression of insects and *B. thuringiensis* was found best amongst them.

Keywords : Pathogens, *Plutella xylostella*, *Helicoverpa*, cabbage.

Introduction

Cabbage is one of the chief vegetables generally cultivated in almost all the states of India. In Gujarat, cabbage is grown during late monsoon and *rabi* season, in an area of about 6.8 thousand hectares (1). Insects that damage the cabbage are Diamond back moth (DBM), head borer, cabbage semilooper, leaf eating caterpillar, aphid, whitefly etc., of which DBM (*Plutella xylostella* Linnaeus) and head borer (*Helicoverpa armigera* Hubner) are the major caterpillar pests causing economic damage and widely distributed throughout the state. The estimated avoidable yield loss caused by *H. armigera* in cabbage is 31.5 per cent (2). Management of cabbage pests is mostly insecticide oriented since last four to five decades (3). In recent past use of insecticides is being curtailed on vegetable crops due to their harmful effects. Hence, control of insects by biological methods has become today's prime need. Hence studies on native insect pathogens viz. *Bacillus thuringiensis* (Berliner) (GAU TOB 1), *Heterorhabditis* sp. (GAU A02) and *Metarrhizium anisopliae* var. *anisopliae* (Metschnikoff) Sorokin (GAU

Ma) for biological control of DBM (*P. xylostella* Linn.) and head borer (*H. armigera* (Hub)) on cabbage (*B. oleracea* var. *capitata* L.) were carried out. The microorganisms used in present study are neither imported nor exotic or genetically modified.

Material and methods

Bioefficacy of three native insect pathogens against *P. xylostella* and *H. armigera* on cabbage in micro plots

The treatments comprised (1) *B. thuringiensis* (GAU TOB1) @ 10^9 spore crystal mixture/m², (2) *Heterorhabditis* sp. (Anand isolate, GAU A02) @ 1,00,000 IJs/ m², (3) *M. anisopliae* var. *anisopliae* (GAU Ma) @ 10^9 conidia/ m², (4) Treated check (Endosulfan 35 EC @ 0.07%) and (5) Untreated check (control). The cabbage crop variety JAVA was planted at a distance of 40 x 40 Cm (3 Rows). The laboratory reared second instar healthy larvae of DBM and head borer were released @ 10 larvae/ micro plot uniformly on the cabbage plants in micro plots located at the Department of Nematology in net house.

Insect Pathogens used for the study

Bacillus thuringiensis (Berliner)

A native isolate of *Bt* (GAU TOB1) isolated from tobacco field (No. 10) of BTRS farm, Anand (4) was used for the study (Identified by Microbial Type Culture Collection (MTCC), Chandigarh). For maintenance and mass production Media used were, Yeast Extract Mannitol Polymixin - B Agar, YEMA (5) and Luria Broth - LB (6).

Entomopathogenic Nematode (EPN)

A native isolate of EPN, *Heterorhabditis sp.* (GAU A02) isolated from tobacco field of nearby village Gamdi, Tahsil and District-Anand was used for the study. It was cultured and mass-produced by *In vivo* mass production on rice moth larvae (*Corcyra cephalonica*) in laboratory (7). For the field application EPN was mass cultured using *in vitro* technique on egg yolk agar media at $27 \pm 1^\circ\text{C}$ (8)

Entomopathogenic Fungus (*Metarrhizium anisopliae*)

A native isolate of *M. anisopliae* (GAU Ma) isolated from infected white grub at Anand, identified by CBI, UK (1986) was used in the study (9). Fungus stock culture was usually accomplished on selective agar media (10, 11) For mass production PDA plates (50) were inoculated under sterile conditions @ 10^4 spores/plate from stock fungal culture.

Test Insects (*P. xylostella* and *H. armigera*)

P. xylostella and *H. armigera* larvae were used as a target and test insect for laboratory studies which were reared in laboratory.

Results and discussion

After 24 hrs of treatment larval mortality was not started in all the native isolates treatment. But, Endosulfan being chemical insecticide induced quick mortality of *P. xylostella* and *H. armigera* viz., 42.50 and 37.50 per cent, respectively. *Bt* came into action after 48 hrs of treatment giving 15.0 and 17.50 per cent mortality in *P. xylostella* and *H. armigera* respectively. Whereas, *Heterorhabditis sp.* and *M. anisopliae* expressed their action only after 3 and 5 days of treatment respectively on both the insects tested.

At 5th day of treatment there was significant differences amongst the treatments. Endosulfan showed 77.50 and 75.0 per cent larval mortality against *P. xylostella* and *H. armigera*, respectively. On the 5th day *Bt* showed good control of larvae recording more than 50 per cent mortality of target insects. *Heterorhabditis sp.* also showed 32.50 and 35.0 per cent mortality, *M. anisopliae* was found relatively less effective among all the pathogens giving 5.01 and 7.5 mortality but it was significantly superior over control. Same trend on larval mortality as of 5th day was also recorded on 7th, 9th and 11th day due to different treatments. At 11th day all the treatments were found significantly superior over control. The highest mortality was observed in Endosulfan followed by *Bt*, *Heterorhabditis sp.* and *M. anisopliae* for both the insects tested. In untreated control no mortality was observed throughout the experiment.

The experiment showed that among the three native insect pathogens, the *Bt* gave higher *P. xylostella* and *H. armigera* larval mortality (65.0 and 67.50 %) followed by *Heterorhabditis sp.* (40.0 and 45.0 %) and *M. anisopliae* (30.0 and 35.0 %) respectively. Study indicates that laboratory augmented different insect pathogens were very effective in suppression of insect and *B. thuringiensis* was found the best.

References

1. Anonymous. 1999. Annual Seasonal Report. Krushi Bhavan, Gandhinagar.
2. Borad, P.K.; Patel, J.R. and Patel, M.H. 1991. Evaluation of vegetable, pigeonpea (*Cajanus cajan*) genotypes resistance to gram- pod borer (*H. armigera*), Plume moth (*M. liophanes*) and Pod fly (*Melanogromyza obtuse*). Indian J. Agric. Sci. **61**: 682-684.
3. Garcia, R.J.L. 1991. Effect of Diazinon, deltamethrin and *B. thuringiensis* var. *kurstaki* on larvae of Lepidopteron on cabbage. Bull. De. Ent. Venezolana **6**:19-25.
4. Maghodia, A.B. 2002. Isolation of native *Bacillus thuringiensis* and its bioefficacy against leaf eating caterpillars of castor, *Spodoptera litura* Fabricius and *Achoaejanata* Linnaeus. M. Sc. (Agri.) Thesis. GAU, Anand.

5. Mossel, D.A.A., Koopman, M.J. and Jongerium, E. 1967. *Appl. Microbiology* **15** : 650.
6. Lennox, E.S. 1955. Transduction of Linked Genetic characters of the host by bacteriophages P_1 . *Virology* **1**:190.
7. Woodring, J. L. and Kaya, H. K. (1988). *Steinernematid and Heterorhabditid nematodes: A handbook of Techniques Southern Cooperatives Series Bulletin 331*. Arkansas Agric. Expt. Stat. Fayetteville, AK, USA pp.30.
8. Vyas, R.V., Pharindra Yadav, Ghelani, Y. H., Chaudhary, R. K., Patel, N. B. and Patel, D. J. 2001. *In vitro* mass production of native *Steinernemas*. *Annal of Pl. Protec. Sci.* **9** : 77-78.
9. Patel, K.C., Vyas, R.V., and Yadav, D.N. 1991. Distribution of milky disease and green muscardine disease of white grub in Central Gujarat. *J. Biol. Cont.* **5** : 101-104.
10. Veen, K.H. and Perron, P. 1966. A selective media for the isolation of *Metarrhizium anisopliae*. *J. Insect Pathol.* **8**:268-69.
11. Liu, Z.Y., Milner, R.J., McRae, C.F. and Lutton, G.G. 1993. The use of dodine in selective media for isolation of *Metarhizium* spp. from soil. *J. Invertebr. Pathol.* **62** : 248-51

Table 1. Bioefficacy of insect pathogen against *P. xylostella* and *H. armigera* in micro plot.

Treatments	Per cent mortality of days									
	1	2	3	4	5	7	9	11		
Bt	DBM [*] 1.51 (0.02)*	H.a. 24.56 (17.50)	DBM 36.23 (35.00)	H.a. 43.56 (47.50)	DBM 46.89 (55.00)	H.a. 50.51 (57.50)	DBM 58.78 (65.00)	H.a. 59.21 (67.50)	DBM 58.78 (65.00)	H.a. 59.21 (67.50)
Hetero sp.	DBM 1.51 (0.02)	H.a. 1.51 (0.02)	DBM 20.54 (12.50)	H.a. 28.25 (22.50)	DBM 34.73 (32.50)	H.a. 36.23 (35.00)	DBM 40.65 (42.00)	H.a. 42.25 (45.00)	DBM 40.68 (42.50)	H.a. 42.25 (45.00)
M.a	DBM 1.51 (0.02)	H.a. 1.51 (0.02)	DBM 1.51 (0.02)	H.a. 1.51 (0.02)	DBM 9.99 (5.01)	H.a. 11.20 (7.50)	DBM 22.33 (15.00)	H.a. 24.56 (17.50)	DBM 29.23 (30.00)	H.a. 29.23 (35.00)
Endo	DBM 40.60 (42.50)	H.a. 33.34 (37.5)	DBM 62.28 (62.50)	H.a. 58.48 (72.50)	DBM 61.78 (77.50)	H.a. 63.11 (75.00)	DBM 69.54 (87.50)	H.a. 68.20 (85.00)	DBM 69.54 (87.50)	H.a. 69.54 (85.00)
Control	DBM 1.51 (0.02)	H.a. 1.51 (0.02)	DBM 1.51 (0.02)	H.a. 1.51 (0.02)	DBM 1.51 (0.02)	H.a. 1.51 (0.02)	DBM 1.51 (0.02)	H.a. 1.51 (0.02)	DBM 1.51 (0.02)	H.a. 1.51 (0.02)
S.Em +	DBM 0.64 (0.02)	H.a. 0.67 (0.02)	DBM 1.23 (0.02)	H.a. 1.23 (0.02)	DBM 2.52 (0.02)	H.a. 2.41 (0.02)	DBM 1.71 (0.02)	H.a. 2.41 (0.02)	DBM 1.91 (0.02)	H.a. 2.41 (0.02)
CD _{0.05}	DBM 1.94 (0.02)	H.a. 2.02 (0.02)	DBM 3.70 (0.02)	H.a. 3.71 (0.02)	DBM 7.59 (0.02)	H.a. 7.27 (0.02)	DBM 5.12 (0.02)	H.a. 7.27 (0.02)	DBM 5.77 (0.02)	H.a. 7.27 (0.02)
CV%	DBM 13.78 (0.02)	H.a. 15.35 (0.02)	DBM 12.23 (0.02)	H.a. 9.45 (0.02)	DBM 16.17 (0.02)	H.a. 13.79 (0.02)	DBM 9.12 (0.02)	H.a. 11.23 (0.02)	DBM 9.98 (0.02)	H.a. 10.73 (0.02)

Hetero sp. = *Heterorhabditis* sp. M.a. = *Metarhizium anisopliae*

Arc sin transformation

*Figures in parentheses are retransformed values

Effect of different herbicides on nutrient uptake by weeds as well as maize under middle Gujarat conditions

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Abstract

An experiment was conducted during *Kharif* seasons of 2001 and 2002 at the College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand to find out the effect of different herbicides on nutrient uptake by weeds as well as Maize under middle Gujarat conditions. The results revealed that all the herbicidal treatments were found to be effective with respect to depletion of nutrients by weeds. In general, minimum depletion of nutrients by weeds and higher uptake of nutrients by crops were observed under pre emergence application of atrazine (0.5 kg/ ha) + pendimethalin (0.25 kg/ha) and treatment of twice hand weeding done at 20 and 40 DAS. Significantly highest depletion of nutrients (17.79, 10.18 and 29.06 kg N, P and K per hectare, respectively) by weeds was recorded under weedy check treatment.

Key words : Herbicides, weeds, uptake and maize.

Introduction

Maize is one of the most important cereal crops in the world's agriculture economy both as food for human being and feed for animals. Being a rainy season crops, its suffers with number of weed species which affect the growth and development. Weeds are generally vigorous growers and their nutrient requirements are often larger than the crop plant. Weeding is normally done after they have attained sufficient growth by which time a great deal of damage has already been done to the crop in terms of drain of nutrients and competition for water and light. The extent of yield reduction due to infestation of grassy weeds, non-grassy weeds and sedge alone was 84.4, 31.7 and 21.5 per cent, respectively over weed free condition in maize (1). Chemical weed control is a better supplemented method and forms an integral part of the modern crop production. Effective control of weeds through two or more herbicidal mixtures curtails the flow of nutrient uptake by weeds and provide weed free environment to the crop. Hence, an experiment was planned to find out the effect of herbicidal mixture on nutrient uptake by weeds as well as maize under middle Gujarat conditions.

Material and methods

A field experiment was carried out for two consecutive rainy seasons of 2001 and 2002 at College Agronomy Farm, Anand Agricultural University, Anand, Gujarat, India. The soil was sandy loam in texture having low available nitrogen and medium available phosphorus and high potassium with pH 7.8. The experiment was laid out in randomized block design with four replications involving 16 treatments comprising atrazine, alachlor and metolachloreach @ 1.0 kg/ha, metribuzin @ 0.30 kg/ ha; pendimethalin @ 0.50 kg/ha and their feasible mixtures were applied at half of the rate and compared with twice hand weedings carried out at 20 and 40 DAS and weedy check. All the herbicides were applied as pre- emergence using 500 L of water/ha. Maize variety GM-4 was sown at a row spacing of 60 cm during first week of July in both the years. Full dose of phosphorus and half dose of the nitrogen through diammonium phosphate and urea were applied at the time of sowing and remaining quantity of nitrogen was applied at knee-high stage. The crop received 484 mm rainfall during 2001 and 1110 mm during 2002. In general, weather conditions were favourable for plant growth and no severe pest and diseases were noticed during both the

years of experimentation. Weed species and their dry weight were recorded periodically from the randomly selected quadrates (1.0 m²) in each plot. Data on density of weeds were subjected to transformation for statistical analysis.

Results and discussion

N, P and K uptake by grains

The results presented in Table 1 clearly indicated that all the herbicidal treatments showed considerable increase in N, P and K uptake by grain. Under conventional method (Twice hand weeding) crop

removed 41.49, 18.03 and 23.60 kg NPK/ha respectively, which was 2.5 times higher than weed check. Similarly, Sangwan *et al.* (2) also observed higher uptake of nitrogen by grain under conventional method. Among herbicidal treatments, application of atrazine + pendimethalin recorded higher uptake of N and K, while pre-emergence application of atrazine + metolachlor recorded higher uptake of P than other treatments. In general, all the herbicidal mixtures were found superior in increasing the uptake of NPK by grain. This might be due to congenial conditions provided through effective control of weeds and consequently made more nutrients available to maize and thereby higher uptake of nutrients. Gonzalez and

Table 1. Effect of herbicidal treatments on nutrient uptake by crop and weeds (Mean of two years)

Treatment	Dose (kg/ha)	Nutrient uptake by grains (kg/ha)			Nutrient uptake by stover (kg/ha)			Nutrient uptake by weeds (kg/ha)		
		N	P	K	N	P	K	N	P	K
T ₁ : Atrazine	1.00	31.18	14.25	19.29	27.11	11.39	48.59	2.92	1.84	5.41
T ₂ : Alachlor	1.00	28.96	13.32	18.28	26.62	12.35	45.55	4.71	3.09	8.44
T ₃ : Metolachlor	1.00	26.73	12.38	18.48	18.36	11.31	43.35	3.86	2.93	9.09
T ₄ : Metribuzin	0.30	20.99	9.97	15.81	19.21	7.81	30.37	5.97	3.44	9.37
T ₅ : Pendimethalin	0.50	30.04	12.53	19.36	30.20	12.37	48.15	4.54	2.34	6.17
T ₆ : Atrazine + Alachlor	0.50 + 0.50	35.15	16.06	21.20	30.74	12.79	48.21	0.35	0.16	0.56
T ₇ : Atrazine + Pendimethalin	0.50 + 0.25	40.66	17.20	23.37	31.12	15.27	50.21	0.21	0.07	0.30
T ₈ : Atrazine + Metolachlor	0.50 + 0.50	34.36	18.58	20.57	27.81	14.19	49.83	1.00	0.43	1.693
T ₉ : Atrazine + Metribuzin	0.50 + 0.15	32.28	13.13	19.52	26.71	14.59	41.36	1.46	0.82	2.69
T ₁₀ : Metolachlor + Metribuzin	0.50 + 0.15	35.09	16.25	20.94	31.00	14.57	46.57	1.26	0.50	1.74
T ₁₁ : Metolachlor + Pendimethalin	0.50 + 0.25	35.01	14.41	19.97	27.92	14.46	48.60	1.47	0.60	2.58
T ₁₂ : Alachlor + Metolachlor	0.50 + 0.50	31.78	12.15	20.05	26.00	12.23	35.16	2.86	1.50	5.32
T ₁₃ : Alachlor + Pendimethalin	0.50 + 0.25	37.28	15.72	21.19	30.90	14.35	47.92	1.98	0.94	2.91
T ₁₄ : Alachlor + Metribuzin	0.50 + 0.15	32.32	12.83	19.75	23.09	10.81	43.00	2.98	1.59	4.58
T ₁₅ : Weed free (HW at 20 & 40 DAS)		41.49	18.03	23.60	31.42	15.70	47.00	0.27	0.13	0.42
T ₁₆ : Weedy check		12.92	8.69	8.80	9.21	5.72	19.73	17.79	10.18	29.06
S.E.m. +		0.79	0.41	0.37	0.36	0.25	0.45	0.32	0.15	0.56
C. D. (P=0.05)		2.39	1.22	1.05	1.02	0.70	1.27	0.97	0.45	1.69
C.V. (%)		5.04	5.29	5.45	4.01	5.88	3.04	5.36	13.49	16.83

Table 2. Effect of herbicidal treatments on yields and economics (Mean of two years)

Treatments	Dose (kg/ha)	Grain yield (kg/ha)	Stover yield (kg/ha)	Cost: benefit ratio
T ₁ : Atrazine	1.00	3386	6155	2.57
T ₂ : Alachlor	1.00	3254	6120	2.63
T ₃ : Metolachlor	1.00	3065	5688	2.20
T ₄ : Metribuzin	0.30	2439	3944	1.73
T ₅ : Pendimethalin	0.50	3314	6166	2.44
T ₆ : Atrazine + Alachlor	0.50 + 0.50	3582	6266	2.78
T ₇ : Atrazine + Pendimethalin	0.50 + 0.25	3652	6366	2.71
T ₈ : Atrazine + Metolachlor	0.50 + 0.50	3548	6245	2.60
T ₉ : Atrazine + Metribuzin	0.50 + 0.15	3489	6162	2.60
T ₁₀ : Metolachlor + Metribuzin	0.50 + 0.15	3494	6219	2.53
T ₁₁ : Metolachlor + Pendimethalin	0.50 + 0.25	3491	6258	2.52
T ₁₂ : Alachlor + Metolachlor	0.50 + 0.50	3271	6019	2.48
T ₁₃ : Alachlor + Pendimethalin	0.50 + 0.25	3509	6253	2.68
T ₁₄ : Alachlor + Metribuzin	0.50 + 0.15	3240	6014	2.55
T ₁₅ : Weed free (HW at 20 & 40 DAS)		3658	6355	2.66
T ₁₆ : Weedy check		1947	3471	1.87
S.E.m.±		62.83	56.85	—
C. D. (P=0.05)		177	160	—
C.V. (%)		12.85	10.22	—

Salas (3) also observed higher uptake of N, P and K by maize under application of atrazine + metolachlor than unweeded control. In weedy check treatment, crop utilized only 12.92, 8.69 and 8.80 kg NPK/ha, respectively. This might be due to acute crop-weed competition for mineral nutrition, which resulted from maximum total weed population.

N, P and K uptake by stover

Differences due to different treatments with respect to uptake of nutrients by stover were found to be significant. The results showed that all the herbicidal and twice hand weeding treatment recorded maximum uptake of N, P and K by stover as compared to weedy check. Crop under twice hand weeding treatment utilized 31.42, 15.70 and 47.00 kg N, P and K per hectare, respectively, which was higher than weedy check. Sangwan *et al.* (2) also reported that conventional method for weed control in maize proved superior and recorded maximum uptake of nitrogen by stover. Maximum uptake of nitrogen, phosphorous and potash was observed under treatments of herbicidal mixtures as weed free condition provided luxurious growth of crop, which directly leads to

increase in nutrient uptake by stover. Under weedy check, crop utilized only 9.21, 5.72 and 19.73 kg N, P and K per hectare, respectively.

N, P and K uptake by weeds

The differences in the total losses of nutrients by weeds were more a function of the total biomass production by these weeds under any particular treatment. Weed control treatments lowered the quantum of N, P and K drain by weeds in comparison to weedy check treatment. Weeds removed 17.79, 10.18 and 29.06 kg N, P and K per hectare, respectively which was the highest in weedy check and the lowest nutrient drain of 0.21, 0.07 and 0.30 kg N, P and K /ha by weeds under pre-emergence application of atrazine + pendimethalin followed by twice hand weeding, atrazine + alachlor and atrazine with metolachlor. These results are in accordance with the results of Sreenivas and Satyanarayana (4) who noted the highest uptake of nitrogen by weeds under weedy check treatment. Thus, it can be concluded that use of herbicidal mixtures helps in minimizing nutrient drain by weeds leading to improvement in the nutrition of crop and enhancement in the crop yield.

Effect of treatments on yield

All the herbicide treatments showed significant variation in grain yield as compared to unweeded control (Table 2). Grain and stover yield of maize were significantly higher under pre-emergence application of atrazine with pendimethalin closely followed by twice hand weeding treatment, pre-emergence application of atrazine with alachlor and metolachlor plus metribuzin. Among herbicidal treatments, significantly lowest grain and stover yields was recorded under pre-emergence application of metribuzin @ 0.30 kg/ha due to its phytotoxic effect on maize crop. The maximum yield under said treatment might be due to enhanced efficacy of herbicides applied as mixture which might have prevented the rapid detoxification and maintained their potent action for a longer period leading to increased nutrient uptake and thereby growth and yield of crop. The yield reduction due to weeds under unweeded control was recorded to the tune of > 44 per cent over manual weeding.

References

1. **Pandey A. K., Prakash V., Singh R. D. and Chauhan V. S.** 1999. Studies on extent of yield reduction due to types of weed flora infestation in maize under mid hills of N-W Himalaya. *8th Biennial conference of Indian society weed science* held at Varanasi. February 5-7, 1999 pp. 38.
2. **Sangwan N., Panwar R. S. and Malik R. K.** 1989. Effect of various herbicides on the nutrient uptake by weeds in winter maize. *Pesticides* **23** : 35-36.
3. **Gonzalez P. R. and Salas M. L.** 1995. Improvement of the growth, grain yield, and nitrogen, phosphorus, and potassium nutrition of grain corn through weed control. *J. Plant Nut.* **18** : 2313-2324.
4. **Sreenivas G. and Satyanarayana V.** 1996. Nutrient removal by weeds and maize (*Zea mays*). *Indian J. Agron.* **41** : 160-162.

Reproductive performance of goats in semi-arid region of North Gujarat

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Abstract

Data were collected on reproductive traits of 925 goats belonging to Mehsana, Kutchi and Sirohi breeds under ICAR-NBAGR network project during 2004-2006. The least squares means for age at first oestrus in Mehsana, Kutchi and Sirohi goats were 13.59 ± 0.07 , 13.27 ± 0.26 and 14.06 ± 0.29 months, respectively. In general, the oestrus cycle was observed to occur around 20 days. The least squares means for oestrus duration were, 42.36 ± 0.42 , 40.37 ± 1.81 and 44.03 ± 0.03 hrs in Mehsana, Kutchi and Sirohi breeds, respectively. The corresponding least squares means for age at first mating were 15.23 ± 0.14 , 15.32 ± 0.27 and 16.06 ± 0.30 months while those for age at first kidding were 20.32 ± 0.12 , 20.41 ± 0.28 and 21.12 ± 0.29 months, respectively. The breed had significant effect ($P < 0.05$) on the service period and kidding interval. The service period was observed to be significantly lowest in Sirohi goats (160.83 ± 5.72 days) followed by Kutchi (172.94 ± 6.69 days) and Mehsana (180.81 ± 2.14 days). The kidding interval also showed the same pattern with estimates of 305.26 ± 4.56 , 315.63 ± 5.74 and 322.27 ± 1.77 days in Sirohi, Kutchi and Mehsana breeds, respectively. The mean gestation period in Sirohi, Kutchi and Mehsana breeds were 150.44 ± 0.78 , 146.92 ± 2.64 and 150.94 ± 0.95 days, respectively.

Key words : Genetic resources, reproductive performance, goats.

Introduction

The goat genetic resources in semi-arid and regions of North Gujarat and Kutch represent an unique example to adjust under the extreme and harsh environment where feed and fodder resources are restricted in quantity and quality, and regular phenomenon of erratic rainfall accompanied with scarcity of water and drought compel goat keepers to migrate during summer. Despite such variable and harsh conditions, the goats contribute significantly to the livelihood of goat owners through milk, meat and manure under low input system prevalent in the area.

The economic traits related to reproduction play an important role in production efficiency, but the information on reproductive traits of goats in North Gujarat is very scanty and the genetic potential of valuable germplasm remains unexploited. The present study, therefore, has been planned to study the reproductive information of goat breeds in North Gujarat under field conditions in farmer's flocks.

Material and methods

The information on reproductive traits in Mehsana (683), Kutchi (43) and Sirohi (199) goats, maintained almost exclusively on grazing/browsing land, were collected from 60 villages randomly selected in the Banaskantha, Patan and Mehsana districts of North Gujarat under ICAR-NBAGR network project during 2004-05. The traits studied were age at first oestrus (months), oestrus cycle duration (days), oestrus duration (hours), age at first mating (months), age at first kidding (months) kidding interval (days) and gestation period (days). The information was collected through a developed questionnaire and also by direct observations in farmer's flocks by regular visits of supervisors and enumerators in the network project. The data were analysed by least squares analysis of variance (1)

Results and discussion

The least squares means along with their standard

Table 1. Least squares means of reproductive traits in different breeds of goats

Traits	Breed		
	Mehsana	Kutchi	Sirohi
Age at first oestrus (months)	13.59 ± 0.07(683)	13.27 ± 0.26 (43)	14.06 ± 0.29(199)
Oestrus cycle duration (days)	20.18 ± 0.12(678)	20.69 ± 0.20(43)	20.50 ± 0.11(32)
Oestrus duration (hours)	42.36 ± 0.42(682)	40.37 ± 1.81 (43)	44.03 ± 0.03 (32)
Age at first mating (months)	15.23 ± 0.14 (674)	15.32 ± 0.27(43)	16.06 ± 0.30(32)
Age at first kidding (months)	20.32 ± 0.12(651)	20.41 ± 0.28(41)	21.12 ± 0.29 (32)
Service period* (days)	180.81 ± 2.14(610)	172.94 ± 6.69(35)	160.83 ± 5.72(32)
Kidding interval* (days)	322.27 ± 1.77(598)	315.63 ± 5.74(35)	304.26 ± 4.56(30)
Gestation period (days)	150.94 ± 0.95(645)	146.92 ± 2.64 (41)	150.44 ± 0.76(32)

Note: Figures within parenthesis indicate number of does.

* Indicate significant difference ($P < 0.05$) between breeds for the traits

errors for reproductive traits in Mehsana, Kutchi and Sirohi goats are presented in Table 1.

The least squares analysis of variance revealed that the breed type was not an important source of variation for age at first oestrus (AFO), oestrus cycle duration (OCD), oestrus duration (OD), age at first mating (AFM), age at first kidding (AFK) and gestation period (AFM), age at first kidding (AFK) and gestation period (GP). The least squares means for AFO, OCD and OD in Mehsana, Kutchi and Sirohi goats were observed to be 13.59 ± 0.07 , 13.27 ± 0.26 and 14.06 ± 0.29 months; 20.18 ± 0.12 , 20.69 ± 0.20 and 20.50 ± 0.11 days, and 42.36 ± 0.42 , 40.37 ± 1.81 and 44.03 ± 0.03 hrs, respectively. The present findings for OCD and OP are in agreement with the results reported by Puneet Kumar (2) in Jamunapari and Beetal goats.

The least squares means for AFM in Mehsana, Kutchi and Sirohi goats were 15.23 ± 0.14 , 15.32 ± 0.27 and 16.06 ± 0.30 months respectively. These findings fairly agree with the reports of Singh *et al.* (3) in Black Bengal goat. However, Kumar and Singh (4) reported higher estimates for AFM in Kutchi goats under organized farm conditions. The corresponding least squares means for AFK in the three breeds were 20.32 ± 0.12 , 20.41 ± 0.28 and 21.12 ± 0.29 months, respectively. The present findings of AFK are in

agreement with the earlier report for Black Bengal (3) and for kutchi and sirohi goats (5). Kumar and Singh (4), however, reported comparatively higher AFK in Kutchi goats under farm conditions.

Least squares analysis of variance showed that there were significant ($P \leq 0.05$) differences between breeds for service period (SP) and kidding interval (KI). Sirohi goats had lowest SP (160.83 ± 0.57 days) followed by Kutchi (172.94 ± 6.69 days) and Mehsana (180.81 ± 2.14 days). Similarly, KI was observed to be significantly lowest in Sirohi (304.26 ± 4.56 days) as compared to Kutchi (315.63 ± 5.74 days) and Mehsana (322.27 ± 1.77 days) goats. These findings are in agreement with the reports of Prakash and Balain (6) for KI in Marwari goats. However, Mishra *et al.* (7) reported lower estimates for SP and KI in Barbari goat.

The least squares means for GP were 150.94 ± 0.05 , 146.92 ± 2.64 and 150.44 ± 0.78 days in Mehsana, Kutchi and Sirohi goats respectively. These finding fairly agree with the reports of Anonymous (5) for large size goat breeds and Mishra *et al.* (7) for Barbari goats.

The overall results revealed that there was no significant difference between Mehsana and Kutchi breeds for majority of reproductive traits studied. However, Sirohi goats excelled in their SP and KI over the other two breeds under farmer's flock in North Gujarat.

References

1. **Harvey, W.R.** 1979. Least-squares Analysis of Data with Unequal Subclass Numbers, ARS, USDA, Beltsville, Maryland.
2. **Puneet Kumar.** 1985. Gestation length, oestrus cycle, oestrus length of different breeds of goat. New Dimensions in goat production CIRG Publication, Makhdoom, Mathura (U.P.).
3. **Singh Satbir, Rana, Z.S., Prakash, B., Kumar Ramesh. Dhaka, S.S. Pander, B.L., Kumar Yogendra and Kumar Sandeep.** 2006. Genetic studies on growth and reproduction traits of Black Bengal goat. Proc. National Symposium on Conservation and Improvement of Animal Genetic Resources. NBAGR, Karnal February 9-10, 2006, pp. 165.
4. **Kumar Arun and Singh, Umesh.** 2004. Factors affecting age and weight at first service and kidding in Kutchi goat. Proc. National Symposium on Livestock Biodiversity. NBAGR, Karnal, February 11-12, 2004 pp.176.
5. **Anonymous.** 2002. Hand Book of Animal Husbandry, Directorate of Information and Publication, ICAR, Krishi Anusandhan Bhavan, Pusa, New Delhi. pp. 121-205.
6. **Prakash, B. and Balain, D.S.** 1992. Conservation, evaluation and utilization of goat germplasm in India. *Indian J. Anim. Prod. Mgmt.* 81:1- 22.
7. **Mishra, A.K., Sharma, B.K., Singh, J.B. and Singh, N.P.** 2004. Performance of Barbari goats in Vindhyaachal region of Madhya Pradesh. *Indian J. Small Ruminant* 10: 134 -136.

Steroid hormones concentrations in follicular fluid of goats

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Abstract

Estradiol 17 β concentrations increased in follicular fluid of goats significantly as the follicle developed ($P < 0.05$, $r = 0.96$). The lowest concentration was found in smallest (8.95 ± 0.89 ng/ml) and highest in anovulatory follicle (53.00 ± 3.01 ng/ml). Similarly progesterone concentration also increased with development of follicle but the differences were non-significant up to pre ovulatory stage. Remarkably higher levels of progesterone with significant difference were noticed in pre ovulatory (128.50 ± 5.87 ng/ml) and anovulatory (728.00 ± 33.52 ng/ml) follicles. Testosterone levels decreased significantly as the development of the follicle advanced showings negative correlation ($P < 0.05$; $r = 0.96$). Highest testosterone level was found in smallest follicle (5.68 ± 0.50 ng/ml) and lowest was in pre ovulatory follicle (0.55 ± 0.03 ng/ml). Ratio of estradiol 17 β to progesterone decreased while ratio of estradiol 17 β to testosterone increased with development of follicle, reflecting their importance with regards to follicle development and maturation.

Keywords : Estradiol 17 β , Progesterone, follicular fluid, testosterone, goat

Introduction

Goat plays a vital role in Indian economy by contributing 469 thousand metric tones of meat and 2200 thousand metric tones of milk per annum (1). The follicle, an ovarian compartment, fulfills dual function of gametogenesis and steroidogenesis. The follicular fluid plays a major role in the physiological, biochemical and metabolic aspects of nuclear and cyto-plasmic maturation of oocyte, release of egg from the ruptured follicle and its fertilization. Estradiol 17 β and progesterone in follicular fluid are required for the development and maturation of follicle and inhibition of atresia of antral follicle. Testosterone serves as precursor for estradiol 17 β (2).

Material and methods

Experimental animals used were Indigenous goats of this area as well as farm born goats. Follicular fluid was collected by aspiration from small size (2-3 mm), medium size (>3-5 mm), large size (> 5 mm), pre ovulatory and anovulatory follicles. Follicular fluid from small, medium and large sized follicle were collected by aspiration from freshly slaughtered goat ovaries. Pooled fluid of same sized follicles from six animals constituted one sample, such ten samples were collected for each category. Follicular fluid samples

(10 each) of pre ovulatory follicles and anovulatory follicles were collected from farm born goats immediately after standing estrus and 72 hrs after breeding respectively. All these samples were centrifuged at 1000 rpm for 5 minutes to remove cell debris and stored at -20 °C till analyzed.

Estradiol 17 β was analyzed by solid phase radio immuno assay described by Robertson, *et al.* (3) while progesterone and testosterone as per the method described by Kubasic *et al.* (4).

Statistical analysis was carried out using two ways Randomized Block Design as per standard statistical procedures.

Results and discussion

The differences in the levels of estradiol 17 β due to size of the follicles were statistically significant (Table, $P < 0.05$). The report of Fortune and Hansal (5) in cows; Pirzada *et al.* (6) in pigs and Kulkarni *et al.* (7) in buffaloes were lower than present results. This may be due to variation of species, age, nutritional status and stage of collection of samples. Nevertheless, the increasing trend observed in present study is at par with that reported by Edwards (8).

Levels of estradiol 17 β showed positive and significant correlation with developmental stages of follicle ($r=0.96$). Such types of correlations are also reported by Kulkarni *et al.* (7), Zeiton, (9), Nigam *et al.* (10) and Thangavel and Nayeem (11) in buffaloes. This increase in estradiol-17 β in developing follicle is due to increase response of growing follicle to gonadotropins for inducing proliferation and differentiation of both theca and granulosa cells (12).

The reduced level of estradiol 17 β in small follicle could be due to large number of FSH receptor in to membrane granulosa cells of follicles as suggested by Polta *et al.* (13). Increased number of LH receptors and higher aromatase activity in granulosa cells and availability of androgen as substrate from theca cells might have played role in formation of maximum estradiol 17 β levels in preovulatory and anovulatory follicles. Similar to estradiol 17 β , progesterone also showed increasing trend, which revealed positive but non significant correlation with size of the follicles ($r = 0.83$). Similar correlation was reported by Moor *et al.* (14) in sheep. The differences observed in progesterone concentrations for small, medium and large follicles were non- significant but significant for preovulatory and anovulatory follicles. Similar results are reported for other species Eilerand Nalbanov (15) and Gerard *et al.* (16) in pigs, Seamark *et al.* (17) in sheep; Fortune and Hansal (5) in cows and Eissa (18) in buffalo.

Significant levels of progesterone in preovulatory and anovulatory follicles are due to the basic fact that 3 β -hydroxysteroid-dehydrogenase; a key enzyme in steroid biosynthesis is acquired by membrane granulosa, which coincides with luteinisation of these

cells leading to higher production (19). Ratio of estradiol 17 β and progesterone decreased gradually from small sized follicle to pre ovulatory follicle, which could be due to remarkable increase in progesterone level. Same type of results has been reported by Gerard *et al.* (16) in cow follicular fluid.

Results on testosterone concentration revealed that it decreased in follicular fluid as the size of the follicle increased with negative and significant correlation between size of follicle and testosterone concentration ($r = -0.90$). Similar trend and correlation have reported by Moor *et al.* (14) in sheep; Handerson *et al.* (20) and Wise (21) in cows and Zeifoun (9) and Nigam *et al.* (1995) in buffaloes. This can be explained as in small healthy follicles, due to low aromatase activity, higher testosterone and lower estradiol 17 β levels are observed in follicular fluid. As the follicle develops, there is increasing concentration of estradiol at the expense of androgens indicating activation of aromatase activity in granulosa cells (22). In support of this, Richard (23), Handerson *et al.* (20) and Wise (21) also reported that in cattle, testosterone was predominant androgen in follicular fluid and its concentration decreased with development of the follicle.

Ratio of estradiol 17 β to testosterone increased as the size of the follicle increased. Palta *et al.* (13) stated that developing follicles have many active receptors for LH and under influence of LH, these follicles produce testosterone which undergoes aromatization and gets converted in to estradiol 17 β . Thus, results of these three steroid hormones and their ratios in follicular fluid during developmental stages reflect their biosynthesis as per physiological demand for

Table 1. Levels of steroid hormones (ng/ml) in follicular fluid during developmental stages of follicle.

Hormones	Categories of follicles				
	Small (2-3 mm)	Medium (> 3-5 mm)	Large (> 5 mm)	Preovulatory	Anovulatory
Estradiol 17 β	8.95 $\pm$ 0.89 ^a	19.30 $\pm$ 1.41 ^b	25.40 $\pm$ 1.60 ^c	32.40 $\pm$ 0.78 ^d	53.00 $\pm$ 3.01 ^e
Progesterone	3.98 $\pm$ 0.40 ^a	8.40 $\pm$ 0.35 ^a	16.15 $\pm$ 1.05 ^a	128.50 $\pm$ 5.87 ^b	728.00 $\pm$ 33.52 ^c
Testosterone	5.68 $\pm$ 0.50 ^c	1.27 $\pm$ 0.13 ^b	0.68 $\pm$ 0.07 ^a	0.55 $\pm$ 0.03 ^a	0.80 $\pm$ 0.09 ^{ab}
Ratio. E: P	2.66 ^d	2.35 ^d	1.58 ^c	0.26 ^b	0.07 ^a
Ratio. E:T	1.67 ^a	16.36 ^b	40.39 ^c	59.71 ^d	69.51 ^e
Ratio. P:T	0.63 ^a	6.87 ^a	26.08 ^a	228.07 ^b	982.42 ^c

Note : Figures with same superscript do not differ within the row.

development and maturation of follicle and oocyte, ovulation and luteinisation of cells under influence of gonadotropins.

References

1. **FAO**, 2002. Bulletin of Statistics., *Rome, Italy*. **2** : 101.
2. **Hafez, E.S.E.** 1987. Reproduction in farm animals, 5th edn., K.M. Vargese Company, Bombay. **7** :119.
3. **Robertson, R.D., Richard, H.P., Peter, C.W. and Douglis, M.S.** 1979. Assesment of oritation by ultrasound and plasma determinations. *Obst. and gynaec.* **54**: 686-91.
4. **Kubasic, N.P., Hallauer, G.D., and Brodows, R.G.** 1984. Evaluation of direct solid phase radio immuno assay for progesterone. *Clin. Chem.* **30** : 284-86.
5. **Fortune, J. E. and Hansal, W.** 1985. Concentration of steroids and gonadotropins in follicular fluid from normal heifers and heifers primed supero-vulation. *Biol. Reprod.* **32** :1069-1079.
6. **Pirzada, J., Crazul, A., Wiesak, Y., Muszynka, A., and Dusza, L.** 1985. Steroid hormones and prolactin in porcine follicular fluid in estrous cycle and early pregnancy. *Exptl. Clin. Endocrino.* **86** : 291-296.
7. **Kulkarni, B.A., Deshmukh, B.T., Katkam, P.P., and Puri, C.P.** 1994. Follicular fluid steroid levels of the Indian buffaloes. *Buffalo J.* **10** : 71-74.
8. **Edwards, R.G.** 1974. Follicular fluid. *J. Reprod. Fertil.* **37** :189-219.
9. **Zeifoun, M.M.** 1995. Steroidogenic potential of granulose cell obtained from buffalo and Brahman cow ovaries. *Alexandraia J. Agric. Res.* **40** : 51-64.
10. **Nigam, R., Lakhchaura, B.D., and Laxmi Chand.** 1995. Concentration of steroids hormones of the follicular fluid of the buffalo during estrus cycle. *Buffalo J.* **11**:199-204.
11. **Thangavel, A., and Nayeem, M.** 2004. Hormonal profiles of buffalo follicular fluid during estrous cycle. *Indian Vet. J.* **81**:515-18.
12. **Lacroix, E., Eechaute, W., and Leusen, Z.** 1974. The biosynthesis of estrogen by cow follicles. *Steroids* **23** : 337-356.
13. **Palta, P., Bansal, N., Prakash, B.S., Manik, R.S., and Madan, M.L.** 1998. Endocrinological observation of attresia in individual buffalo ovarian follicle. *Indian J. Anim. Sci.* **68** :447-57.
14. **Moor, R.M., Hay, M.F., Dott, M.M., and Cran, D.G.** 1978. Macroscopic identification and ste-roidogenic function of atretic follicles in sheep. *J. Endocrinol.* **77** : 309.
15. **Eiler, H. and Nalbanov, A.V.** 1977. Sex steroid in follicular fluid and blood plasma during estrus cycle of Pig. *Endocrinol.* **100** : 331.
16. **Gerard, M., Menezo, Y., Rombauts, P., Szollosi, D. and Thilbault.** 1979. In-vitro studies of oocyte maturation and follicle metabolism in the Pig. *Ann. Biol. Anim. Biochem. Biophys.* pp.19.
17. **Seamark, R.F., Moor, P.M., and Me, Intosh, J.E.** 1974. Steroid hormones production by sheep ovarian follicles cultured in vitro. *Indian Vet. J.* **41**:143-158.
18. **Eissa, H.M.** 1995. Concentration of steroids and biochemical constituents in follicular fluid of buffalo cows during different stages of estrous cycle. *Buffalo J.* **3** : 331-40.
19. **Hay, M.F. and Moor, P.M.** 1973. The graphian follicle of sheep: relationship between gonadotropins , steroid production, morphology and oocyte maturation. *Ann. Biol. Anim. Biochem. Biophys.* **13** : 241.
20. **Handerson, K.M., Me, Neilly, A.S., and Swanston, J.A.** 1982. Gonadotropins and steroid concentration in bovine follicular fluid and their relationship to follicle size. *J. Reprod. Fertil.* **65** :467-73.
21. **Wise, T.** 1987. Biochemical analysis of bovine folli-cular fluid .Albumin, Lysosome enzyme, Ions, Steroids, and Ascorbic acid contents in relation to follicular size, rank , attresia , classification and day of estrous cycle. *J. Anim. Sci.* **64** :1153-69.
22. **McNatty, K.P., Heath, D.A., Henderson, K.M., Lun, S., Hurst, P.R., Ellis, L.M., Montgomery, G.W., Morrison, L, and Thureley, D.C.** 1984. Some aspects of thecal and granulose cell function during follicular development in the bovine ovary. *J. Reprod. Fertil.* **72** : 39-53.
23. **Richards, J.S.** 1980. Maturation of ovarian follicles: action and interaction of pituitary and ovarian hormones on follicular cell differentiation. *Physical Review* **60** : 51.

Hatching efficiency in the cysts of *Artemia salina* strain in varying salinity

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Abstract

Importance of the *Artemia* cysts in aquaculture is described in this paper. Hatching efficiency of the cysts in different salinity levels was studied and described in this paper in salinity range of 15 ppt to 20 ppt. Cyst of *Artemia* could hatch out from purely fresh water to 35 ppt salinity. Total mortality of nauplii in 2 ppt salinity was seen within 1.5 hrs. Mortality of nauplii in 5 ppt salinity to 35 ppt salinity was not found (total survival). Maximum hatching efficiency was recorded in the water having 25 ppt salinity. (Av. 84 %)

Keywords : *Artemia salina*, hatching efficiency, cysts.

Introduction

Due to increasing demand of shrimps in the foreign market as well as saturation in shrimp catch from wild stock has diverted aquaculturist to produce shrimp through culture. At present coastal aquaculture in India is in a stage of momentum. For better yield of economically important varieties of shrimps per unit area good quality stocking material i.e. seeds are required. These are produced in hatcheries in almost all maritime states of India. The hatcheries need cysts of *Artemia* as feed of Mysis-I to PL - 16. There is no substitute of *Artemia* cysts as live feed in shrimp hatchery at present. Thus *Artemia* culture and production of cysts have become an essential aspect in coastal aquaculture (Finfish and shell fish hatcheries) practices today.

Artemia is widely used by aquaculture as an excellent food source for the fish and crustaceans. In many instances, it is the only food available for the larval stages of cultured species. *Artemia* as food showed higher significant growth as survival for larvae of Milk fish (*Chanos chanos*) and prawn than other live feed or artificial diets.

The effect of antibiotics on the hatching of *Artemia* cyst has been studied by Coleman *et al.* (1). Dwivedi *et al.* (2) carried out mass culture of brine shrimp under controlled conditions in parent pools at Bombay. The salinity range was in between 30 to 75 % by adding filtered concentrate of crude common salt. Laboratory and field studies on an Indian strain of the

brine shrimp revealed that the nauplii preferred a salinity of 35 ‰ and temperature of 27 °C Royan (3).

Sorgeloos *et al.* (4, 5) have studied a simple technique for the improvement of the use of brine shrimp in aquaculture through decapsulation of *Artemia* cysts. They have also described the culture of *Artemia salina* on rice bran. Thus, most of these studies are limited to the culture of *Artemia salina* only.

The earlier studies mentioned above did not reveal the hatching efficiency of *Artemia* cysts in varying salinities, which is of utmost importance for calculating the required densities for culturing of intermediate larval stages such as zoea-I to mysis-III stages of economically important peraeid shrimps.

This paper deals with the study of hatching efficiency of *Artemia* cyst in varying hydrological conditions. Cysts were collected from salt pans of Okhamandal area.

Material and methods

Glass jars of 4 lit. capacity were disinfected prior to introduction of water with varying salinities. Eight jars containing water having 2 ppt to 5 ppt salinity and so on up to 35 ppt salinity with a difference of 5 salinity except 1st and 2nd (where it was 3) were arranged serially on the table, with aeration and fluorescent lights. Previously weighed and counted cysts of *Artemia*, 1 gm in each jar were introduced. Water temperature, pH were recorded through mercury thermometer and pH meter (digital), respectively.

Table 1. Hatching in different salinity in *Artemia* cyst

Salinity (Ppt)	Experiment	pH	Water Temp. (°C)	Live Hatched Nauplius	Unhatched Cyst (%)	Mortality (%)
2	1 st	7.00	28.50	10.00	90.00	60.00
	2 nd	7.00	28.50	10.20	89.60	61.00
	3 rd	7.00	28.50	11.50	88.50	59.00
	Average	7.00	28.50	10.57	89.43	60.00
5	1 st	7.50	28.50	29.50	70.50	NIL
	2 nd	7.50	28.50	57.20	42.80	NIL
	3 rd	7.50	28.00	28.90	71.10	NIL
	Average	7.50	28.33	38.53	61.47	NIL
10	1 st	7.50	27.50	50.80	49.20	NIL
	2 nd	7.50	28.50	64.80	35.20	NIL
	3 rd	8.00	28.50	48.30	51.70	NIL
	Average	7.60	28.17	54.63	45.37	NIL
15	1 st	7.00	29.50	60.40	39.60	NIL
	2 nd	8.00	26.50	84.30	15.70	NIL
	3 rd	8.00	27.50	52.50	47.50	NIL
	Average	7.60	27.83	65.73	34.27	NIL
20	1 st	7.00	29.50	80.60	19.40	NIL
	2 nd	8.00	27.50	65.40	34.60	NIL
	3 rd	7.50	26.50	60.00	40.00	NIL
	Average	7.50	27.83	68.67	31.33	NIL
25	1 st	7.00	28.50	85.10	14.90	NIL
	2 nd	7.00	27.50	86.60	13.40	NIL
	3 rd	8.00	27.50	80.30	19.70	NIL
	Average	7.33	27.83	84.00	16.00	NIL
30	1 st	7.50	28.50	80.40	19.60	NIL
	2 nd	7.00	27.50	47.80	52.20	NIL
	3 rd	8.00	28.00	54.50	45.50	NIL
	Average	7.50	28.00	60.90	39.10	NIL
35	1 st	7.00	28.50	55.50	44.50	NIL
	2 nd	8.00	27.50	88.20	11.80	NIL
	3 rd	8.00	28.00	78.90	21.10	NIL
	Average	7.67	28.00	74.20	25.80	NIL

Results and discussion

Hatching percentage of cysts in varying salinities are shown in Table 1. It was observed that hatching percentage increased from 2 ppt salinity to 15 ppt salinity, steady in 15 ppt to 20 ppt and again increased in 25 ppt. Hatching efficiency above 25 ppt did not increase. Minimum and maximum hatching efficiency

were observed at 2 ppt and 25 ppt salinity, respectively, when water temperature and pH fluctuated from 28.16 °C and 7.0 and 27.6 °C and 7.3, respectively.

At 2 ppt salinity most of the nauplius died within 1.5 hrs. There was no mortality of hatched out nauplii in 5 ppt salinity to 35 ppt salinity.

As maximum hatching of cysts occurs at 25 ppt salinity (pH-7.3 and 27.6 °C temperature) there is no need to prepare less or high salinity for hatching of *Artemia* cysts. It helps in minimizing expenditure on fresh water to some extent as well as saving of time. (looking to the unavailability of adequate quantity of fresh water at present at most of the places).

Acknowledgement

Authors are highly indebted to the Campus Director, Gujarat Agricultural University, Junagadh and Director of Research & Dean, Faculty of PG. Studies, GAU, Ahmedabad for facilities provided.

References

1. Coleman, D.E., Nakagawa, L.K., Nakamura, R.M. and Chang, E. 1980. The effect of antibiotics on the hatching of *Artemia* cyst. *The Brine Shrimp Artemia* pp.153.
2. Dwivedi, S. N., Ansari, S. K.R., Ahmed, M. Q. 1980. Mass culture of Brine shrimp under control condition in cement pools at Bombay, India. *The Brine Shrimp Artemia* pp. 175.
3. Royan J.P., 1980. Laboratory and field studies on an Indian strain of the brine shrimp *Artemia*. *The Brine Shrimp Artemia* pp. 223.
4. Sorgeloos, P., Bossuyt, E., Lavina, E., Baeza Mesa M., Persoone, G. 1977. Decapsulation of *Artemia* cysts. a simple technique for the improvement of the use of brine shrimp in aquaculture. *Aquaculture* 12 : 311-316.
5. Sorgeloos, P., M.Baeza-Mesa, E. Bossuyt, E. Bruggeman, J. Dobbeleir, D. Versichele, E. Lavina, C. R. Mock, M. Talloen. 1979. The culture of *Artemia salina* on rice bran : the conversion of a waste product into highly nutritive animal protein. Paper submitted for the 10th Annual Meeting of the WMS, Honolulu, Hawaii, U.S.A., Jan. 20-26.

Personal characteristics of students of veterinary colleges in Gujarat

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Abstract

The personal characteristics of the students determine their attitude towards education. Six variables regarding the personal characteristics of the veterinary students in Gujarat were studied. The average age of the students was 21 years with a majority of them being either the first or second born child in the family. Majority of the students belonged to the upper caste, had a good academic record and were unmarried. The level of participation in extracurricular activities was found to be very low.

Keywords : Personal characteristics, attitude, veterinary students.

Introduction

India is basically an agrarian country with majority of its population based in the rural areas. The students nucleus of most of the veterinary College is rural based. Hence it is important to understand the personal characteristics of the students, in order to determine and understand their attitude towards veterinary education. Personal characteristics play a significant role in deciding the future choice of job. Keeping this in mind, a study has been conducted on the personal characteristics of students of the veterinary College in Gujarat.

Methodology

In order to determine the kind of prospective students taking to veterinary science as a career a study was made about the personal characteristics of the enrolling students at the two veterinary colleges in Gujarat state. Data were collected by direct questionnaire from 284 students of the B.V.Sc. & A.H. degree course during the academic year 1991-92. For measurement of the selected variables the following techniques were used.

Table 1. Variables and Measurement technique.

Sr. No.	Name of the variable	Measurement Technique
1	Age	Chronological age of respondent
2	Birth Order	Ordinal position by birth of the respondent
3	Caste	Scoring procedure development (SC, ST, Nomadic tribe, Denotified -NT, Other backward and non - reserved were allotted scores of 1,2,3,4,5 and 6 respectively)
4.	Academic achievement	Percentage of marks obtained in B.V.Sc.& A.H. degree course examination in the concerned semester.
5.	Participation in extra curricular activities	Scoring procedure developed. (Participation and prize winners were awarded score 1 and 2 respectively. Total of these will be participation score of extra curricular activities)
6.	Number of real brothers and sisters	Actual number of real brothers and sisters.

Results and discussion

The data on the personal characteristics of the students were analyzed and is presented in Table 2

Age

Students enrolled were above 17 and the average age of the students was 21 years. The maximum number (54.57 %) of students were in the age group of 20-22 years.

Birth order

Table 2 shows that about an equal number of students were first and second born children (18.52 and 27.82 percent, respectively). Combined forming more than half of the students number, 24.65 percent and 19.00

percent of the students were born at 4th and above ordinal position and 3rd position, respectively. These findings are supported by the findings of Pandey (1) and Solanki (2).

Caste

From Table 2 it can be seen that majority (90.50 percent) of the respondents were from non-reserved caste categories, whereas the respondents belonging to reserved caste categories were only 9.50 percent. It is a well known fact that the literacy rate, social and economic condition of the non-reserved caste is higher than the reserved castes, so they can afford higher education for their children, This may be the probable reason for majority of the Veterinary college students in Gujarat belonging to higher caste.

Table 2. Distribution of respondents according to their personal characteristics

Sr. No.	Characteristics	Number	Percentage
1	Age (years)	17-19(years)	60
		20-22(years)	155
		23-25(years)	69
	Mean Score: 20.99		
2	Birth Order	1 st	81
		2 nd	79
		3 rd	54
		4 th and above	70
	Mean Score: 2.56		
3.	Caste:	Non reserved	257
		Other backward	10
		Denotified	00
		Nomadic tribe	04
		Schedule tribe	02
		Schedule caste	11
	Mean Score: 5.7		
4.	Marital status:	Married	62
		Unmarried	222
5.	Academic achievement	Pass class (4.5 to 5.99)	132
		Second class (6.0 to 6.89)	129
		First class (6.9 to 7.39)	23
		Distinction (7.4 and above)	00
6.	Average grade point: 59.46 Participation in extracurricular activities	Low participation (upto 3 score)	254
		Medium participation (4 to 6 score)	24
		High participation (6 & and above score)	6
	Mean score: 1.365		

This finding is in concurrence with the findings reported by Solanki (2).

Marital Status

Among the respondents studied 21.83 percent were married and 78.17 percent were unmarried. On scrutinizing the questionnaire the students were found to belong to various communities. The varied customs and social obligation of individual community was definitely the reason for the above observation.

Academic achievement

It can be observed from the table 2 that merely half of the respondent (48.48 percent) were in pass class (4.5 to 5.99 O.G.P.A.) categories, while proportion of respondents in second class (6.0 to 6.89 O.G.P.A.) and first class (6.0 to 7.3 O.G.P.A.) was 45.42 and 8.10 percent, respectively. From the personal discussion with students it was known that this was because of change of medium of instruction from Gujarati to English.

Participation in extracurricular activities

It was observed that participation in extracurricular activities like athletics and games like Cricket, *Khokho*, *Kabadi*, Volley ball, Badminton, Basket ball, Table Tennis, Chess and other cultural programmes, Debates, NSS and NCC at College, University, State or at the National level was very low in majority (89.44 percent) of the students, while 8.45 percent respondents have medium level of participation and only 2.11 percent were having high level of participation. This may be due to the pattern of

semester system education in the veterinary faculty which leads to the students being overloaded with study and examination work leaving them with very less leisure time to participate in other activities. Also the fact that majority of the students belong to rural areas and that they are still in the learning process with regard to various games due to which they may shy away from active participation till they reach the senior level at College.

Conclusion

From the above findings, it can be concluded that majority of the respondent's were from higher caste, having good academic achievement but their participation in extracurricular activities was low. Hence there is an urgent need to popularize veterinary education among the lower caste of Gujarat state, and also to encourage the students to actively participate in extracurricular activities.

References

1. **Pandey, R.** 1973. Social structure and educational aspiration of College going youth, an empirical evaluation of explanatory factors. *Indian J. Social Work.* **34** : 195-207.
2. **Solanki, G. K.** 1975. Value orientation and job preference of undergraduate Agricultural Colleges under Gujarat Agricultural University. M. Sc. (Agri.) Thesis. Gujarat Agricultural University, Sardarkrushinagar.

Employment pattern of the farmers of arid region of North Gujarat

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Abstract

The study was conducted to know the existing employment pattern of the farmers of the North Gujarat. Two districts having maximum area under arid climate were selected purposively. Two talukas from each district and three villages from each taluka were selected purposively. Total 120 respondents were selected randomly. The data revealed that maximum (85.00 %) farmers were getting employment from their own farm only for half year. Animal Husbandry was the other source of employment through which maximum farmers were earning their livelihood. Their employment through other than farm work was very limited. Three variables viz., education, land holding and herd size were found positively and significantly related with employment pattern.

Keywords: Employment pattern, relational analysis, animal husbandry.

Introduction

In the last decade, India had made tremendous advancement in agricultural sector due to technologies, which were responsible for making the country self-sufficient in the food front. From the food scarcity to food security, is quite apparent. However, this advancement has mostly confined to the areas with assured irrigation and favourable environment. The arid and semi-arid areas of the country in particular have not been benefited by these technologies. These areas possess harsh environment with low and erratic rainfall, high wind velocity, high temperature, induced evapotranspiration coupled with a number soil related problems such as low water holding capacity, erosion, salinity, sodicity etc. The recurring droughts are most common phenomena which results in instability. The farmers generally cultivate only monsoon season. For remaining period, they depend on other employment-oriented activities. The present study was therefore planned with specific objectives. (1) To know the period of employment available to the farmers during the year, (2) To study the existing employment pattern of the farmers with respect to agriculture and other occupations and (3) To study the relationship between selected personal, socio-economic, communication and psychological characteristics of the farmers and their existing employment pattern.

Methodology

Two districts viz. Banaskantha and Patan were selected purposively as maximum area of these districts fall under arid climate. From each district, two talukas fall under arid climate were selected purposely. Thus, four talukas were selected. From each taluka, three villages were selected randomly. Ten farmers were selected from each village randomly making a sample of 120 respondents. A structured interview scheduled was developed for data collection.

Results and discussion

Period of employment available to the farmers during a year

The details regarding the period of employment available to the farmers from various sources is depicted in the subsequent tables.

Period of employment on own farm

The data in respect of employment available to the farmers on their own farm during a year are presented in Table 1.

Table 1. Distribution of the respondent families according to their period of employment on own farm.

Sr. No.	Working days/year	Number	Per cent
1.	Up to 90 days	40	33.33
2.	91 to 180 days	62	51.67
3.	More than 180 days	18	15.00
	Total	120	100.00

Table 1 show that 51.67 per cent respondents were found getting employment from their own farm for 91 to 180 days followed by 33.33 per cent getting employment up to 90 days. Only 15.00 per cent were employed on their own farm for more than 180 days. This may be due to reason that with no / limited irrigation facility, most of them cultivate either *kharif* or *kharif* + winter crops.

Employment period on other's farm

The data in respect of employment available to the farmers on other's farm during a year are presented in Table 2.

Table 2. Distribution of the respondent families according to their period of employment on other's farm.

Sr. No.	Working days/year	Number	Per cent
1.	No work available / not necessary	41	34.17
2.	Up to 90 days	51	42.50
3.	91 to 180 days	18	15.00
4.	More than 180 days	10	8.33
	TOTAL	120	100.00

It can be seen from Table 2 that 42.50 per cent farmers were getting employment on other's farm for up to 90 days. On the other hand 15.00 per cent respondents were getting employment on other's farm for 91 to 180 days. Only 8.33 per cent of them were getting employment for more than 180 days. Remaining 34.17 per cent respondents either could not get employment on other's farm or could not go for such employment.

Employment period on other than farm work

This include employment in manual labour, cutting of fuel wood, working as labour under private contractor/ private factories, small occupation like *pan parlor*, carpentry, tailoring, skilled labour etc. during a year. The data regarding this are presented in Table 3.

Table 3. Distribution of the respondents according to period of employment on other than farm work.

Sr. No.	Working days/year	Number	Per cent
1.	Not getting work	80	66.67
2.	Up to 90 days	33	27.50
3.	More than 90 days	07	5.83
	Total	120	100.00

Table 3 indicate that opportunity for getting employment through other than farm work was very limited. Two- thirds respondents could not get any work. On the other hand, 27.50 per cent of them were getting employment up to 90 days. Only 5.83 per cent were getting employment for more than 90 days from other than farm work.

Period of employment in animal husbandry

Animal husbandry as a subsidiary occupation by farmers has generally been observed in North Gujarat. Hence, the period of employment available to the farmers through animal husbandry was studied.

Table 4. Distribution of the respondents according to their period of employment in animal husbandry.

Sr. No.	Working days/year	Number	Per cent
1.	Up to 90 days	21	17.5
2.	91-180 days	63	52.5
3.	More than 180 days	36	30.0
	Total	120	100.0

Animal husbandry was found to be important source of employment. Due to limited irrigation sources, most of the respondents keep animals. As a result, more than half (52.5%) of them were getting employment for 91-180 days. On the other hand, 30 per cent were getting employment for more than 180 days may be due to their big herd size. Only 17.5 per cent were found getting employment from animal husbandry for up to 90 days.

Period of employment in watershed work

In some of the villages, National Watershed Development Project was operating. The details of the employment received under this project are depicted in Table 5.

Table 5. Distribution of the respondents according to their period of employment in watershed work.

Sr. No.	Working days/year	Number	Per cent
1.	Not getting work	80	66.67
2.	Up to 90 days	31	25.83
3.	More than 90 days	09	7.50
	Total	120	100.00

Watershed work was in operation in some villages. Table 5 show that 25.83 per cent respondents were getting employment up to 90 days, whereas 7.50 per cent respondents were employed for above 90 days. It was observed that 66.67 per cent respondents could not get any employment from watershed work

Period of employment available throughout the year

As discussed above, the farmers were employed in various types of farming and non-farming works. The data regarding their total employment from various sources during the year are given in Table 6.

Table 6. Distribution of the respondent families according to their total employment throughout the year.

Sr. No.	Working days/year	Number	Per cent
1.	Up to 90 days	7	5.83
2.	91 to 180 days	68	56.67
3.	181 to 270 days	26	21.67
4.	More than 270 days	19	15.83
	Total	120	100.00

More than half at the respondents (56.67%) had the employment for the period of 91 to 180 days during the year followed by 21.67 per cent employed for the period of 181-270 days during a year. On the other hand 15.83 per cent farmers were employed for more than 270 days. Very few i.e. 5.83 per cent were found getting employment up to 90 days.

Existing Employment Pattern

Employment pattern refers to the working numbers in days by all the workable members in different kinds and types of work to earn the money during a year. The information in this regard is presented in Table 7.

Table 7. Distribution of the respondent families according to their employment pattern.

Sr. No.	Working days/year	Number	Per cent
1.	Low (Up to 50 score)	62	51.66
2.	Medium (51-75 score)	47	39.17
3.	High (Above 75 score)	11	9.17
	TOTAL	120	100.00

Low level of employment pattern was observed among 51.66 percent respondents. On the other hand, 39.17 per cent had medium level of employment pattern. It is unfortunate to note that only 9.17 per cent had high employment pattern.

Relational Analysis

The results regarding relationship between selected characteristics of the farmers and their employment pattern are depicted in Table 8.

Table 8. Relationship of selected characteristics with employment pattern. (n=120)

Sr. No.	Variables	Correlation coefficient
I	Personal	
X ₁	Age	-0.112
X ₂	Education	0.518**
II	Socio-economic	
X ₃	Family type	0.091
X ₄	Family size	0.099
X ₅	Occupation	0.131
X ₆	Land holding	0.346**
X ₇	Irrigation facility	0.082
X ₈	Herd size	0.242*
X ₉	Material possession	0.127
III	Communication	
X ₁₀	Extent of use of information sources	0.092
IV	Psychological	
X ₁₁	Economic motivation	0.087

*Significant at 0.05 level of significance

** Significant at 0.01 level of significance

It can be seen from the Table 8 that only two variables viz., education (0.518) and land holding (0.346) were found positively and significantly related with employment pattern at 0.01 level of significance. Herd size was (0.242) was positively and significantly related with employment pattern at 0.05 level of significance. Remaining variables viz., age, family type, family size, occupation, irrigation facility, material possession and extent of use of information sources have failed to establish any significant relationship with employment pattern.

Entrepreneurial behaviour of potato growers of North Gujarat agro-climatic zone of Gujarat State

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Abstract

Looking to the production scenario of the country, potato will be the important crop to satisfy the food requirement in the coming days. Though, potato cultivation requires higher capital investment, monetary output is uncertain due to the fluctuating wholesale price index. It is also a highly risky crop. All these aspects point out that the potato growers are real agripreneurs in comparison to other entrepreneurs and farmers. The present research was intended to measure the entrepreneurial behaviour of potato growers and its relationship with the extent of adoption of recommended potato technology. The results of the study depict that majority of the respondents were observed in the medium level of entrepreneurial behaviour index and had adopted the recommended practices of potato cultivation from medium to high extent. The extent of adoption of recommended potato production technology was statistically found to be positively and significantly correlated with entrepreneurial behaviour of potato growers.

Keywords: Entrepreneurial behaviour, potato growers.

Introduction

Advanced and scientific agriculture is based on capital investment and its outputs. It also requires entre-preneurship. Entrepreneurship is the character, practice, and / or skill of an entrepreneur. An entrepreneur is a person who organizes, manage and assumes the risk of a business. Accordingly, entrepreneurship restors to identifying/innovating ideas, product and servres mobilizing resources, organizing production / services and finally, marketing them covering the risk with constant strive for growth and excellence. Bisht and Sharma (1). Looking to the production scenario of the country, potato will be the important crop to satisfy the food requirement in the coming days. Though, potato cultivation requires higher capital investment, monetary output is uncertain due to the fluctuating wholesale price index. It is also a highly risky crop considering the natural hazards. All these aspects point out that the potato growers are real agripreneurs in comparison to other entrepreneurs and farmers. However, very few researches have been conducted in the past on potato growers to know their entrepreneurial behaviour.

The present study was conducted to measure the entrepreneurial behaviour of potato growers of North Gujarat Agro-climatic Zone of Gujarat State with following specific objectives.

1. To measure the entrepreneurial behaviour of potato growers.
2. To assess the extent of adoption of recommended potato technology by the potato growers.
3. To study the relationship between the extent of adoption of recommended potato technology and entrepreneurial behaviour of potato growers.

Methodology

To measure the entrepreneurial behaviour of potato growers, an objective scale was developed using Normalized Rank Approach as suggested by Guilford (2). North Gujarat Agro-climatic Zone is an intensive potato farming area of the Gujarat State which accounts for 80 per cent of total potato production of the state therefore, it was purposively selected. The multi-stage random sampling technique was used for

the selection of districts, talukas and villages. Banaskantha and Gandhinagar districts having the largest area under potato cultivation were purposively selected. A total of six talukas and 18 villages were covered and the size of sample was kept as 270 based on variability in overall modernization in the universe. A field survey by personal contact the basic method for primary and raw data collection was used. A special interview schedule was designed for collecting the data. The data were collected by personal interview with 270 respondents.

In order to measure the entrepreneurial behaviour of the potato growers, the scale so constructed was applied to the 270 respondents. In order to calculate the entrepreneurial behaviour index for each respondent each scale item was first rated for the maximum of that particular main indicator, then the actual scale value of score obtained was multiplied by scale value and entrepreneurial behaviour index (EBI) was calculated by using the following formula.

$$EBI = \frac{\sum \text{Score obtained for the indicator} \times \text{Scale value of the indicator}}{\sum \text{Maximum score for the indicator} \times \text{Scale value of the indicator}} \times 100$$

The potato growers were grouped into low, medium and high category of Entrepreneurial Behaviour Index (EBI) using $\pm$ S.D. from mean. For the purpose of measurement of extent of adoption of various recommended/improved practices of potato crop by the potato growers, a simple adoption scale was developed. Using the formula suggested by Sengupta (3) adoption of quotient was worked out and potato growers were grouped into low, medium and high category levels of adoption using $\pm$ S.D. from mean.

Correlation of coefficient was used to measure relationship between the extent of adoption of recommended potato production technology and entrepreneurial behaviour of the potato growers.

Results and discussion

Entrepreneurial behaviour of the potato growers

A special constructed scale was applied to measure the entrepreneurial behaviour of the potato growers. From the scale values entrepreneurial behaviour index was calculated for each respondent and on the basis of that, the respondents were grouped into three categories of EBI.

The distribution of respondents on the basis of their entrepreneurial behaviour is presented in Table 1.

Table 1. Distribution of the respondents by their entrepreneurial behaviour index.

Sr. No.	Category	Frequency	Percentage
1.	Low (upto 61.41 EBI)	50	18.52
2.	Medium (61.15 to 72.82 EBI)	176	65.56
3.	High (Above 72.82 EBI)	44	15.92

$$\bar{X} = 66.98 \quad S.D. = 5.84 \quad C.V. (\%) = 8.72$$

It can be seen from Table-1 that majority of the respondents were observed in the medium level of entrepreneurial behaviour index, while 18.52 per cent respondents fell under the category of low entrepreneurial behaviour. The remaining 15.92 per cent respondents possessed high level of the entrepreneurial behaviour.

Thus, it can be discerned from the results that by and large, the potato growers has fairly good entrepreneurial behaviour. This might be due to their better score on almost all the parameters selected to measure the entrepreneurial behaviour. Secondly, now-a-days agriculture is considered both as professional industry and enterprise on economic point of view. Potato cultivation requires higher capital investment in comparison to other rabi vegetable crops. It is also highly risky crop considering the natural hazards and day to day fluctuating wholesale price index. Under these circumstances, such type of better entrepreneurial behaviour of the potato growers might have helped them not only in managing their enterprises more efficiently and profitably, but also had a positive rating of their economic progress.

Extent of adoption of recommended potato technologies

Adoption in this investigation was considered as the use of recommended specific aspects or package of practices of potato cultivation by the farmers for obtaining expected benefits in terms of higher yield. The data with regard to adoption of recommended potato cultivation technology by the farmers are presented in Table 2.

Table 2. Distribution of the respondents according to their adoption quotient(AQ).

Sr. No.	Adoption Quotient	Frequency	Percentage	Mean score of EBI
1.	Low (upto 52.30 A.Q.)	45	16.67	62.65
2.	Medium (52.31 to 74.04 A.Q.)	161	59.63	66.91
3.	High (Above 74.04 A.Q.)	64	23.70	70.20
	Total	270	100.00	66.98*

* Mean of E.B.I. $\bar{X}$ = 63.17, S.D. = 10.87, C.V.(%) = 17.20

A cursory look at the data presented in Table 2 revealed that majority (83.33%) of the potato growers had adopted the recommended practices of potato cultivation from medium to high extent. The findings really indicate a happy state of affairs with respect to adoption level. This might be due to more concentration in maximising profit and better extension participation of the potato growers. Table 2 also depict that the low category of the adoption quotient of potato growers corresponds to low level of entrepreneurial behaviour score (62.65 mean E.B.I.) while potato growers with high category of adoption quotient had high level of entrepreneurship (70.20 mean E.B.I.). From this, it can be concluded that the extent of adoption of improved package of practices in potato cultivation had increased with increasing entrepreneurial behaviour score of potato growers. The probable reason behind this might be the decision making ability of the potato growers, the main component of entrepreneurial behaviour, which may have direct influence on the entrepreneurial behaviour as well as the process of adoption.

Relationship between extent of adoption of recommended potato production technology and entrepreneurial behaviour of the potato growers

The data pertinent to relationship between extent of adoption of recommended potato production technology and entrepreneurial behaviour of the potato growers are presented in Table 3.

Table 3. Correlation, coefficient showing the relationship between the extent of adoption of recommended potato production technology and entrepreneurial behaviour of the potato growers. (n=270)

Sr. No.	Consequent variable	Correlation coefficient 'r' value
1.	Extent of adoption of recommended potato production technology.	0.429**

**Significant at 0.01 level of significance.

It is clear from Table-3 that the extent of adoption or recommended potato production technology (0.429) was statistically found to be positively and significantly related with entrepreneurial behaviour of potato growers at 0.01 level of significance.

It can be concluded that the entrepreneurial behaviour was affecting the extent of adoption of recommended potato production technology of potato growers. The probable reason might be that the entrepreneurial behaviour is the function of many components. All the identified components of entrepreneurial behaviour are leading the farmers to earn high profit. In order to earn the profit, the farmers may have adopted most of the recommended potato production technology.

References

1. Bisht, Narendra, S. and Sharma, Pamila, K. 1991. Entrepreneurship Expectations and Experiences. Himalaya Publishing House, New Delhi.
2. Guilford, J.P. 1954. Psychometric methods Tala McGraw Hill Book Publication Co., New Delhi. pp. 178-183.
3. Sengupta, T. 1967. A simple adoption scale used for farmers for high yielding varieties programme in rice. *Indian J. Extn. Edn.* 3 : 107-115.

Comparison of some stability analysis models based on pearl millet genotypes tested over space and time

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Abstract

Three popular stability analysis models proposed by Eberhart and Russell (1966), Perkins and Jinks (1968) and Freeman and Perkins (1971) were compared empirically for their efficiency using yield data of nine pearl millet genotypes tested over five different locations raised in summer season for two years in Gujarat. Considering the ranking pattern of genotypes based on stability parameters, degree of freedom associated with regression, information used in estimating stability parameters and simplicity in estimation, the Eberhart and Russell model was recommended for stability analysis of genotypes/varieties tested over space and time.

Key words : Stability models, regression, correlation, pearl millet.

Introduction

Stability in performance is a desirable property for selection or recommendation of a specific genotype in plant breeding programme. The concept of stability is either biological or agronomical (1). Biologically genotype with minimum variance under different environments is considered as stable. An agronomically stable genotype has minimum interaction with environments but responds to favourable environment(s). Numbers of statistical methods have been developed (2,3,4,5,6,7,8) to evaluate the phenotypic stability of genotypes.

The literature on use of stability concept for comparing genotypes of different crops is available in plenty. But literature on comparison of stability analysis models based on genotype tested under varying environmental condition is very scanty (9,10).

The present study aims to compare some stability analysis models empirically using grain yield data of nine genotypes of pearl millet (*Pennisetum glaucum* L.) tested over space and time in Gujarat.

Material and methods

The nine pearl millet genotypes viz., GHB 526 (G_1), GHB 537 (G_2), GHB 538 (G_3), GHB 558 (G_4), GHB 559 (G_5), GHB 564 (G_6), GHB 573 (G_7), GHB 577

(G_8) and GHB 591 (G_9) were tested at five different environments (locations) of different agroclimatic zones of Gujarat viz., Deesa (E_1), Vijapur (E_2), Sardarkrushinagar (E_3), Anand (E_4) and Jamnagar (E_5) during the summer season of the year 2001 and 2002. The trial was laid out in randomized block design (RBD) with three replications. Genotype were sown in first week of March every year at all the environments. The spacing was 45 cm. x 15 cm. for Sardarkrushinagar while it was 60 cm. x 15 cm. at four other environments. Thus net plot size for Sardarkrushinagar was 5 m. x 1.8 m. and the same was 5 m. x 2.4 m. for remaining four environments. Thus net plot size comprised four rows each of 5.0 m, length. Due to different sizes of plot at Sardarkrushinagar as compared to other environments, the data on grain yield was converted to kg/ha and subjected to statistical analysis.

Statistical methods

Analysis of variance was followed for year-wise and pooled over both the years. Further stability analysis was carried out as per Eberhart and Russell model (ER), Perkins and Jinks model (PJ) and Freeman and Perkins model (FP) to estimate stability parameters. In ER model three stability parameters viz., mean performance ($\bar{Y}_i$), regression of mean performance on environmental index (b_i^E) and mean square deviation from regression [$S_{di}^{2(E)}$] for every geno-

type were estimated. In PJ model also three stability parameters viz., mean performance ($\bar{Y}_i$), regression of Genotype $\times$ Environment ($G \times E$) interaction on environmental index (β_i) and mean square deviation from regression [$\bar{S}_{di}^{2(P)}$] were estimated [Note: $\bar{S}_{di}^{2(E)}$ and $\bar{S}_{di}^{2(P)}$ have the same values]. In case of FP model mean performance ($\bar{Y}_i$), regression coefficient (b_i^F) and mean square deviation from regression [$\bar{S}_{di}^{2(E)}$] were estimated by dividing replication into two groups, one replication was used for measuring environmental index whereas remaining two replications were considered for estimating stability parameters. Simple correlation coefficient (r) between stability parameters were worked out for studying association behaviour of the parameters and thereby signify the comparison of models.

Results and discussion

The variable effect of genotype (G), environment (E) and $G \times E$ interaction on grain yield was significant in individual year (Y) analysis, while in pooled analysis

Y, $Y \times E$, $Y \times G$ and $G \times E$ interactions were significant. The later showed non-significant influence of E, G and $Y \times G \times E$ interaction. Results clearly indicated differential response of genotype in different environments and also seasonal variation. The presence of $G \times E$ interaction is creating problems in ordering and relative ranking of genotypes and also causing difficulties in demonstrating significant superiority of any genotype. Such situation imposed restriction to evaluate and predict the performance of genotype accurately over the environments and hence leads to the stability analysis. The objective of the study was to compare stability analysis models, hence the data were analysed accordingly. The results are presented in Table 1 and 2. The stability parameters (Table 1) indicated high heterogeneity among regression coefficients.

The mean grain yield pooled over two years, ranged from 4313 kg (G_9) to 4793 kg (G_8). None of the genotypes showed significant b_i^E , β_i and b_i^F values, indicating that all the genotypes were average in response over space and time. The four genotypes viz., G_1 , G_3 , G_8 and G_9 significantly deviated from linearity and thus observed to be unstable genotypes. The

Table 1. Estimates of stability parameters based on five environments using various models for grain yield.

Genotype	$\bar{Y}$	b_i^E	β_i	b_i^F	$\bar{S}_{di}^{2(E)}$	$\bar{S}_{di}^{2(F)}$
G_1	4716	1.101	0.101	1.101	151036.90**	321640.30
G_2	4761	1.005	0.005	0.911	64526.31	167588.30
G_3	4394	0.821	-1.179	0.761	248867.90**	148663.80
G_4	4537	1.001	0.001	0.981	21240.08	51042.75
G_5	4435	1.104	0.104	1.021	-15012.79	154037.40
G_6	4606	1.143	0.143	1.091	-7677.33	84352.17
G_7	4480	0.902	-0.098	0.871	46840.39	96331.78
G_8	4793	1.058	0.058	1.111	112669.80**	4331.79
G_9	4313	0.864	-0.136	0.801	134577.90**	388249.20

Table 2. Correlation matrix of stability parameters for grain yield.

	$\bar{Y}$	b_i^E	β_i	b_i^F	$\bar{S}_{di}^{2(E)}$
b_i^E	0.6082				
β_i	0.6082	1.0000**			
b_i^F	0.6934*	0.9415**	0.9415**		
$\bar{S}_{di}^{2(E)}$	-0.1194	-0.6085	-0.6085	-0.4655	
$\bar{S}_{di}^{2(F)}$	-0.3478	-0.2363	-0.2363	-0.3193	0.3812

Legend: * Significant at 0.05 probability level ** Significant at 0.01 probability level

ranking pattern for b_i^E and β_i were by definition ($r=1.00$ Table 2). Since b_i^E and β_i are related as $b_i^E = 1 + \beta_i$, the simple correlation between these two parameters is the same indicating that both models (ER and PJ) were identical. The ranking pattern of genotypes using values was nearer to similarity to that of ER and PJ models as $r=0.9415$ (Table 2).

However, cent per cent association was not observed in ranking pattern. In ER model, G_6 had the highest regression coefficient (1.143) while it was with G_8 in FP model (1.111). The lowest regression coefficient value was observed with G_3 in ER model (0.821) and in FP model (0.761). None of the genotype possessed significant deviation from regression under FP model i.e. $\bar{S}_{di}^{2(F)} = 0$.

In PJ model a regression of $G \times E$ interaction on environmental index was worked out while in ER model regression of mean performance on environmental index was worked out. This is the basic difference between these two models. The sum of square due to environment (linear) in ER model has 1 degree of freedom whereas same estimate termed as joint regression in PJ model has $E-1$ degree of freedom. In normal analysis linearity component (regression SS) has 1 degree of freedom. The ambiguity in degree of freedom associated with testing of regression component is likely to affect inference. Apparently from ranking pattern of genotypes and deviation from regression estimates, it can be generalised that PJ model does not give additional information in comparison to ER model.

The ranking pattern of genotypes based on responsiveness (b_i^F) in FP model was not similar to that of ER and PJ models. This deviation in ranking pattern was due to the fact that b_i^E and β_i were estimated using information of all replications, whereas b_i^F was based on few replications. Similarly $\bar{S}_{di}^{2(E)}$ and $\bar{S}_{di}^{2(F)}$ were obtained. The variation in sample size (replications) affected the estimates causing deviation in ranking pattern of genotypes in ER and FP models, very specifically with reference to estimates of both the models (Table 2). Any estimate based on full set of data is more reliable and precise than that with partial data set.

It is, therefore, concluded that ER model be used for stability analysis for genotypes tested over space and time. Luthra and Singh (8), Lin and Thompson (9) and Prajapati *et al.* (10) also recommended ER model on

the ground of simplicity, computational convenience and on the basis of providing an of enough information for the identification of high performing stable genotype with general adaptability.

References

1. **Becker, H.C.** 1981. Correlation among some statistical measures of phenotypic stability, *Euphytica*, **30** : 835-840.
2. **Finlay, K.W. and Wilnkions, G. N.** 1963. The analysis of adaptation in a plant breeding programme. *Australian J. Agric. Res.* **14** : 742-754.
3. **Eberhart, S. A. and Russell, W. A.** 1966 Stability parameters for comparing varieties. *Crop Sci.* **6** : 36-40.
4. **Perkins, J. N. and Jinks, J. L.** 1968. Environmental and genotype-environmental components of variability. III multi-le lines and crosses, *Heridity*, **23**:339-356.
5. **Freeman, G. H. and Perkins, J. M.** 1971. Environmental and genotypes-environmental components of variability, viii relation between genotypes grown in different environments and measures of these environments. *Heridity*, **27**: 15-23.
6. **Tai, G. C. C.** 1971. Genotypic stability analysis and its application to potato regional trials. *Crop Sci.* **11** :184-190
7. **Shukla, G. K.** 1972. Sum statistical aspects of partitioning genotypes-environmental components of variability. *Heridity*. **29** : 237-245.
8. **Luthara, O. P. and Singh, R. K.** 1974. A comparison of different stability models in wheat. *Theo. and Appl. Gen.* **45**:143-147.
9. **Lin, C. S. and Thompson, B. K.** 1975. An empirical methods of grouping genotypes based on a linear function of the genotype-environments interaction. *Heridity*. **34** :255-263.
10. **Prajapati, B. H., Patel, N. M. and Chauhan, R. M.** 2001. On comparison of some stability analysis models -A case study of weedicide experiment, *GAU Res. J.* **26** : 71-76.

Influence of assumptions underlying analysis of variance on precision of field experiments

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Abstract

Coefficient of variation (C.V.%) is a good index of reliability of results of field experiments. The C.V. % of 906 experiments conducted in randomized complete block design at 25 research stations of the Gujarat Agricultural University on six pulse crops indicated that out of 906 experiments, 20.86 %, 24.06 % and 5.19% of the experiments did not satisfy basic assumptions underlying analysis of variance viz. normality, additivity and both respectively. The results obtained in the present study revealed that the basic assumptions viz. normality and additivity significantly influenced C.V. % (precision) of the field experiments. The C.V. % was reduced by about 44.96 % per cent, when experimental data which satisfied both the assumptions (15.36%) compared to the experimental data did not satisfy these assumptions (27.89 %). Therefore, in order to improve the precision of experimental results (or to reduce C.V.%), it is advisable to test, normality and additivity of data and use an appropriate transformation (if necessary) before applying analysis of variance technique.

Keywords: Analysis of variance, coefficient of variance, precision, basic assumptions.

Introduction

Coefficient of variation (C.V. %) is a good index of reliability of experimental results or precision of field experiments (1). Additivity and normality are the basic assumptions underlying analysis of variance (ANOVA). Departure from one or more of these assumptions affects the level of significance *i.e.* the sensitivity of F test and ultimately the precision of the experimental results. In this situation, present study was undertaken to know the effect of these assumptions on the precision of results of field experiments through an empirical study.

Material and methods

Among various field layouts (designs of experiments) of agricultural field experiments, Randomized Complete Block Design (RCBD) occupies the first position showing large proportion of experiments as compared to other designs (2, 3, 4, 5). Considering the area and importance of pulse crops in the state, plot-wise yield data were collected for 906 experiments conducted in randomised complete block design on six important pulse crops at 25 research stations of the Gujarat Agricultural University. The experiment-wise data were subjected to statistical analysis following analysis of variance for RCBD with a view to obtain error mean square and thereby C.V. % of each

experiment. C. V. % was assumed as random variable in testing difference between mean C.V. % by 't' test.

As mentioned earlier, the normality, additivity and independency are the basic assumptions related to various components of ANOVA. The treatments were assigned to experimental units at random hence errors were assumed as random and independent. Further, assumptions viz. normality and additivity were tested as described by Snedecor and Cochran (6) and Tukey (7) respectively.

Results and discussion

Effect of Normality

On the basis of test of assumptions, all the experiments were classified into two groups viz. experiments which satisfied an assumption of normality and experiments which did not satisfy an assumption of normality. The average C.V. % of both the groups were worked out and their difference was tested by 't' test which is presented in Table-1.

It was noticed that 20.86 per cent of the total experiments of pulse crops did not satisfy the assumption of normality. The results revealed that the average C.V. per cent of the experiments following normality was significantly lower (16.87 %) than the

Table 1. Mean C.V. % of experiments) following and not following assumptions of normality, additivity and both alongwith 't' values.

Assump- tion	Results	No. of Experi- ments	Mean C.V. %	't' value
Normality	Normal	717	16.87	5.50*
Additivity	Non-normal	189	22.17	7.39*
	Additivity	688	16.37	
	Non-additivity	218	23.05	
Normality and Additivity	Following both (Group-1)	546	15.35	7.99
	Not-following Both (Group-2)	47	27.89	

* Significant at 95 per cent level of confidence.

average C.V. % of the experiments showing non-normality (22.17 %). The results thus showed that the assumption of normality influenced C.V. % (precision) of the field experiments. The average C.V. % was reduced (efficiency of experiments increased) by about 23.91 per cent by following the assumption of normality.

Effect of additivity

The experiments were classified (Table 1) into two groups *i.e.* additivity and non-additivity on the basis of additivity test as described by Tukey (7). It was observed that sizable number of experiments (24.06 per cent) had violated the basic assumption of additivity. The average C.V. % of the experiments showing non-additivity was significantly higher (23.05) than that of showing additivity (16.37). This results indicated that C.V. % can be reduced by about 28.98 per cent by satisfying the basic assumption of additivity. The results thus showed that the assumption of additivity influenced C.V. % (precision) of the field experiments. Joint effect of normality and additivity.

The joint effect of both these assumptions *i.e.* normality and additivity on mean C.V. % was also studied (Table 1) by classifying all the 906 experiments into two groups, *viz.*, those experiments satisfying both the assumptions as group-1 (546) and group-2 (47) wherein both the assumptions were not satisfied. It was observed that only 60.26 per cent of the total experiments (906) have followed both the assumptions of ANOVA.

The experiments wherein both the assumptions were satisfied (group-1) produced lower C.V. % (15.35) than experiments not satisfying both the assumptions (27.89). The C.V. % was reduced by about 44.96 per cent by satisfying both the basic assumptions *i.e.* normality and additivity underlying ANOVA. It was also observed that the group-2 produced high C.V. per cent (27.89) than that of either non-normality (22.17) or non-additivity (23.05). Contradictory to this, group -1 produced low C.V. % (15.35) than that of either normality (16.87) or additivity (16.37).

The results obtained in the present study revealed that the basic assumptions *i.e.* normality and additivity significantly influenced C.V. % (precision) of the experiments. In order to ensure better precision (low C.V. %) of experimental results, data need to be tested for the basic assumptions before employing analysis of variance procedure. If required, the data be transformed to appropriate scale before employing ANOVA to reduce C.V. % and thereby increasing precision as well as validity of the experimental results.

References

1. Gomez, K.A. and Gomez, A.A. 1984 Statistical procedures for agricultural workers. Second Edition, John Wiley and Sons, New Delhi.
2. Khosla, R.K., Sardana, M.G., Saksena, M. P. and Sahni, M. L. 1973. Review of agricultural experimentation in India during 1965-70, *Ind. J. Agri. Sci.* **43** : 337-340.
3. Cavell, Brownie, and Venns, C.B. 1993. Estimating special variation in analysis of data from yield trials : A comparison of methods. *Agron. J.* **85** : 1244-1253.
4. Lin, C.S., Binns, M.R., Voldeng, H. D. and Guillemette, R. 1993. Performance of RBD's in field experiments. *Agron. J.* **85** : 168-171.
5. Singh, D., Tyagi, B. N., Kathuria, O.P. and Sahni, M. L. 1971. A survey of agricultural experimentation in India. *Indian J. Agric. Sci.* **41** : 901-905.
6. Snedecor, G.W. and Cochran, W. G. 1967. Statistical Methods. Sixth Edition. Oxford & IBM Publishing Co., New Delhi.
7. Tukey, J. W. 1949. One degree of freedom for non-additivity, *Biometrika*. **5** :232-242.

Optimum plot size for field experiment in irrigated chickpea (*Cicer arietinum*, Linn.)

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Abstract

Uniformity trial on irrigated chickpea crop was conducted at Main Pulses Research Station, Gujarat Agricultural University, Sardarkrushinagar to find out optimum size and shape of plot, number of replications and land use efficiency for the same. Three methods viz. (i) Maximum curvature method (ii) Fair-field Smith's variance law and (iii) Comparable variance method were used for this purpose. A plot of 9.6 m² size having shape of 4 m. length (E-W) and 2.4 m. cross width (8 rows in N-S) was considered optimum plot size with 6 minimum replications at 5 % S. E. level of accuracy for irrigated chickpea field experiments at Sardarkrushinagar. Relative land use efficiency for different sizes and shapes of plots also exhibited similar trend to that of C.V. per cent.

Keywords : Plot size, shape, replications, land use efficiency, chickpea.

Introduction

Efficient planning of field experiments depends on various factors of which suitable size and shape of plot is one, which varies with the crop. Each experimental site has an inherent soil variability, which could be assessed through uniformity trial. The study of such variation helps in proper choice of size and shape of plots and blocks, experimental design and number of replications. Such studies based on uniformity trials were undertaken with various legume crops like pigeonpea (1, 2), mungbean (3), black gram (4) and gram (5) under Indian conditions.

However, there is no report on optimum plot size for irrigated chickpea for North Gujarat, being predominantly irrigated chickpea growing area. Hence the present investigation was taken up.

Material and methods

Uniformity trial on Chickpea crop (cv. ICCV-4) was conducted during *rabi* season of 2002-2003 at Main Pulse Research Station, Gujarat Agricultural University, Sardarkrushinagar to workout optimum size and shape of plot and number of replications for the same. The crop was raised East-West direction with inter row spacing 30 cm. Four blocks each of size 20 m. length and 12m. width were marked covering total area of about 0.5 hectare. Each block consisted of 40

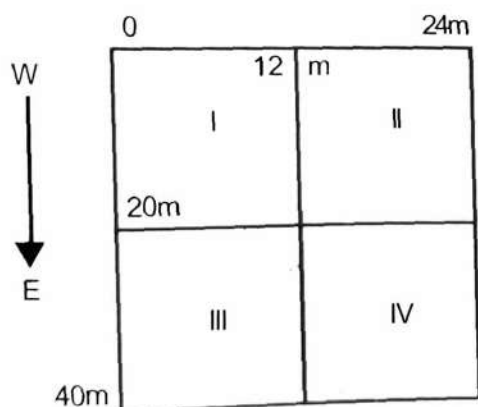
rows with 20 m. length. One basic unit was taken as 2 rows of 1 m. length. There were 400 basic units per block and in all 1600 units under trial. The dimensions of the smallest basic unit were 1 m. length and 0.60 m. width (0.60 m²). Border area were excluded from each side of experimental plot. The grain yield for each basic unit was recorded separately. The different sized plots of size 1, 2, 4, 5, 8, 10, 16, 20, 25, 40 and 50 units were formed by combining the adjacent units both length wise as well as width wise. The coefficient of variation (C.V. %) for each such arrangement was calculated independently.

Results and discussion

The coefficient of variation (C.V.%) were calculated for different size and shape of plot using grain yield data and are presented in Table 1. The results revealed that C.V. % decreased with increase in plot size. The decrease in C.V. % was more rapid with an increase in length rather than increase in width. The average C.V. % decreased from 37.35 % to 9.0 % with increase in plot size from 1 unit to 50 units. The decrease in average C.V. % was from 37.35% to 13.08 % with the increase in plot size up to 16 units size, thereafter, the reduction in C.V.% was not proportionate to the area added. Thus 16 units plot size, (4 m. X 2.4 m.) could be considered as optimum plot size, which is just beyond the point of maximum curvature.

Table 1. C.V. % per unit size for grain yield of chickpea

No. of Units	Combinations	C.V. % for Different Blocks				Average C.V. % for Block	Average C.V. % for plot Size
		I	II	III	IV		
1	1X1						
2	2X1	41.90	44.23	31.61	31.65	37.35	37.35
	1X2	32.27	34.11	25.37	26.31	29.52	28.19
4	4X1	29.79	29.44	22.81	25.41	26.86	
	2X2	24.98	27.61	21.32	21.18	23.77	21.89
	1X4	22.72	22.80	18.53	21.44	21.37	
5	5X1	20.44	23.44	19.55	18.70	20.53	
	1X5	22.79	26.72	20.50	19.60	22.40	20.35
8	4X2	17.41	18.74	20.01	17.06	18.31	
	2X4	17.77	18.48	16.06	17.44	17.44	17.02
10	10X1	15.68	18.56	15.83	16.31	16.60	
	5X2	17.90	23.12	17.05	14.40	18.12	15.92
	2X5	15.61	17.74	16.06	16.52	16.48	
	1X10	13.15	13.87	16.80	14.77	14.65	
16	4X4	13.48	15.93	15.16	13.11	14.42	
20	10X2	12.40	13.84	13.12	12.97	13.08	13.08
	5X4	13.02	15.67	13.56	13.21	13.87	12.77
	4X5	10.91	15.01	14.35	12.59	13.22	
	2X10	10.11	10.91	15.42	11.81	12.06	
25	5X5	10.92	11.94	12.99	11.96	11.95	
40	20X2	09.08	09.14	15.00	11.41	11.16	11.16
	10X4	09.84	12.44	12.08	07.76	10.53	10.17
	4X10	08.69	14.02	11.92	10.14	11.19	
	2X20	08.91	09.21	11.91	10.09	10.03	
50	10X5	07.38	09.86	07.61	10.86	8.93	
	5X10	07.95	07.31	12.37	08.85	9.12	9.08
		07.55	08.10	11.68	08.86	9.05	

Layout and experimental details

Location	: Main Pulses Research Station, G.A.U., S.K. Nagar
Crop Variety	: ICCV-4
Total Area	: 40 m. X 24 m. = 960 m ²
Block Area	: 20m. X 12m. = 240m ²
Spacing	: 30cm.
Basic Unit Area	: 1m. X 0.60m. = 0.60m ²
No. of Basic Unit per Block	: 400
Total Basic Units	: 1600

The difference between average C.V.% of the consecutive points (plot size) may help to estimate per unit decrease in C.V.% and there by the point of maximum curvature. The results are summarized in Table 2. The results indicated that per unit decrease in C.V.% decreased with the increase in plot size. The highest per unit decrease in C.V. % was also observed upto 16 units plot. Therefore, 16 units plot size could be taken optimum plot size for chickpea. Beyond 16 unit plot size, the decrease in C.V. % was not proportional to the amount of land use.

The well known Smith (6) equation $Y = a x^{-b}$ was fitted between plot variance and plot size for different sized. The fitted equation was $Y = 48.6 X^{-0.626}$ with $R^2 = 64.35$. The value of 'b' indicating existence of correlation between neighbouring plots. The Smith's method just serves as guide line only.

From the estimates of average C.V. % (Table 2), the minimum number of replications and area required for 5 % S.E.m for different plot size were calculated and are given in Table 3. The number of replications required for a given level of accuracy decrease with increase in the plot size, which indicates greater

Table 2. Per unit decrease in C.V.% for grain yield of chickpea

Plot Size in Units	Average C.V. %	Difference in C.V. %	Per unit decrease in C.V. %
1	37.35	-	-
2	28.19	9.16	9.16
4	21.89	6.30	3.15
5	20.35	1.54	1.54
8	17.02	3.33	1.11
10	15.92	1.10	0.55
16	13.08	2.84	0.47
20	12.77	0.31	0.08
25	11.16	1.61	0.32
40	10.17	0.99	0.07
50	9.08	1.09	0.11

efficiency of smaller plots. The results showed that as the size of plot (units) increased, the number of replications and relative land use efficiency of plot is decreased as compared to small plots. Relative efficiency is very high with small plot size but practical difficulties arise when experiment is conducted with small plot size. Therefore, such size of plot should be considered more efficient with lesser number of replications. As plot size increase, the number of replications and the relative land use efficiency decrease up to 16 units. Thereafter the decrease was not proportionate to the amount of land added for the plot. Thus 6 replications could be considered minimum number of replications at 5 % S.E. level of accuracy.

Thus the results leads to the conclusion that 16 unit plot size i.e. 4 m. length and 8 rows width (4 m. X 2.4 m. = 9.6 m²) could be considered optimum plot size with 6 minimum replications for 5 % SE level of accuracy for chickpea crop raised under irrigated conditions when grown east-west at Sardarkrushinagar.

Table 3. Number of replications and land use efficiency for grain yield of chickpea

Plot Size in Units	Average C.V. %	Number of Replications	Area Required	Relative land use efficiency	
1	37.35	55	55	33.0	100.00
2	28.19	32	64	38.4	85.94
4	21.89	19	76	45.6	72.37
5	20.35	16	80	48.0	68.75
8	17.02	11	88	52.8	62.50
10	15.92	10	100	60.0	55.00
16	13.08	6	96	57.6	57.29
20	12.77	6	120	72.0	45.83
25	11.16	5	125	75.0	44.00
40	10.17	4	160	96.0	34.38
16	9.08	3	150	90.0	36.67

References

1. Reddy, M.N. and Chetty, C.K.R. 1985. Experimental plot size and shape based on data from uniformity trial with dry pigeonpea. *Indian J. Agric. Sci.* **55** : 538-543.
2. Prajapati, B.H., Tikka, SBS, Purohit, L.P. and Chaudhari, G.K. 2004. Pot size study from uniformity trial data on Pigeonpea under north Gujarat condition. *Indian J. Pulses Res.*, **17**:25-27.
3. Singh, V.P. and Singh, D.P. 1989. Estimation of Optimum plot size for field experiment with mungbean. *Narendra Dev J. Agric. Res.* **4** : 61-64.
4. Rao, C.S. and Prasad, A.S.R. 1991. Optimum plot size for estimating yield of blackgram. *Indian J. Agric. Sci.*, **61** : 574-578.
5. Lakhera, M.L., Singh, V.P., Sunder, R.M. and Patel, N.M. 1995 Optimum Plot size and shape for field experiment on gram. *GAU Res. J.* **21**:142-148.
6. Smith, H.F. 1938. An empirical law describing heterogeneity in the yield of agricultural crops. *J. Agric. Sci.* **28** : 23-28.

Screening of clusterbean genotypes against bacterial leaf blight

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Bacterial leaf blight (*Xanthomonas axonopodis* pv. *Cyamopsidis*) is an important wide spread disease of clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.]. The disease is a potential constrain to guar production where the crop is grown during rainy season. Under epiphytotic condition, BLB alone is found to be responsible for reduction in yield by 50 to 66.73 per cent. For the resistance breeding programme, information on nature and magnitude of genetic variability for disease resistance is of great importance.

Eighty five genotypes of clusterbean were screened during *kharif* 2002 and 2003 at Main Pulses Research Station, Gujarat Agricultural University, Sardarkrushinagar. The infector row technique was followed for screening against bacterial leaf blight (BLB) disease (1). To get uniform disease intensity, the BLB inoculum (10^8 cells/ ml.) was sprayed twice at 7 days interval during evening hours starting from 35 DAS. The infector rows of susceptible check Pusa Navbahar were sown alternate to each genotype and

Table 1. Evaluation of eighty five genotypes under artificially inoculated condition against bacterial leaf blight of clusterbean

Disease intensity Percentage	Category	Number of genotypes	Name of genotypes
0 %	Immune	-	Nil
1 - 10 %	Resistant	11	GAUG-0001, GAUG-0003, GAUG-9915, GAUG-0010, GAUG-0011, HGS-884, GAUG-0206, RGC-870, RGC-1002, CAZG-97, GAUG-9406.
10.1 - 20 %	Susceptible	44	GAUG-9012, GAUG-9007, GAUG-9107, GAUG-9703, GAUG-9712, GAUG-21, GAUG-20, GAUG-60, GAUG-89, GG-1, GAUG-8819, GAUG-8832, GAUG-9002, GAUG-9003, GAUG-9005, GAUG-9012, GAUG-9707, GAUG-9714, GAUG-9709, GAUG-9801, GAUG-9803, GAUG-9804, GAUG-9805, GAUG-9806, GAUG-9810, GAUG-9811, GAUG-9813, GAUG-9814, GAUG-9901, GAUG-0115, GAUG-9908, GAUG-9909, GAUG-9910, GAUG-9911, GAUG-0114, GAUG-9008, GAUG-9809, GAUG-9702, GAUG-0111, GAUG-9106, GAUG-0109, HG-75, Naveen, RGC-936.
>20 %	Highly susceptible	30	Pusa Navbahar, GAUG-73, GAUG-9711, GAUG-9713, GAUG-9716, GAUG-9807, GAUG-9812, GAUG-9902, GAUG-9903, GAUG-9904, GAUG-9905, GAUG-9906, GAUG-9907, GAUG-9013, GAUG-0002, GAUG-0004, GAUG-0005, GAUG-0006, GAUG-0007, GAUG-0008, GAUG-0009, GAUG-0012, GAUG-0013, GAUG-0014, GAUG-0015, GAUG-01 01, GAUG-01 03, GAUG-01 05, GAUG-0107, GAUG-0108.

also on periphery of the experimental plot. The disease intensity of BLB was recorded using 0 to 5 scale (0 = Immune, 1 = 1-10 %, 2 = 10.1 -25 %, 3 = 25.1 - 50 %, 4= 50.1 - 75 % and 5= > 75%) and average disease reaction was calculated in both the years. The disease intensity due to BLB was calculated as :

$$\text{Disease intensity (\%)} = \frac{\text{Sum of numerical ratings}}{\text{Highest rating} \times \text{total no. of leaves observed}} \times 100$$

To measure the intensity of the Bacterial Leaf Blight disease, the infector row-technique was followed Anahosur and Hegde (1). The disease intensity of Bacterial Leaf Blight was recorded using 0 to 5 scale (0= Immune, 1= 1-10%, 2= 10.1 - 25%, 3 = 25.1550 %, 4=: 50.1 - 75 % and 5= > 75%) and average disease reaction was calculated in both the years.

During both the years severe attack of Bacterial Leaf Blight was found. On the basis of average of both the years, the lines were categorized into three groups

i.e. resistant (< 10%), susceptible (10-20%) and highly susceptible (> 20%). The results showed that eleven genotypes viz., GAUG 0001, GAUG 0003, GAUG 9915, GAUG 0010, GAUG 0011, HGS 884, GAUG 0206, RGC 870, RGC1002, CAZG 97 and GAUG 9406 showed resistant reaction incidence, while 44 genotypes were susceptible and 30 genotypes were highly susceptible against Bacterial Leaf Blight (Table 1). Gupta *et al.* (2) also reported a number of genotypes resistant against Bacterial leaf blight utilizing infector row technique.

References

1. **Anahosur, K. H. and Hegde, R. K.** 1979. Assesment of techniques used for screening sorghum genotypes for downey mildew. *Mysore J. Agric. Sci.* **13**:449-451.
2. **Gupta, P. P., Gupta, Vivek, Singh, J. V., Punia, Anita and Kapoor, Richa.** 2003. Advances in Arid Legumes Res., Indian Arid Legumes Society. Scientific Publ. Jodhpur. pp. 415-418.

Validity period for groundnut (GG-2) under ambient conditions

Short Communication

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Ageing is a natural, irreversible phenomenon resulting in seed deterioration which leads to loss of viability and vigour during storage. The loss of seed viability and vigour leads to reduction in germination, sub-optimal survival, poor performance of surviving plants and ultimately reduction in yield. Therefore present study was undertaken to assess whether the validity period of nine months is appropriate for groundnut crop (GG-2) stored under ambient conditions.

The experiment was conducted during December 1997 and April 2000 under ambient conditions under the National Seed Project programme at the Main Millet Research Station, Gujarat Agricultural University, Jamnagar. Groundnut variety GG-2 produced *kharif* - 1997 and 1999 with 5 to 8 % moisture content stored in gunny bags having minimum standard of seed certification was used as experimental material. Observations on germination (%), field emergence (%) and moisture content (%) were recorded, at three and two months interval during 1998 and 2000, respectively. Germination percentage was recorded as per the prescribed procedure of ISTA (1), while moisture content (%) was estimated by oven drying at 105° C for 8 hour as per method adopted by Dange *et al.* (2) in groundnut. The weather data like room temperature, relative humidity, rainfall and rainy days were recorded during the entire experimental period (Appendix 1).

The results obtained during two years (Table 1) indicated that groundnut GG-2 seed showed germination percentage above seed certification standard (>70%) up to six months of storage period. As storage period increased beyond six months seed germination decreased during both the years. The seed germination was tested in laboratory as well as in field condition from the start of seed storage under ambient conditions in both the years.

Germination percentage was more in laboratory than that of field condition which is obvious. Hence, there is a need to revise the validity period of groundnut

(pods) produced during *kharif* season from the existing nine months to six months. Similar results were reported by Basave Gowda and Kenchanagouder (3) for five different varieties of groundnut (pods) produced in summer season. Sarwa *et al.* (4) reported that the pods of three groundnut varieties viz., ICGS-11, R-8808 and JL-24 harvested from *kharif* season had seed germination above minimum seed certification standard (>70 %) up to 6, 7 and 8 months, respectively, when stored under ambient conditions. The moisture content remained constant up to six months from the date of storage in gunny bag under ambient conditions, but after that it increased during storage which developed the insect population and damaged the seeds which might have affected the seed viability. This research center is near the sea shore and the results of the studies at this station may be considered for the coastal region where groundnut seed (pods) is stored to utilize for subsequent seasons.

Table 1. Seed germination (%), moisture content (%) and field emergence (%) Influenced by storage period in *kharif* ground nut (GG-2).

Experiment year: 1997-98

Character	Storage period (Three months interval)			
	Initial	3 months	6 months	9 months
Germination (%)	98.00	99.50	95.50	53.00
Moisture content (%)	4.98	4.93	4.29	5.97
Field emergence (%)	96.00	95.50	81.50	10.50

Experiment year : 2000-01

Character	Storage period (Two months interval)				
	Initial	2 months	4 months	6 months	8 months
Germination (%)	97.00	91.00	81.00	78.00	62.00
Moisture content (%)	4.96	4.96	5.06	5.18	5.12
Field emergence (%)	86.00	87.00	81.00	72.00	59.00

Appendix-1

Weather Data (Room Temperature, Relative humidity and Rainfall during experimental period)

Month	Std. week	Temperatur °C		RH %		Rainfall (mm)	Rainy days
		Maxi.	Mini.	Maxi.	Mini.		
December-97	49	25	22	60	60	-	-
	50	25	21	58	60	-	-
	51	22	20	59	55	-	-
	52	25	20	61	60	-	-
January-98	1	22	19	58	60	-	-
	2	25	21	65	57	-	-
	3	22	19	53	45	-	-
	4	22	18	54	48	-	-
February-98	5	25	20	60	58	-	-
	6	26	22	58	47	-	-
	7	26	23	54	52	-	-
	8	25	22	72	54	-	-
March-98	9	26	22	77	50	-	-
	10	27	25	63	49	-	-
	11	29	25	62	53	-	-
	12	31	28	56	43	-	-
April-98	13	33	29	53	43	-	-
	14	35	30	64	48	-	-
	15	33	29	59	41	-	-
	16	33	29	65	54	-	-
May-98	17	34	31	70	65	-	-
	18	35	32	74	60	-	-
	19	36	32	71	49	-	-
	20	37	33	67	58	-	-
June-98	21	36	33	63	56	-	-
	22	35	33	66	61	-	-
	23	35	32	69	65	69.0	2
	24	35	30	77	68	-	-
July-98	25	35	32	71	58	-	-
	26	33	31	74	70	71.0	1
	27	31	28	88	83	23.3	2
	28	31	30	82	71	0.8	-
August-98	29	32	29	79	68	-	-
	30	32	30	78	69	1.0	-
	31	32	30	80	74	14.4	2
	32	32	30	80	79	4.0	1
September-98	33	32	29	78	77	-	-
	34	34	30	75	71	-	-
	35	31	29	80	77	27.0	2
	36	32	29	73	68	-	-
October-98	37	32	29	77	71	-	-
	38	31	28	83	77	57.0	3
	39	32	29	82	77	20.0	1
	40	34	30	79	72	-	-
November-98	41	36	31	73	62	7.5	1
	42	30	27	81	73	96.0	2
	43	32	27	75	70	-	-
	44	31	27	70	62	-	-
	45	31	27	63	63	-	-
	46	29	24	57	47	-	-
	47	27	23	56	53	-	-
	48	27	21	57	52	-	-

Cont...

Weather Data (Room Temperature, Relative humidity and Rainfall during experimental period)

Month	Std. week	Temperatur °C		RH %		Rainfall (mm)	Rainy days
		Maxi.	Mini.	Maxi.	Mini.		
April-2000	14	33	28	64	35	-	-
	15	34	28	67	44	-	-
	16	33	29	71	49	-	-
	17	34	29	73	53	-	-
	18	29	29	72	58	-	-
May-2000	19	35	30	68	53	-	-
	20	35	30	68	55	-	-
	21	35	31	69	55	-	-
	22	35	31	72	59	8.5	1
June-2000	23	35	32	68	57	-	-
	24	35	32	64	56	-	-
	25	35	32	66	55	-	-
	26	34	32	68	60	-	-
July-2000	27	31	30	80	78	215.5	5
	28	31	30	84	79	169.0	3
	29	31	29	86	78	6.0	1
	30	32	30	79	67	-	-
	31	32	30	78	67	-	-
August-2000	32	32	30	77	72	30.5	1
	33	30	28	85	79	32.5	1
	34	32	29	83	78	7.0	1
	35	31	29	82	76	0.5	-
September-2000	36	31	29	79	73	0.5	-
	37	31	29	77	69	-	-
	38	32	29	76	66	-	-
	39	35	31	71	58	-	-
October-2000	40	35	32	68	48	-	-
	41	34	32	69	52	-	-
	42	34	30	68	48	-	-
	43	33	30	73	53	-	-
	44	32	29	56	43	-	-
November-2000	45	31	30	70	65	-	-
	46	30	28	64	54	-	-
	47	27	24	62	58	-	-
	48	28	23	49	51	-	-
December-2000	49	25	21	50	47	-	-
	50	25	23	49	50	-	-
	51	25	22	52	53	-	-
	52	25	20	58	55	-	-
January-2001	1	23	20	51	50	-	-
	2	21	20	58	52	-	-
	3	22	19	53	45	-	-
	4	23	19	53	44	-	-
	5	22	19	49	41	-	-

References

1. ISTA. 1985. International rules for seed testing. Proc. Int. Seed Test. Assoc. **31** : 1 -52.
2. Dange, S.R.S., Patil, V.J., Ladani, M.G. and Manvar, O.K. 1985. Effect of relative humidity and storage period on fungal invasion and viability of groundnut seeds. Bull. Grain Tech. **22** : 225-231.
3. Basave Gowda and Kenchanagoudar. P.V. 2000. Effect of genotypes and storage period on seed quality in summer groundnut. Seed Tech. News. **30** : 22-23.
4. Sarwa, R.K., Deshpande, V.K. and Shekhargouda, M. 2002. Prediction of storability of groundnut through accelerated aging. Seed Tech News Abst. **32** : 115.

Integrated weed management in summer soybean [*Glycine max* (L.) Merrill.]

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Production statistics shows that productivity of soybean crop in India (917 kg ha^{-1}) and Gujarat (581 kg ha^{-1}) is far low as compared to the world average (1921 kg ha^{-1}). A large number of weed species infest the crop during its growth and resulting decline in the productivity from 27 to 71 per cent (1). Unavailability of adequate labourers during weeding peaks and difficulty in the use of mechanical weeders create problems for effective control of weeds. Herbicidal weed control remains the only choice under such situation. The herbicides are costly and the availability in desired quality and knowledge regarding application time, method and rate are main constraints for adoption.

A field experiment was conducted at Navsari during the summer season of 1999-2000. The soil of experiment plot was clayey in texture with low in total N (0.039 %), medium in available P_2O_5 (27.3 kg ha^{-1}) and fairly high in available K_2O (410 kg ha^{-1}) and neutral in reaction. Fourteen treatments (Table 1) were compared in a RBD with three replications. Crop variety "Gujarat Soybean 2" was sown on 3rd February 1999 at 45 cm apart by using uniform seed rate of 60 kg ha^{-1} . The herbicides were applied in aqueous solution @ $600 \text{ litres ha}^{-1}$.

Weed intensity

The dominating weeds in crop were *Desmostachya bipinnata* L., *Cynodon dactylon* (L.) Pers., *Echinochloa colonum* Link., *Sorghum halepense* as grassy weeds; *Euphorbia geniculata* L., *Digera arvensis* (L.) Forsk., *Physalis minima* L., *Phyllanthus maderaspatensis* L., *Trianthema portulacastrum*, *Convolvulus arvensis* as broad leaf weeds and *Cyperus rotundus* L. as sedges.

The maximum weed intensity was recorded under unweeded control at 30, 60 and 90 DAS as well as at harvest. The lowest weed density was observed at 30 DAS, when Fluchloralin @ 1.5 kg ha^{-1} applied as

pre sowing. Chemical and mechanical weed control methods when applied in combination reduced weed infestation significantly than both the methods used alone (Table-1). These treatments having lower weed intensity consequently produced significantly lower weed biomass than unweeded control. These findings are in conformity with the results reported by Padmavathi *et al.* (2) and Nandurkar *et al.* (3). The highest weed control efficiency was recorded at 60 DAS (89.0 per cent) and at harvest (84.6 per cent) with the application of fluchloralin @ 1.0 kg ha^{-1} with hoeing and HW at 30 DAS and closely followed by pendimethalin @ 1.0 kg ha^{-1} with hoeing followed by HW at 30 DAS. The impressive higher weed control efficiency under these treatments might be due to appreciable reduction in weed biomass under these treatments resulting in higher weed control efficiency.

Crop performance

In general plant height was the maximum under the application of fluchloralin @ 1.0 kg ha^{-1} with hoeing and hand weeding. Number of branches per plant, pods per plant and seeds per pod were maximum under application of fluchloralin @ 1.0 kg ha^{-1} with hoeing followed by HW at 30 DAS and were at par with pendimethalin @ 1.0 kg ha^{-1} with hoeing followed by HW but significantly superior to rest of the treatments (Table 2). Similarly, grain and straw yields were significantly higher under these treatments than rest of the treatments. This can be attributed due to the low weed dry weight, which offered less competition for light, nutrient, moisture, space and air which resulted in better growth consequently higher yield (Table 2). Above results corroborates the findings of Padmavathi *et al.* (2) and Nimje (4).

Economics

Net realization over control as well as net return per rupee invested was affected by all the weed management treatments (Table 2). Among the

Table 1. Effect of weed management on weed intensity, weed biomass and weed control efficiency of soybean

Sr. No.	Treatment	Weed intensity (Plants m ⁻²)				Weed biomass (gm m ⁻²)				WCE (%)	
		30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest (kg ha ⁻¹)	90 DAS	At harvest
T ₁	Fluchloralin 1.5 kg ha ⁻¹ pre-sowing	3.38 (10.67)	6.38 (40.00)	4.27 (17.33)	4.53 (19.67)	4.4	16.8	26.0	290.9	77.5	75.1
T ₂	Fluchloralin 1.0 kg ha ⁻¹ pre-sowing	3.91 (14.67)	6.52 (41.67)	4.57 (20.00)	4.85 (22.67)	4.9	21.1	28.1	300.4	71.8	74.3
T ₃	Pendimethalin 1.5 kg ha ⁻¹ pre-emergence	3.58 (12.00)	6.40 (40.33)	4.19 (16.67)	4.16 (16.33)	5.2	19.0	26.2	292.0	74.6	75.0
T ₄	Pendimethalin 1.0 kg ha ⁻¹ pre-emergence	4.09 (16.00)	6.59 (42.67)	4.29 (17.67)	4.68 (21.00)	5.1	21.9	30.1	330.4	70.7	71.8
T ₅	Alachlor 2.0 kg ha ⁻¹ pre-emergence	3.62 (12.33)	6.55 (42.00)	4.78 (22.00)	4.96 (23.67)	6.0	22.8	30.0	340.9	69.5	70.9
T ₆	Alachlor 1.5 kg ha ⁻¹ pre-emergence	4.20 (16.67)	6.82 (45.67)	4.61 (20.33)	5.14 (25.67)	6.1	24.7	34.3	360.2	67.0	69.2
T ₇	Oxyfluorfen 0.25 kg ha ⁻¹ pre-emergence	3.44 (11.33)	6.43 (40.67)	4.46 (19.00)	4.58 (20.00)	7.0	21.5	31.0	330.2	71.3	71.3
T ₈	Oxyfluorfen 0.20 kg ha ⁻¹ pre-emergence	4.16 (16.33)	6.65 (43.33)	4.41 (18.67)	5.00 (24.00)	6.3	23.4	34.5	380.6	68.7	67.5
T ₉	Fluchloralin 1.0 kg ha ⁻¹ pre-sowing + Hoeing and hand weeding at 30 DAS	3.99 (15.00)	4.80 (22.33)	3.33 (10.33)	3.48 (11.33)	4.8	8.20	15.0	180.8	89.0	84.6
T ₁₀	Pendimethalin 1.0 kg ha ⁻¹ pre-emergence + Hoeing and hand weeding at 30 DAS	4.07 (15.67)	5.19 (26.00)	3.16 (9.33)	3.45 (11.00)	5.2	9.80	19.8	220.3	86.9	81.8
T ₁₁	Alachlor 1.5 kg ha ⁻¹ pre-emergence + Hoeing and hand weeding at 30 DAS	4.20 (16.67)	5.79 (32.67)	3.38 (10.67)	3.67 (12.67)	5.7	13.9	25.0	290.9	81.4	75.1
T ₁₂	Oxyfluorfen 0.20 kg ha ⁻¹ pre-emergence + Hoeing and hand weeding at 30 DAS	4.18 (16.67)	5.75 (32.33)	3.48 (11.33)	3.55 (12.00)	6.2	18.1	28.0	310.7	75.8	73.5
T ₁₃	Hoeing followed by hand weeding at 30 DAS	5.87 (33.67)	7.39 (53.67)	5.93 (34.33)	6.28 (38.67)	30.4	37.2	43.2	480.3	50.3	59.0
T ₁₄	Unweeded control	6.99 (48.00)	8.36 (69.00)	7.46 (54.67)	7.39 (53.67)	35.8	74.8	108	1170	-	-
CD at 5%		0.86	0.84	0.86	0.77	2.75	6.46	6.18	60.65	-	-

*Figures in parentheses are actual weed population

Table 2. Effect of weed management on growth, yield and economics

Sr. No.	Treatment	Plant height (cm)	Branches plant ⁻¹	Pods plant ⁻¹	Seeds plant ⁻¹	Seed yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Net realization (Rs ha ⁻¹)	Net realization over control (Rs ha ⁻¹)	Net return per rupee invested
T ₁	Fluchloralin 1.5 kg ha ⁻¹ pre-sowing	73.6	3.4	33.8	2.27	993	1,595	3,057	2,563	0.98
T ₂	Fluchloralin 1.0 kg ha ⁻¹ pre-sowing	72.7	3.3	30.9	2.25	931	1,377	3,272	2,778	1.76
T ₃	Pendimethalin 1.5 kg ha ⁻¹ pre-emergence	73.5	3.4	31.4	2.22	987	1,410	3,469	2,976	1.44
T ₄	Pendimethalin 1.0 kg ha ⁻¹ pre-emergence	70.9	3.1	27.5	2.20	852	1,265	2,322	1,828	1.18
T ₅	Alachlor 2.0 kg ha ⁻¹ pre-emergence	70.8	3.3	26.7	2.24	840	1,235	2,350	1,859	1.36
T ₆	Alachlor 1.5 kg ha ⁻¹ pre-emergence	70.5	3.0	25.1	2.16	803	1,194	2,225	1,732	1.66
T ₇	Oxyfluorfen 0.25 kg ha ⁻¹ pre-emergence	70.9	3.1	28.3	2.20	881	1,350	2,202	1,708	0.83
T ₈	Oxyfluorfen 0.20 kg ha ⁻¹ pre-emergence	70.6	3.0	26.1	2.15	834	1,209	1,994	1,500	0.91
T ₉	Fluchloralin 1.0 kg ha ⁻¹ pre-sowing + Hoeing and hand weeding at 30 DAS	76.4	4.0	39.0	2.52	1,271	1,906	6,955	6,461	3.03
T ₁₀	Pendimethalin 1.0 kg ha ⁻¹ pre-emergence + Hoeing and hand weeding at 30 DAS	75.8	3.8	36.5	2.40	1,204	1,800	6,154	5,660	2.70
T ₁₁	Alachlor 1.5 kg ha ⁻¹ pre-emergence + Hoeing and hand weeding at 30 DAS	75.2	3.5	33.9	2.31	1,005	1,641	4,229	3,735	2.34
T ₁₂	Oxyfluorfen 0.20 kg ha ⁻¹ pre-emergence + Hoeing and hand weeding at 30 DAS	73.9	3.4	33.7	2.29	993	1,543	3,446	2,952	1.34
T ₁₃	Hoeing followed by hand weeding at 30 DAS	66.7	3.3	22.7	2.11	685	1,037	1,248	754	1.37
T ₁₄	Unweeded control	63.4	2.5	17.0	1.90	578	968	494	-	-
	CD at 5%	6.1	0.5	5.0	0.19	141	193	-	-	-

*Figures in parentheses are actual weed population

different treatments (Rs. 6,955 ha⁻¹) over the control (Rs. 5,660 ha⁻¹) and net return per rupee invested (3.03) were maximum under application of fluchloralin @ 1.0 kg ha⁻¹ as pre sowing with hoeing and HW at 30 DAS followed by pendimethalin @ 1.0 kg ha⁻¹ as pre emergence with hoeing and HW at 30 DAS. The net return per rupee invested (0.83) was the minimum when oxyflurofen @ 0.25 kg ha⁻¹ used alone.

References

1. Jha, V., Tripathi, S. C., Mithyantha, M. S. and Sivasankaran, K. 1993 Efficiency of sethoxydim for the control of grassy weeds in soybean. *Indian Soc. Weed Sci.* **11**: 161 -162
2. Padmavathi, P., Satynarayana, V, Rao, P. C., Latchanna, A. and Varaprasad, P. V. 1995 Integrated weed management system in soybean (*Glycine max* L.). *J. Oilseeds Res.* **12**:282-285
3. Nandurkar, G. P., Malvi, G. C. and Nandurkar, P. N. (1997) Weed control in soybean through chemical, mechanical and cultural methods. *J. Soil and Crops.* **7** : 30-32
4. Nimje, P. M. 1996 Effect of row spacing, mulching and weed control on weed growth and yield of soybean (*Glycine max*). *Indian J. Agron.* **41** : 427-432

Growth and yield of pearl millet hybrids as influenced by different dates of sowing under North Gujarat agro-climatic conditions during summer season

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Pearl millet [*Pennisetum glaucum* (L.) R. Br. Emend. Stuntz] is one of the major cereal crops grown in the arid and semi-arid region of the world. It is generally grown as rainfed crop in *kharif* on almost all types of soils and as a matter of fact, it is a component crop of dry land system. In Gujarat, this crop is grown both in *kharif* as well as in summer season. Date of sowing and selection of hybrids are recognized as most important non-monetary inputs affecting the yield of summer grown pearl millet. Adoption of high yielding short duration hybrids is an important input, which plays an important role in the maximization of pearl millet production per unit area per unit time. Hence, this study was undertaken to find out suitable hybrids and their optimum time of sowing under North Gujarat agro-climatic condition during summer season.

The study was carried out at Sardarkrushinagar during summer season of 2001 at Agronomy Instructional Farm, C.P. college of Agriculture, Gujarat Agricultural University, Sardarkrushinagar. The treatments consisted of four dates of sowing (D_1 : 20th February; D_2 : 2nd March; D_3 : 12th March and D_4 : 22nd March) and three hybrids (V_1 : MH-169; V_2 : GHB-235 and V_3 : GHB-316) were tried in split plot design with four replications by assigning dates of sowing in main plots and hybrids into subplots. The crop was sown with 3.75 kg/ha seed rate at a spacing of 45 cm between rows and was fertilized with 120-60-00 NPK kg/ha. The soil was loamy sand with pH 7.7 and the available N, P_2O_5 and K_2O was 140.0, 35.7 and 119.2 kg/ha, respectively. All the recommended packages of practices were followed and the crop was harvested at maturity.

Growth and yield attributes

Plant height increased with delayed sowing while total number of tillers, dry matter accumulation per plant

and LAI increased upto 2nd March sowing and later on, it decreased (Table-1). Plant height increased with delayed sowing upto 22nd March due to progressive increase in temperature. Similar findings were also reported by Rao (1) and Koli (2). Results also indicate that effective tillers per plant, length and diameter of ear head, number of grains and grain weight per ear head and 1000-seed weight (Table 1) differed significantly due to different dates of sowing. All the yield attributes increased up to 2nd March sowing and thereafter, there was decrease under 12th March and 22nd March sowing. These results are in accordance with earlier reports (3,4,5) Among hybrids, GHB-316 recorded significantly higher values of plant characters viz., effective tillers per plant, diameter of ear head, number of grains per ear head and plant height, but in case of plant height and effective tillers per plant, it was at par with GHB-235 and both were significantly superior than MH-169 for effective tillers per plant. These differences in plant characters might be due to genetical make up of plant. Similar results were reported by Verma (6). The interaction effects due to different dates of sowing and hybrids were non-significant for different growth and yield attributes as well as yield.

Grain and straw yield

Grain yield is a complex function of all physiological processes with combined effect of biological and biochemical changes. These changes are obviously influenced by temperature and vapour pressure and therefore, the date of sowing holds its own significance. Differences in grain and straw yields as well as harvest index due to different dates of sowing and hybrids were found significant (Table 2). Significantly highest grain and straw yields as well as harvest index were recorded for 2nd March sowing, but these values were at par with 20th February sowing.

This increase in grain and straw yields due to 2nd March sowing was to the tune of 6, 20 and 49 per cent and 5, 11 and 29 per cent over 20th February, 12th March and 22nd March sowing, respectively. This increase in yield is mainly attributed to the higher values of yield parameters viz., effective tillers per plant, length and diameter of ear head, number of grains and grain weight per ear head as well as 1000-seed weight (Table 1). The possible reasons responsible for reduction in

yields under advanced and delayed sowing were temperature, rainfall and wind velocity. 20th February sowing produced lower yields due to lower temperature during the major growth period of the crop. Delayed sowing beyond 2nd March resulted in damage due to high temperature at the time of flowering and grain setting which creates hindrance in fertilization as well as early pre-monsoon showers at time of grain development. These results confirm the findings of patel (5).

Table 1. Growth and yield attributes as well as harvest index as influenced by different dates of sowing and hybrids.

Treatments	Plant height at maturity (cm)	Dry matter accumulation at maturity (g plant ⁻¹)	LA I (70 DAS)	Total tillers/plant	Effective tillers/plant	Length of ear head (cm)	Diameter of ear head (cm)	Number of grains/ear head	Grain weight (g)/ ear head	1000-grain weight (g)
Dates of sowing										
D ₁ : 20 th February	151.5	63.99	4.88	5.34	2.53	21.36	1.96	1460	9.88	7.06
D ₂ : 2 nd March	172.2	67.29	4.98	5.50	2.62	22.07	2.05	1562	10.66	7.24
D ₃ : 12 th March	187.4	57.61	4.63	4.83	2.35	19.97	1.80	1288	8.56	6.72
D ₄ : 22 nd March	203.2	50.98	4.37	3.90	2.29	18.54	1.74	1081	7.57	6.51
CD (P=0.05)	24.9	7.62	0.33	0.20	0.19	1.12	0.18	178	1.29	0.44
Hybrids										
V ₁ : MH-169	170.4	54.85	4.31	4.39	2.24	20.50	1.70	1205	9.10	7.02
V ₂ : GHB-235	178.2	58.00	4.43	5.28	2.52	20.95	1.79	1349	8.29	6.83
V ₃ : GHB-316	187.0	67.06	5.40	5.00	2.58	20.02	2.18	1489	10.12	6.79
CD (P=0.05)	11.3	4.90	0.31	0.18	0.17	NS	0.10	97	0.99	NS

NS= Non significant

Table 2. Grain and straw yields and harvest index as well as economics as influenced by different dates of sowing and hybrids.

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	Cost of production (Rs. ha ⁻¹)	Net realization (Rs. ha ⁻¹)	Net BCR
Dates of sowing						
D ₁ : 20 th February	4621	9408	33.00	14060	13897	0.99
D ₂ : 2 nd March	4891	9866	33.21	14060	15524	1.10
D ₃ : 12 th March	4080	8866	31.56	14060	10684	0.76
D ₄ : 22 nd March	3273	7648	29.94	14060	5736	0.41
CD (P=0.05)	454	926	0.33	-	-	-
Hybrids						
V ₁ : MH-169	3870	7957	35.53	14060	9357	0.67
V ₂ : GHB-235	4151	8780	31.95	14060	11048	0.79
V ₃ : GHB-316	4628	10103	31.30	14060	13933	0.99
CD (P=0.05)	270	555	0.21	-	-	-

Among different hybrids, GHB-316 produced significantly highest grain and straw yields as compared to MH-169 and GHB-235 to the tune of 20 and 11 per cent for grain and 27 and 15 per cent for straw yields, respectively (Table 2). This increase in grain yield was due to higher values for plant characters viz., effective tillers per plant, length and diameter of ear head and number of grains and grain weight per ear head recorded under GHB-316 (Table 1). Similar increase in grain yield with newly released hybrids were reported by Verma (6).

Economics

The maximum net realization of Rs. 15,524 ha⁻¹ with 1.10 net BCR was recorded with the sowing on 2nd March, followed by 20th February sowing. Among the hybrids, GHB-316 registered maximum net realization of Rs. 13,933 with 0.99 net BCR, followed by GHB-235. (Table 2).

References

- 1 **Rao, G.N.** 1973. Effect of sowing dates based on temperature, sources fertilizer and split application on performance of Hybrid Bajra-3 during summer season. M.Sc.(Agri) Thesis. Gujarat Agricultural University, Sardarkrushinagar.
- 2 **Koli, S.E.** 1975. Effect of sowing date on grain yield of pearl millet (*Pennisetum typhoides* S & H). *Ghana J. Agric. Sci.* 8:117-121.
- 3 **Ong, C.K.** 1983. Response to temperature in a stand of pearl millet (*Pennisetum typhoides* S & H). *Vegetative Development J. Expt. Bot.* 34 : 322-326.
- 4 **Dixit, A.G.** 1994. Effect of time, methods of planting and phosphorous on productivity and economics of summer pearl millet. Ph.D. Thesis. Gujarat Agricultural University, Sardarkrushinagar.
- 5 **Patel, B.J.** 2000. Response of summer pearl millet dates, method of sowing and nitrogen levels under North Gujarat agro-climatic conditions. Ph.D. Thesis. Gujarat Agricultural University, Sardarkrushinagar.
- 6 **Verma, H.N.** 1986. Effect of levels of nitrogen and phosphorous on yield of hybrids of pearl millet under North Gujarat conditions. M.Sc.(Agri) Thesis. Gujarat Agricultural University, Sardarkrushinagar.

Influence of fertility and sulphur levels on yield and quality of lucerne (*Medicago sativa* L.)

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A field experiment was conducted during *rabi* seasons of 1994-95 to 1996-97 at Forage Research Station, Anand on sandy leam soil. The experimental soil had pH 8.1, available nitrogen 219.5-227.4 kg/ha, phosphorus 87.9-92.5 kg/ha, potassium 247.9-268.0 kg/ha and available sulphur 24.0 ppm. The treatments comprised of three fertility levels (20:50:50; 15:37.5:37.5 and 10:25:25 kg N, P₂O₅ and K₂O/ha) and four sulphur levels (0, 20, 40 and 60 kg S/ha). The entire quantity of N and P through diammonium phosphate and urea, K through muriate of potash and S through gypsum were applied at the time of sowing

as per treatments. Variety Anand-2 was sown in rows 25 cm apart using seed rate of 10 kg/ha. The crop was sown during second fortnight of November and 5 cuts of forage were harvested during all the three years. The first cutting was done at 60 days after sowing and subsequent cuttings were taken at an interval of 25 to 30 days. Fresh weight of forage from each plot was recorded after each cutting. 500 g samples were taken and dried at 70° C for dry matter estimation. The crude protein percentage was worked out on dry weight basis by estimating nitrogen content.

Table 1. Effect of fertility and sulphur levels on green forage, dry matter and crude protein yields of income (Total of five cuts)

Treatment	Green forage yield (q/ha)				Dry matter yield (q/ha)				Crude protein yield (q/ha)			
	1994-95	1995-96	1996-97	Pooled	1994-95	1995-96	1996-97	Pooled	1994-95	1995-96	1996-97	Mean
Fertility levels												
(NPK, Kg/ha)												
20:50:50	671	581	482	578	128.9	124.4	92.9	115.4	23.44	26.51	20.61	23.52
15:37.5, 37.5	663	579	501	581	130.3	124.8	97.1	117.4	23.54	27.69	22.08	24.41
10:25:25	656	594	493	581	127.9	125.8	94.8	116.2	23.52	27.91	21.45	24.29
S.Em±	11	12	8	6	2.2	2.5	1.4	1.2	--	--	--	--
C.D. at 5%	NS	NS	NS	NS	NS	NS	4.0	NS	--	--	--	--
Sulphur levels												
(S, Kg/ha)												
0	655	572	491	573	128.2	121.4	95.3	115.0	23.55	20.01	21.92	24.03
20	660	572	496	576	129.7	123.0	95.4	116.0	23.46	26.91	21.30	23.89
40	61	588	488	579	129.0	125.4	93.9	116.1	23.84	27.52	20.90	24.09
60	677	605	493	592	129.1	129.9	95.1	118.0	23.15	28.41	21.39	24.32
S.Em±	13	13	9	7	2.5	2.9	1.6	1.4	--	--	--	--
C.D. at 5%	NS	NS	NS	NS	NS	8.3	NS	NS	--	--	--	--
C.V. %	6.53	7.96	6.35	7.05	6.69	8.10	5.81	7.15	--	--	--	--

Table 2. Effect of fertility and sulphur levels on crude protein NDF content and plant height of income

Treatment	Crude protein yield (q/ha)				NDF content (%) 1996-97	Plant height (cm)			
	1994-95	1994-95	1994-95	1994-95		1994-95	1994-95	1994-95	1994-95
Fertility levels (NPK, Kg/ha)									
20:50:50	18.65	22.30	22.91	21.29	39.1	86.3	85.3	72.2	81.3
15:37.5, 37.5	18.75	23.16	23.05	21.65	39.8	87.1	84.8	73.4	81.8
10:25:25	18.87	22.91	22.85	21.54	38.6	86.3	85.3	72.5	81.4
Sulphur levels (S, Kg/ha)									
0	18.96	22.81	22.87	21.55	39.4	85.5	84.8	73.1	81.1
20	18.58	22.77	22.90	21.42	39.7	86.6	84.1	72.5	81.1
40	18.94	22.73	22.71	21.46	38.9	86.7	86.2	72.9	81.9
60	18.55	22.85	23.26	21.56	38.7	87.5	85.4	72.3	81.7

Green forage yield did not differ significantly due to different fertility levels during individual years as well as in pooled results (Table 1). Application of 15 : 37.5 : 37.5 kg N, P₂O₅ and K₂O/ha gave significantly higher dry matter yield (97.1 q/ha) than 20 : 50 : 50 kg N P₂O₅ and K₂O/ha during 1996-97 and also recorded the high dry matter and crude protein yields in average of three years (Table 1). The beneficial effect of 15:37.5:37.5 kg N, P₂O₅ and K₂O/ha on dry matter and crude protein yields were reflected through the highest crude protein-content and plant height under this level in average of three years. Patel *et al.* (1) also reported that application of phosphorus failed to increase seed yield of lucerne at Anand.

Application of 60 kg S/ha gave the highest green forage yields during 1994-95, 1995-96 and in pooled results however differences due to sulphur levels were found not significant. Similarly dry matter yield did not differ significantly during 1994-95, 1996-97 and in pool analysis. However application of 60 kg S/ha recorded significantly higher dry matter yield (129.9 q/ha) than no sulphur application during 1995-96. The non-significant response to sulphur application might be due to sufficient available sulphur in the experimental soil (14.0 ppm). Patel (2) also reported marginal (2.0 to 3.0 %) response of groundnut in soils testing more than 10 ppm available sulphur. Application of 60 kg S/ha synthesized the

lowest NDF content (38.7 %) and gave maximum crude protein yield (24.32 q/ha) in average of three years due to the highest crude protein content in forage during 1995-96, 1996-97 and average of three years (Table 2). Hajra and Sinha (3) also reported that sulphur plays important role in legumes particularly where the sink material is largely sulphur containing amino acids.

It was concluded that fertility levels had no significant influence on forage yield of lucerne and the crop do not respond to sulphur fertilization in the soil with adequate amount of available sulphur.

References

1. **Patel P.R., Patel, A.T., Patel P.C. and Patel, R.B.** 1990. Effect of seed rate and phosphorus levels on the seed production of lucerne var. A-2 under different dates of sowing. *GAU Res. J.* **15**: 6-11.
2. **Patel M.S.** 1985. Groundnut response to S and its critical level in medium black calcareous soils of saurashtra. *Proceeding of UAS-Fact seminar on sulphur, Bangalore.* pp. 210.
3. **Hazra O.R. and Sinha N.C.** 1996. *Forage Seed Production.* South Asian Publishers Pvt. Ltd. New Delhi.

Evaluation of different tree species for fuel wood production under rainfed condition

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The estimated annual fuel wood demand is likely to vary between 200-385 m³ by 2000 AD for which about 40 million ha. of additional land area will be needed. North Gujarat has only 9.45 per cent of area under the forest land unable to meet the present demand. During the last ten years on account of low erratic rainfall, the production from arable cropping has gone down. Under the situation plantation of MPTs is expected to meet the ever increasing demand for fodder, fuel, food and small timber, beside protecting the underneath soil.

An exploratory long term research was carried out on the performance of indigenous and exotic fast growing six fuel wood tree species *Acacia tortalis*, *Prosopis juliflora*, *Dichrostuchus nutan*, *Albizzia lebbek* and *Dalbergia sisso* by allowing to grow these for the period of ten years in order to hasten the fuel wood production in the wasteland of the zone. The selected tree species were fast growing, drought resistant and hardy in growth habit. One year old saplings of above tree species were planted in a 1 m³ refilled pits, spaced 3 x 3 m with a mean of 1111 plants per ha arranged in a randomized block design with four replications. After ten years of plantation the trees were felled. The total dry biomass production in terms of dry fuel wood weight was recorded after three months.

The soils of the experimental site was loamy sand with loose structure, very deep, well drained, undulating and poor in productivity falling under the classes III and IV of land capability classification. It is low in organic carbon (0.16%), available N (228 kg

ha⁻¹), medium in available P (59.4 kg ha⁻¹) and high in K (200.3 kg ha⁻¹).

The tree species *Albizzia lebbek* performed significantly superior among all the other species tested (Table 1) in the production of sun dried fuel wood (120 t ha⁻¹) as well as in other characteristics like height (1102 cm), collar diameter (205 cm) and DBH at 105 cm (159.8 cm). This species has shown favourable and significant adoptability in this agro-ecological situation. For urgent afforestation programme in maintaining balance between requirement and production of firewood in plain areas of semi-arid zones this tree species seems to be most promising for the energy plantation of quick growing and high productive firewood. It has ability to check complete cutting in rural sites. Moreover the leaves of this tree have got good fodder value, may be lopped and fed to the cattle during acute shortage of fodder resources during drought years of summer months.

Soil analysis at completion of experimentation indicated organic carbon 0.20 to 0.35 %, available P 60 to 102 kg ha⁻¹ and available K 199 to 241 kg ha⁻¹. In general tree species increased the available nutrient content in soil compared to the fellow.

Based on survival, growth parameters, biomass production and utility as fuel wood and timber, *Siris* (*Albizzia lebeck*) followed by *Shisham* (*Dalbergia sisso*) were identified as promising MPTS for Agroforestry system in dryland agriculture. Studies conducted by Jaimini and Tikka (1) on multipurpose tree species have also indicated higher biomass in *siris*.

Table 1. Production of sun-dried firewood (t/ha) and other observations recorded for the different tree species.

Sr. No.	Species	Sun dried firewood (t/ha)	Height (cm)	Collar diameter (15cm)	DBH (105cm)
1	<i>Acacia tortalis</i>	54.92	791.5	9.28	10.51
2.	<i>Prosopis juliflora</i> (Israel)	62.01	754.2	11.53	9.17
3.	<i>Prosopis juliflora</i> (Peru)	65.42	850.7	114.58	9.73
4.	<i>Dichrostuchus nutan</i>	8.31	300.3	4.84	-
5.	<i>Albizzia lebek</i>	119.60	1102.1	205.3	159.8
6.	<i>Dalbergia sisso</i>	31.96	713.4	11.00	8.28
	S.E.m±	9.17	50.9	1.17	1.17
	C.D. at 5%	26.83	153.6	3.52	3.60

Table 2. Available nutrients in soil (0-20 cm depth) after felling the tree species (After ten years of plantation)

Sr. No.	Treatment	Org. C (%)	P ₂ O ₅ (kg ha ⁻¹)	K ₂ O(kg ha ⁻¹)
1	<i>Acacia tortalis</i>	0.24	118	241
2.	<i>Prosopis juliflora</i> (Israel)	0.22	117	210
3.	<i>Prosopis juliflora</i> (Peru)	0.23	113	209
4.	<i>Dichrostuchus nutan</i>	0.25	94	224
5.	<i>Albizzia lebek</i>	0.26	102	235
6.	<i>Dalbergia sisso</i>	0.35	132	222
	S.E.m±	0.19	77	199
	C.D. at 5%	0.03	10	17
	Initial	0.20	60	219

References

1. Jaimini, S.N. and Tikka, S.B.S. 2001. Studies on multipurpose tree species for agroforestry in dryland agriculture. *Indian J. Forest.* **24** : 185-188.