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Short Communication

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Heterosis and inbreeding depression study in mungbean under optimum and sub-optimum moisture conditions

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Abstract

Nine parents, their 36 F_1's and 36 F_2's was grown in randomized block design with three replications in two sets during summer 2003 to study the genetic components in mungbean [*Vigna radiata* (L.) Wilczek]. One set of the experiment was facilitated with optimum irrigations as and when needed (E_1 through out its life span whereas, other set was forced to the moisture stress at 30 DAS and 45 DAS (E_2). The analysis of variance revealed significant differences among the genotypes for almost all the traits in both the environments and generations indicating the great deal of diversity among the genotypes. High heterosis was observed for grain yield per plant, clusters per plant, pods per plant, harvest index, leaf area index and dry matter efficiency under both the environmental condition, whereas moderate heterosis was observed for days to 50 per cent flowering, days to aturity, plant height, seeds per pod, 100-seed weight and protein content. Three best crosses showing high heterosis over mid parental value viz., TM-9458 x CO-5 (55.73%), TM-9458 x TM-9850 (54.96%) and TM-9458 x GM-3 (54.77%) under optimum moisture condition and TM-9458 x TM-9850 (55.91 %), TM-9458 x CO-5 (49.05%) and TM-9850 x GM-4 (41.99%) under sub-optimum moisture condition, which also exhibited desired relative heterosis for pods per plant in both the environments. The crosses TM-9458 x TM-9850 and TM-9458 x CO-5 should be given more importance because they have performed well during optimum and sub-optimum moisture condition. These crosses may be helpful for developing drought resistant cultivars. High inbreeding depression for grain yield per plant (25 crosses under optimum moisture condition and 10 crosses under sub-optimum moisture condition) was mainly due to the inbreeding depression for one or more of its components.

Keywords : Heterosis, inbreeding, depression, mungbean

Introduction

Pulses are basic ingredient in the diets of a vast majority of Indian population as they provide a perfect mix of high biological value protein when supplemented with cereals. Despite the over-riding importance of pulses, no major break through has yet been achieved in these crops and the productivity per unit area remained low and sometimes un-economical. Although high degree of heterosis has been reported for mungbean, its commercial exploitation has not been possible because of clistogamous nature of flower and non-availability of proper sterility mechanisms. The development of pure lines from the variable population is therefore has been the main approach pursued by the plant breeders working on this crop. The yield levels in this crop could be increased by the way of genetic improvement such as incorporation of earliness, uniform maturity, better fertilizer response, photo thermo-insensitivity, high harvest index, wider adaptability and resistance to the biotic and abiotic stresses. Heterosis is the phenomenon in which crosses between inbred lines or pure bred populations are better than the average of the two parental

populations. It is the reverse for inbreeding depression and usually appears in a trait that shows depression in the performance upon inbreeding (1). The main cause of het-erosis is dominance effect of genes and of non-additive gene actions also contribute to the inbreeding depression.

Materials and methods

Nine varieties of mungbean, [*Vigna radiata* (L.) Wilczek] were obtained from the germplasm collection maintained at Main Pulses Research Station, S.D. Agricultural University, Sardarkrushinagar. Acomplete set of 36 crosses developed from these 9 parents following diallel mating design excluding reciprocals during *Kharif* 2002. Some seeds of all the 36 F_1's were sown during *Rabi* 2002-03 in the poly house to get the F_2 seeds at the Department of Rural Engineering, S. D. Agricultural University, Sardarkrushinagar. Two sets of all the 9 parents, their 36 F_1's and 36 F_2's was grown during *summer* 2003 in randomized block design with three replications. One set of the experiment was facilitated with optimum irrigations as and when needed (E_1) through out its life span whereas, other set was forced to the moisture stress at 30 DAS and 45 DAS (E_2). Each entry consisted of single row with 1.5m length. The row to row and plant to plant distance measured 30 cm and 10 cm, respectively. All the recommended package of practices was adopted to raise the good crop. Observations were recorded on grain yield per plant (g), days to 50% flowering, days to maturity, plant height (cm), branches per plant, clusters per plant, pods per plant, pod length (cm), seeds per pod, 100-seed weight (g), harvest index (%), protein content (%), leaf area index (%) and dry matter efficiency (%). Analysis of variance was carried out as per Panse and Sukhatme (2) following linear model. Heterosis, heterobeltiosis as well as inbreeding depression was estimated for both optimum (E_1 and sub optimum (E_2) moisture conditions.

Results and discussion

The analysis of variance revealed significant differences among the genotypes for all the traits studied except for branches per plant, pod length and dry matter efficiency under optimum moisture condition (E_1 indicating the great deal of diversity among the genotypes (Table 1). Mean squares due to hybrids were significant for grain yield per plant, days to maturity, clusters per plant, pods per plant, 100-seed weight, harvest index, protein content and leaf area index under optimum moisture condition (E_1 also indicating a great deal of diversity among the hybrids for these traits. Under sub-optimum moisture condition (E_2) parents were highly significant for days to 50 % flowering, days to maturity and 100-seed weight indicating significant variation among them (Table 2). Mean squares due to parents v/s F_1 were significant for grain yield per plant and pods per plant under optimum moisture condition (E_1) and for branches per plant and 100-seed weight under sub-optimum moisture condition (E_2) proved that differences in the performance of parents and hybrids were real and manifested the presence of heterosis for these characters. Mean squares due to parents v/ s F_2were highly significant for all the characters except protein content, leaf area index and dry matter efficiency under optimum moisture condition (E_1 and for all the characters except plant height, pod length, harvest index, protein content, leaf area index and dry matter efficiency under sub-optimum moisture condition (E_2) proved the differences in the performance of parents and crosses in F_2 generation. The range of relative heterosis and heterobeltiosis presented in Table 3 for different traits revealed that high heterosis was observed for grain yield per plant, clusters per plants, pods per plant, harvest index, leaf area index and dry matter efficiency under both the environmental condition, whereas moderate heterosis was observed for days to 50 per cent flowering, days to maturity, plant height, seeds per pod, 100-seed weight and protein content. Moll (3) reported that higher magnitude of heterosis was associated with genetic diversity of parents.

An examination of overall performance of hybrids under optimum moisture condition (E_1) with respect to heterosis over mid parent and better parent for seed yield per plant revealed that 9 and 7 hybrids manifested significant positive heterosis and heterobeltiosis, respectively (Table 4). Several hybrids registered significant relative heterosis and heterobeltiosis in desired direction for various components traits (Table 4) viz., days to 50% flowering (3 and 0), days to maturity (1 and 1), plant height (6 and 3), cluster per plants (14 and 2), pods per plant (8 and 4), harvest index (2 and 0), protein content (5 and 5), leaf area index (11 and 2) and dry matter efficiency (9 and 7). None of the hybrids, however, showed significant desirable heterosis as well as heterobeltiosis for branches per plant, pod length, seeds per pod and 100-seed weight.

Performance of hybrids under sub-optimum moisture condition (E_2) with respect to relative heterosis and heterobeltiosis for seed yield per plant (Table 4)

Table 1. Analysis of variance of experimental design for different characters under optimum (E_1) moisture condition in mungbean.

Source	d.f.	Characters						
		Grain yield per plant (g)	Days to 50 % flowering	Days to maturity	Plant height (cm)	Branches per plant	Clusters per plant	Pods per plant
Replication	2	0.90	40.05**	54.84**	138.69**	1.01	1.09	0.99
Genotype	80	7.89**	21 .80**	32.50**	53.65**	0.59	1.37**	59.96**
Parent	8	2.39	11.84	11.98	36.45	0.46	0.55	14.44
F_1	35	3.23**	8.71	13.60**	57.14	0.38	2.04**	31.80**
F_2	35	1.77	25.09**	49.60**	42.62**	10.33**	8.64**	11.43
Parent v/s F_1	1	42.22**	2.82	2.53	45.99	0.55	0.37	314.95**
Parent v/s F_2	1	45.22**	134.00**	132.01**	336.04**	7.58**	19.84**	318.63**
Error	160	2.36	7.31	7.02	20.97	0.32	0.34	16.27
		Pod length (cm)	Seeds per pod	1 00-seed weight (g)	Harvest Index (%)	Protein content (%)	Leaf area index	Dry matter efficiency (%)
Replication	2	0.28	0.89	0.02	35.98	0.71	0.008	0.07
Genotype	80	0.41	0.98**	0.55**	41.24**	4.59**	0.16*	0.05
Parent	8	0.09	0.59	0.19	24.25	4.48**	0.15	0.003
F_1	35	0.51	0.67	0.44**	44.27**	4.32**	0.21	0.006
F_2	35	0.27	1.14**	0.46**	25.32	4.38**	0.09	0.01
Parent v/s F_1	1	0.61	0.19	0.19	30.34	0.82	0.27	0.07
Parent v/s F_2	1	3.21**	5.08**	0.87**	383.38**	5.51	0.05	0.00
Error	160	0.53	0.53	0.16	22.02	1.86	0.09	0.04

*and ** significant at 5 % and 1 % level probability, respectively.

Table 2. Analysis of variance of experimental design for different characters under sub-optimum (E_2) moisture condition in mungbean.

Source	d.f.	Characters						
		Grain yield per plant (g)	Days to 50 % flowering	Days to maturity	Plant height (cm)	Branches per plant	Clusters per plant	Pods per plant
Replication	2	3.78	29.33**	15.31*	42.20**	3.10**	1.61**	32.87**
Genotype	80	2.79**	4.53	4.88	17.12	0.59	1.42**	22.08**
Parent	8	1.03	10.09**	17.50**	21.70	0.67	0.41	4.79
F_1	35	2.13*	6.60*	12.96**	18.41	0.47	2.24**	15.63*
F_2	35	1.48	21.63**	19.94**	11.53	8.41**	7.00**	13.16
Parent v/s F_1	1	3.18	2.27	16.02	37.30	4.69**	0.45	3.08
Parent v/s F_2	1	17.08**	68.98**	51.03**	2.08	8.41**	15.45**	215.18**
Error	160	1.32	4.08	5.39	13.70	0.38	0.34	9.97
		Pod length (cm)	Seeds per pod	100-seed weight (g)	Harvest Index (%)	Protein content (%)	Leaf area index	Dry matter efficiency (%)
Replication	2	1.07	24.66	0.06	48.01	1.40	0.05	0.95
Genotype	80	1.28**	1.60*	0.40**	39.41**	4.87*	0.10	0.18
Parent	8	0.46	1.51	0.29**	18.60	4.98	0.16*	0.36
F_1	35	1.46**	0.94	0.24**	57.29**	4.33	0.11	0.17
F_2	35	0.95	1.41	0.47**	25.32	4.51	0.08	0.17
Parent v/s F_1	1	1.21	3.91	2.10**	12.15	0.11	0.25	0.008
Parent v/s F_2	1	1.76	23.39**	4.81**	10.42	12.44	0.11	0.007
Error	160	0.69	0.98	0.10	20.92	3.37	0.08	0.21

*and ** significant at 5 % and 1 % level probability, respectively.

Table 3. Mid parent heterosis, heterobeltiosis and inbreeding depression for grain yield per plant and pods per plant in per cent under optimum (E_1) and sub-optimum (E_2) moisture condition in mungbean.

Crosses	Grain yield per plant (E_1)			Pods per plant (E_1)			Grain yield per plant (E_2)			Pods per plant (E_2)		
	ID	MP	BP	ID	MP	BP	ID	MP	BP	ID	MP	BP
TM-9458 x CO-5	55.73**	41.23**	24.22**	56.55**	44.64*	28.71**	55.91**	53.27*	44.37**	29.95	26.29	43.49
TM-9458 x TM-9850	54.96**	39.91*	41.02**	53.05**	39.86*	42.03**	49.05*	48.94*	31.27*	20.20	13.15	18.67
TM-9458 x GM-3	54.77**	33.38*	37.13**	53.42**	32.15*	37.50**	41.99*	33.57	26.70	33.50	30.85	25.48
TM-9458 x GM-8904	54.72**	29.44*	55.30**	52.03**	29.68	53.78**	37.15*	-31.07	47.70**	16.38	13.65	33.07*
TM-9850 x CO-5	54.35**	53.00**	49.64**	68.89**	66.89**	51.42**	32.55	24.22	51.89**	23.19	15.96	55.06**
CO-5 x HUM-1	45.33**	42.86*	34.22**	31.49*	23.85	32.10**	31.73	25.95	14.21	26.60	20.66	17.90
TM-9458 x HUM-1	44.89**	33.93	25.56**	31.82	15.29	24.93*	21.40	15.09	39.29**	18.20	16.46	38.77**
CO-5 x AKM-9602	38.27**	31.82*	37.24**	36.82*	29.81	37.32**	20.38	12.91	32.15	6.10	6.10	28.32
TM-9458 x GM-9301	30.97**	10.21	22.52	30.48	12.39	27.56*	19.92	18.34	25.69	15.07	12.45	31.73*
TM-9850 x HUM-1	29.54	26.26	34.46**	11.40	6.12	22.48	18.25	16.34	-4.07	9.51	5.97	-3.76

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

revealed that 4 and 2 hybrids manifested significant positive heterosis and heterobeltiosis, respectively. Several hybrids registered significant relative heterosis and heterobeltiosis in desired direction for various components traits (Table 4) viz., 5 and 0 for days to 50% flowering, 1 and 0 for days to maturity, 12 and 9 for clusters per plant, 3 and 1 for pod length, 1 and 0 for 100-seed weight, 1 and 1 for harvest index, 8 and 8 for protein content and 6 and 5 for leaf area index. None of the hybrids showed significant desirable heterosis as well as heterobeltiosis for plant height, branches per plant, pods per plant, seeds per pod and dry matter efficiency.

Three best crosses showing high heterosis over mid parental value (Table 3) viz., TM-9458 x CO-5 (55.73%), TM-9458 x TM-9850 (54.96%) and TM-9458 x GM-3 (54.77%) under optimum moisture condition and TM-9458 x TM-9850 (55.91 %), TM-9458 x CO-5 (49.05%) and TM-9850 x GM-4 (41.99%) under sub-optimum moisture condition, which also exhibited desired relative heterosis for pods per plant in both the environments (Table 3). These crosses also recorded the high heterobeltiosis as well as moderate *per se* performance. This heterotic response is due to heterosis observed for some of the important yield components. This indicated that the heterotic crosses for grain yield per plant did not show high heterosis for all the yield components. In fact, high heterosis for one or two components was sufficient to manifest heterosis for seed yield. Similar results were obtained by Loganathan *et al.* (4) and Salwale *et al.* (5). A large number of workers have also reported moderate to high heterosis for seed yield per plant in mungbean (6, 7, 8).

Out of 36 crosses, seven crosses viz., TM-9850 x CO-5, CO-5 x HUM-1, TM-9458 x CO-5, TM-9458 x TM-9850, TM-9458 x GM-3, CO-5 x AKM-9602 and TM-9458 x GM-8904 under E_1 and two crosses viz., TM-9458 x CO-5 and TM-9458 x TM-9850 under E_2 (Table 3) showed good heterobeltiosis for grain yield per plant and its attributing traits. These crosses may be utilized in selection of transgressive segregants in subsequent generations. The crosses TM-9458 x TM-9850 and TM-9458 x CO-5 should be given more importance because they have performed well during optimum and sub-optimum moisture condition. These crosses may be helpful for developing drought resistant cultivars.

The results on inbreeding depression (Table 4) revealed that high inbreeding depression for grain yield per plant (25 crosses under optimum moisture condition and 10 crosses under sub-optimum moisture condition) was mainly due to the inbreeding depression for one

Table 4. Range of heterosis, heterobeltiosis and inbreeding depression alongwith number of crosses showing significant desired heterosis, heterobeltiosis as well as significant inbreeding depression under optimum (E_1) and sub-optimum (E_2) moisture condition in mungbean.

Character	E_1						E_2					
	Range			Number of crosses showing significance			Range			Number of crosses showing significance		
	Heterosis	Heterobeltiosis	Inbreeding	Hete-rosis	Hetero-beltiosis	Inbree-ding	Heterosis	Heterobeltiosis	Inbreeding	Hete-rosis	Hetero-beltiosis	Inbree-ding
Grain yield per plant (g)	0.38-55.73	-9.99-53.00	6.47-55.30	9	7	25	-22.47-55.91	-38.03-53.27	15.08-51.89	4	2	10
Days to 50 % flowering	-8.20-9.02	-6.56-16.04	-33.05-8.13	3	-	9	-10.22-8.94	-7.50-12.61	-29.60-11.94	3	-	6
Days to maturity	-7.61 -9.64	-7.37-10.44	-15.56-5.70	1	1	14	-6.95-10.51	-5.43-11.41	-15.59-6.67	5	-	3
Plant height (cm)	-32.25-22.19	-31.82-31.81	-38.62-43.75	7	3	1	-18.57-27.76	-13.92-32.80	-12.23-27.80	-	-	-
Branches per plant	1.94-5.98	-41.53-2.06	-24.42 -16.67	-	-	-	0.50-5.08	-8.51-0.50	-30.52-13.94	-	-	-
Clusters per plant	-35.42-63.33	-42.06-68.24	-95.16-30.67	14	2	2	-39.39-95.71	-43.82-80.26	-76.56-35.76	12	9	4
Pods per plant	-7.55-68.89	-8.36-66.89	-9.30-44.44	8	4	27	-30.50-33.50	-30.82-30.85	-3.76-55.06	-	-	8
Pod length (cm)	-13.47-6.02	-13.84-5.58	-12.32-16.24	-	-	3	-27.57-26.63	-26.50-21.13	-20.67-32.27	3	1	6
Seeds per pod	-13.40-11.59	-20.25-7.69	-17.27-20.87	-	-	6	-29.41-22.54	-34.94-8.75	-37.50-41.33	-	-	7
100-seed weight(g)	-27.49-8.70	-30.37-6.59	-43.00-30.46	-	-	12	-28.74-15.51	-28.99-31.41	-32.09-37.41	1	-	8
Harvest Index (%)	-27.09-30.48	-29.52-15.31	-27.03-32.77	2	-	6	-17.65-45.74	-17.65-45.74	-36.00-25.23	1	1	6
Protein content (%)	-13.30-17.25	-18.19-13.25	-12.80-17.56	5	5	8	-12. 63-20.52	-17.37-20.50	-6.97-23.57	8	8	3
Leaf area index	-27.00-42.93	-34.58-39.04	-36.94-34.79	11	2	3	-23.77-40.80	-33.34-34.19	-47.08-26.56	6	5	1
Dry matter efficiency (%)	-11. 25-36.30	-12.97-35.30	-4.34-30.23	9	7	-	-9.62-36.21	-4.34-30.23	-26.82-26.82	-	-	-

or more of its components. It indicates that there was a considerable amount of inbreeding depression in F_2 generation for all the traits under study in both the environments. The results are in conformity with the findings Singh and Singh (10) who reported measurable inbreeding depression in F_2 generation for various characters in mungbean. The highest inbreeding depression was observed in the three crosses viz., TM-9458 x GM-8904 (55.30%), TM-9850 x CO-5 (49.64%) and GM-9301 x AKM-9602 (47.63%) under optimum moisture condition whereas, under sub-optimum moisture condition crosses, CO-5 x GM-3 (51.89%), GM-3 x GM-8904 (47.70%) and GM-4 x GM-9301 (46.90%) manifested highest inbreeding depression for grain yield per plant. The relationship between heterotic response and inbreeding depression (i.e. crosses showing high heterosis also showed high inbreeding depression) suggests the importance of non-additive gene actions. The results are in close agreement with those of Rathi *et al.* (11), who also noticed that inbreeding depression in yield was due to inbreeding depression in yield attributing components.

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Genotype x environment interaction and stability analysis in grain amaranths *(Amaranthus spp.)*

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Abstract

Genotype x Environment interaction studies of fifty (50) exotic and indigenous genotypes drawn from different species viz. *A. hypochondriacus (L.), A. cruentus* (L.), *A. paniculatus* (L.) and *A. edulis (L.)* of grain amaranth *(Amaranthus spp.)* were attempted over three different artificially created environments *viz.*, three sowing dates i.e., early sowing (1st Nov.), timely sowing (15th Nov.) and late sowing (1st Dec.) at All India Coordinated Research Project on Underutilized Crops, Regional Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The perusal of data revealed that both linear and non-linear components of genotype x environment were responsible for stability of genotypes. None of the genotype exhibited stable performance for all the traits, however, genotypes IC 38145, IC 38147 and IC 95597 were stable for seed yield per plant and genotype IC 38042 was identified as better adapted to poor environments for grain yield per plant.

Keywords : Grain amaranth, stability, G X E interactions, Linear and non-linear components

Introduction

Genotype x Environment interactions were known to interfere with the evaluation of genotype and reduces the progress of selection in plant breeding programmes as the genetic nature of a genotype is masked (1) and such. These interactions are of considerable importance in developing improved varieties and rationalization of procedure for future genetic improvement in crop plants. Stable genotypes help to achieve predictable performance through wider adaptability of genotypes (2) linear regression as a measure of stability was advocated by Finley and Wilkinson (3) while, Eberhart and Russel (4) emphasized the importance of both linear and non linear components. A variety should have fairly high mean in order to be of practical value in the assessment of genotypes. Therefore, this is an attempt to screen and identified phenotypically superior genotypes over different environment conditions in grain amaranth.

Materials and methods

The experimental material comprised of 50 genotypes of diverse geographic and genetic origin of grain amaranth species [*A. hypochondriacus* (L.), *A. cruentus (L.), A. paniculatus (L.) and A. edulis (L.)*]. Out of these, 35 were obtained from National Bureau of Plant Genetic Resources, New Delhi, while rest were procured from All India Co-ordinated Research Project on Underutilized Crops, Regional Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat. The experiment was conducted in Randomized Block Design with 3 replications in 3 artificially created environments through different dates of sowing *i.e.*, early sowing (1st Nov.), timely sowing (15th Nov.) and late sowing (1st Dec.) at All India Coordinated Research Project on Underutilized Crops, Regional Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. 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. Data were recorded on grain yield/ plant (g) and its component traits like days to 50 per cent flowering, plant height (cm), inflorescence length (cm), number of branches/plant, days to 80 per cent maturity, straw yield per plant (g), harvest index (%), 1000-seed weight (g), protein content (%). Data were subjected to genotype x environment interaction as per the procedure suggested by Eberhart and Russell (4).

Results and discussion

Analysis of variance (Table 1) revealed that the genotypes differed significantly for all the traits indicating the presence of variability in the material. Similarly, environments in which the genotypes were grown were also differed significantly for all the characters. Variance due to G x E interactions was highly significant for all the characters except plant height and protein content indicating the differential response of genotypes in expression of the characters to varying environments. The partitioning of G x E interactions indicated that a substantial portion of variation was linear for grain yield per plant, inflorescence length, number of branches per plant, days to 80 per cent flowering, straw yield per plant and harvest index reflecting the predictability of the performance of genotypes over environments, while the non-linear component was important for days to 50 per cent flowering and plant height and both linear and non-linear components were equally important for 100 seed weight and protein content. These observations are in agreement with Waghmode *et al.* (5), Sharma *et al.* (6) and Varalaxmi and Reddy(7).

On the basis of stability performance, the stable genotypes are identified for various characters and depicted in Table 2. The genotypes, IC-17974, IC-38047, IC-38145, IC-38561 and IC-42306 were stable for days to 50 per cent flowering with low mean, average response and non-significant deviation in desired direction. The genotype, IC-38101 was early to flower and identified as stable and ideal genotype for earliness in poor environments. Mean number of days taken to maturity ranged from 81.22 (IC-42306) to 104.33 (IC-38615) over environments with a general mean of 91.24 days. Eleven genotypes *viz.,* IC-17947, IC-38045, IC-38101, IC-38122, IC-38131, IC-38237, IC-38353, IC-38561, IC-38635, IC-42310 and IC-42345 were identified as stable for early maturity as evident from unit regression and deviation from regression zero. Dwarf genotypes, IC-38635, IC-17947, IC-42008, IC-42345 and IC-42306 were stable across environments in respect of plant height while, genotypes, IC-38131, IC-38147 and IC-38237 were good only for better environments and IC-38353 for poor environments. The genotypes IC-35696, RAM-4, IC-120588, RGAS-92-10-1 and SKNA-21 showing maximum inflorescence length, while genotype, IC-17947, IC-38102, IC-38131, IC-38131, IC-38147 and IC-38107 having more number of branches per plant were classified as stable across environments. For number of branches per plant IC-38340 and for inflorescence length, IC-21925 was identified as stable

Table 1 : Analysis of variance (mean square) for phenotypic stability for different characters in grain amaranth

Source	d.f.	Characters									
		Grain yield per plant (g)	Days to 50 % flowering	Plant height (cm)	Inflores-cence length (cm)	Branches per plant	Days to 80 per cent maturity	Straw yield per plant (g)	Harvest Index (%)	1000-seed weight (g)	Protein content (%)
Genotype (G)	49	32.273**++	629.564**++	2303.768**++	590.750**++	20.889**++	142.550**++	473.198**++	73.150**++	0.018273**++	4.979**++
Environemnt(E)	2	165.746**++	1438.868**++	838.186**++	716.100**++	3.586**++	364.781**++	9606.421**++	87.098**++	0.124**++	3.425**++
GxE	98	18.038**	7.375**	46.023	58.511**	0.278**++	15.155**++	186.301**	13.722**++	0.005**	0.209
E (linear)	1	331.491**++	2877.736**++	1676.371**++	1432.200**++	7.171**++	729.562**++	19212.840**++	174.196**++	0.24873**++	0.350**
GxE (Linear)	49	20.663**	7.148**	40.466	58.880**	0.427**++	23.975**++	236.174**++	21.288**++	0.005**	0.213
Pooled Deviations	50	15.104**	7.449**	50.549	56.980**	0.126**	6.208**	133.699**++	6.033**	0.005**	0.201
Pooled Error	294	0.873	0.375	39.023	25.082	0.017	0.484	19.824	1.732	0.0001	0.168

*, ** indicates significance against pooled error M.S. at 5% and 1% levels, respectively.
+, ++ indicates significance against pooled deviation M.S. at 5% and 1% levels, respectively

Table 2 Outstanding genotypes with general and specific adaptability for different characters in grain amaranth

Characters / Stability	Characters									
	Grain yield per plant (g)	Days to 50 % flowering	Plant height (cm)	Inflores-cence length (cm)	Branches per plant	Days to 80 per cent maturity	Straw yield per plant (g)	Harvest Index (%)	1000-seed weight (g)	Protein content (%)
Ideal genotypes with general adaptability bi=1; $S^2di=0$	IC-38145	IC-17947	IC-17947	IC-35696	IC-17947	IC-42310	IC-38045	IC-38047	IC-38122	IC-42008
	IC-38147	IC-38145	IC-42008	RAM-4	IC-38102	IC-38101	IC-38047	IC-38188	IC-38237	IC-17947
	IC-95597	IC-38561	IC-42345	IC-120588	IC-38131	IC-38045	IC-42345	IC-38145		IC-38147
	IC-38635	IC-42306	IC-42306	RGAS-92-10-1	IC-38147	IC-42345	GA-2	IC-38561		IC-38599
		IC-38047		SKNA-21	IC-38107	IC-17947	IC-38599	IC-198135		SKNA-21
Specific adaptability to better environment bi>1; $S^2di=0$	-	-	IC-38131	IC-21925	IC-38340	IC-38145	-	IC-38599	-	-
			IC-38147					IC-17947		
			IC-38237							
Specific adaptability to poor environment bi<1; $S^2di=0$	IC-38042	IC-38101	IC-38353	-	-	IC-38599	IC-38122	-	-	IC-38340
							IC-38353			
							IC-38561			
							IC-42306			

for better environments. The genotype, IC-38145 matured early and identified as stable for favourable environment whereas, genotype IC-38599 was identified as stable for poor environment with early maturity. General adaptability for early maturity was reported by the genotypes, IC-42310, IC-38101, IC-38045, IC-42345 and IC-17947.

The genotypes, IC-38045, IC-38047, IC-42345, GA-2 and IC-38599 with low mean values were identified as stable across the environments for straw yield per plant as they exhibited non-significant linear and non-linear component. Stable genotypes under poor environments, IC-38122, IC-38353, IC-38561 and IC-42306 were identified with low straw yield per plant. The genotypes, IC-38047, IC-38188, IC-38145, IC-38561 and EC-198135 for harvest index; IC-38122 and IC-38237 for 1000-seed weight; IC-42008, IC-17947, IC-38147, IC-38599 and SKNA-21 for protein content were ideally stable genotypes with general adaptability. Two genotypes, IC-38599 and IC-17947 were identified as stable under better environments for harvest index ideal while one genotype, IC-38340 was ideal and stable genotype over poor environment for protein content.

With respect to grain yield, twenty six genotypes displayed higher grain yield among which only tree genotypes viz., IC-38145, IC-38147 and IC-95597 were classified as stable genotypes with average response. One genotype, IC-38042 manifested high mean yield was highly responsive and adaptable to poor environmental conditions. The highest yielding genotype EC-359411 had unpredictable behaviour as evident from significant deviation from regression. From the present study, it can be concluded that variation in all the characters besides being genetic was also affected by environment and there were significant G x E interactions except for plant height and protein content. Amongst fifty genotypes, IC-38145, IC-38147 and IC-95597 were stable for grain yield per plant. Genotype, IC-38145 showed stability for days to 50 percent flowering and harvest index. While, IC-38147 was found stable for number of primary branches per plant and protein content. The results indicated that none of the genotype studied was found consistently superior for all the characters in all environments. The stable genotypes identified could be used as parents in future breeding programme for development of suitable genotype for North Gujarat.

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Effect of different storage techniques on vaiability of seeds of pearl millet (*Pennisetum glaucum* (L) R. Br.) germplasm

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Abstract

A laboratory experiment was carried out to evaluate the different storage techniques for preserving the germplasm of bajra at Millet Research Station, Gujarat Agricultural University, Jamnagar. Significantly minimum physical seed damage (1.15 & 2.60 %, respectively) during 6 month and 12 month storage were recorded with treatment (T_4 in which the bajra ear heads were stored in hanging gunny bag at room temperature. However, it was found at par with treatment T_5& T_6 for 6 month of storage and T_5 for 12 month of storage. Similarly, the percentage of germination was also found significantly superior and maximum percentage of germination (91.15 & 88.15%, respectively) during 6 & 12 months of storage were also registered in treatment (T_4). Likewise, significantly the maximum percentage of seed damage and minimum percentage of germination were recorded with treatment T_7 (control) in which the seeds Were stored only in paper bags. In case of moisture percentage, the result was found non significant.

Keywords : Pearlmillet, storage techniques, germination, moisture

Introduction

Pearl millet is an important cereal crop of Gujarat state after Rajsthan in our country. It covers maximum acreage as compared to any other food crops in the state. It is being grown in area of 1.30 million hectares of total area under cultivation with remaining second largest state of India. Bajra germplasm is the stepping stone for cultivar improvement programme of the crop. Breeder can depends on the different lines of germplasm and select the materials from the germplasm on the basis of required characters for hybridization programme. The maintenance and evaluation of the germplasm lines at each season is an important task for research work. About 2700 lines of the germplasm are maintained at this station. The seed storage of the different lines of germplasm is the major problems for the bajra breeder for maintaining the bajra germplam from year to year. Generally, the fresh seeds are stored in paper bag (packet) for storage period up to 12 to 16 months. During storage, there is very serious problem with highly physical damage due to attacks of different storage pests like *Tribolium, Rhizopertha* and *Corcyra* which affects the germination of seeds and becomes the major constraints against maintenance of different germpalsm lines. Hence, for overcoming that particular problem and increasing the storage life of seed, an experiment was conducted.

Materials and methods

The experiment for storagibility of bajra seeds was conducted at Main Millet Resrach Station, Gujarat Agricultural University, Jamnagar. The present investigation was carried out with a view to find out the effective storage techniques whivh gives higher protection to the seeds without affecting the germination. The fresh seeds and ear heads were used and the experiment was conducted in Completely Randomized Design (C.R.D) with four replication.

Table 1 : Effect of different storage techniques on physical seed damage, germination and moisture percentage bajra at 6 & 12 months of storage.

Treatments	Physical seed damage (%)		Germination (%)		Moisture content (%)	
	6 month	12 month	6 month	12 month	6 month	12 month
T_1	1.25	9.25	83.15	64.50	9.58	8.97
T_2	57.00	68.90	35.40	20.70	8.30	7.63
T_3	43.45	63.35	44.95	28.05	8.26	8.00
T_4	1.15	2.60	91.15	88.15	8.61	7.67
T_5	5.55	6.60	86.60	73.25	8.18	7.72
T_6	76.35	77.25	17.70	8.75	8.17	7.10
T_7	78.00	82.05	17.15	7.00	7.98	7.75
S. Em+	1.52	1.682	1.182	1.761	0.663	0.371
C. D. at 5%	4.51	5.00	3.51	5.23	NS	NS
C. V. %	8.08	7.61	4.39	8.48	15.74	9.46

Total 7 treatments viz. Seed treatment with thirum @ 2.5 g/kg of seed than seeds were packed in polythene bag (T_1), Seed packets stored in sealed galvanized box (Fresh seeds were first stored in paper packets than kept in air tight galvanized box) (T_2), Oven dried seed packets in sealed galvanized box (The fresh seeds were oven dried at 70 C° for one hour then stored in air tight galvanized box) (T_3), Hanging gunny bag with ear heads at room temperature (The fresh ear heads wrapped with selfing bag i.e. parchment paper bag were sun dried and then stored in hanged gunny bag at room temperature) (T_4), Oven dried seed packets in hanging polythene bag at room temperature (The fresh seeds were oven dried as mentioned in the treatment T_3 and stored in seed packets and than it kept in polythene bags which were hanged) (T_5), Seed packets in sealed galvanized box without oven drying of seed (Fresh seeds in seed packets stored in galvanized box without sealing at room temperature) (T_6) and control (Storing the seeds in seed packets only) (T_7). The treatment T_4 & T_5 in which the ear heads and seeds were hanged in gunny bag and polythene bag at room temperature, respectively. The necessary observations were recorded with five randomly selected samples. The mean value of samples were utilized for statistical analysis.

Results and discussion

Physical damage to seed

From the data, it is reveled that the result was found significant for both at 6 and 12 months of storage. Significantly lowest percentage of physical damage to the seed (1.15 & 2.60%, respectively) at 6 & 12 months of storage were recorded with treatment T_4 in which the fresh ear heads wrapped with selfing bag i.e. parchment paper bag and than sun dried and than stored in hanged gunny bag at room temperature. However, it was found at par with treatment T_1 & T_5 for 6 month of storage and T_5 for 12 month of storage, respectively. Similarly, maximum damage at 6 & 12 months (78.00 & 82.05%, respectively) were registered in control (T_7).

Germination percentage (%)

The germination percentage was also observed significantly superior for both 6 & 12 months of storage period. Maximum percentage of germination (91.15 % 88.15%, respectively) at 6 & 12 months of storage were noted where the fresh ear heads wrapped with selfing bag i.e. parchment paper bag and than sun dried and than stored in hanged gunny bag at room temperature (T_4) followed by treatment T_5 & T_1 for both the period of storage. The result may be due

to lower or minimum infection of the storage pests like *Tribolium*, *Rhizopertha*, *Corcyra* etc. during storage of ear heads with hanging methods at room temperature which might be reduced the physical and physiological seed damage resulted in highest germination percentage of the seed. The similar result was also noted by Guaret *et al*, (1) and said that the effectiveness of thirum under controlled atmospheric condition (30 Co & 30% Rh) has been observed better for viability of bajra seed. Gupta and Aneja (2) studied the field efficacy of seed dressing chemicals on seedling emergence in soyabean and found that the thirum in polythene bag gave significantly better filed stands. Likewise, lowest percentage of germination (17.15 & 7.00%) were registered in control (T_7).

Moisture percentage (%)

The moisture percentage of seeds at both, 6 & 12 months of storage period was found non significant.

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Effect of irrigation scheduling and fertilizer doses on growth and yield attributing characters and water expense efficiency of summer clusterbean [*Cyamopsis tetragonoloba* (L.)Taub.]

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Abstract

A field experiment was conducted during the summer season of 2001, 2002 and 2003 on clusterbean *(Cyamopsis tetragonoloba* (L.)Taub.) to study the effect of irrigation scheduling (0.4,0.6 and 0.8 IW:CPE ratios) and fertilizer doses (10 N + 20 P_2O_5 kg ha^{-1}, 20 N + 40 P_2O_5 kg ha^{-1} and 30 N + 60 P_2O_5 kg ha^{-1}) at Main Pulses Research Station, Gujarat Agricultural University, Sardarkrushinagar on loamy sand soil. The results revealed that irrigation scheduling at 0.8 and 0.6 IW:CPE ratios recorded at par and significantly higher growth and yield attributing parameters like plant height, branches per plant, pods per plant, seeds per pod, 1000-seed weight, straw and seed yields over that observed in 0.4 IW:CPE ratio. An application of 30 N + 60 P_2O_5 kg ha^{-1} recorded significantly higher growth and yield attributing parameters, seed and straw yields over the application of 10 N + 20 P_2O_5 kg ha^{-1} except 20 N + 40 P_2O_5 kg ha^{-1}. IW:CPE ratio of 0.4 recorded maximum water expense efficiency of 3.17 kg ha-mm^{-1} followed by 0.6 and 0.8 IW:CPE ratios. Increased fertilizer doses from lower to higher increased water expense efficiency from 2.60 to 3.02 kg ha-mm^{-1}.

Keywords : Clusterbean, IW:CPE ratios, water expense efficiency, growth, yield attributing characters

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. Being a leguminous annual, its primary use is in soil health enrichment through atmospheric nitrogen fixation. Atwal and Sidhu (1) reported that application of nitrogen in small doses improved nodulation, growth and nitrogen fixation in clusterbean. On an average basis, it has been estimated that it may fix nearly 30 kg N ha^{-1}. Further, due to complete shedding of leaves up to maturity, It increased the organic carbon in the soil.

Water need of clusterbean crop may vary with the climatic conditions and type of soil. Hence, scheduling of irrigation at an appropriate time and in right amount is one of the most important factors for realizing high yield of summer clusterbean, especially under scarce and costly irrigation water. Scheduling of irrigation based on climatological approach may provide information not only about water use of the crop but also about the proper time of irrigation suggested by Parihar *et al.*(2).

Timely application of irrigation and fertilizer with optimum dose not only increase crop productivity but also help in their judicious utilization. Therefore, present investigation was undertaken.

Materials and methods

A field experiment was conducted at Main Pulses Research Station, Gujarat Agricultural University, Sardarkrushinagar to study the response of summer clusterbean to irrigation based on cumulative pan evaporation ratio under varying doses of fertilizers. Experiment was laid out in split plot design considering three irrigation levels (0.4, 0.6 and 0.8 IW:CPE ratios) as a main plot and three doses of fertilizers (10 N + 20 P_2O_5 kg ha-^{1}, 20 N + 40 P_2O_5 kg $ha^{-1}$and 30 N + 60 P_2O_5 kg ha^{-1}) as a subplot with four replications. The soil was loamy sand in texture having 0.22% organic carbon, 46 kg ha^{-1} available P_2O_5 and 236 kg ha^{-1} K_2O. The quantity of fertilizers was

drilled in the soils at 5 cm below the seed according to fertilizer treatments as a basal dose. The seeds were sown keeping 45 cm row spacing using 15 kg seeds ha^{-1} on 25, 26 and 28 February during 2001,2002 and 2003, respectively. The quality of irrigation water was good. Irrigation water was measured with a 15 cm Parshall flume having throat size of 15 cm installed in field channel in the experimental field. Irrigation water of 50 mm depth was applied at each irrigation.

Results and discussion

The results of the experiment revealed that irrigation levels and fertilizer doses significantly influenced on yields, growth and yield attributes (Table 1).

Number of pods plant $^{-1}$

Number of pods $plant^{-1}$ differed significantly due to irrigation levels. Among the irrigation levels, higher number of pods $plant^{-1}$ was recorded by 0.8 IW:CPE ratio followed by IW:CPE ratio of 0.6 which was at par with each other and significantly higher than that of 0.4 IW:CPE ratio. Similar results were also obtained by Vijayalakshmi and Rajagopal (3) in summer greengram.

An application of 30 N + 60 P_2O_5 kg ha^{-1} gave significantly higher number of pods $plant^{-1}$ than that observed in application of 10 N + 20 P_2O_5 kg ha^{-1} but was at par with the application of 20 N + 40 P_2O_5 kg ha^{-1}. This is in conformity with the finding of Mohan Kumar and Balakrishna (4) in *kharif* cowpea.

Number of seeds pod $^{-1}$ ***and 1000-seed weight***

Application of irrigation at IW:CPE ratio of 0.8 recorded significantly higher number of seeds pod^{-1} and 1000-seed weight as compared to that of application of irrigation at 0.4 IW:CPE ratio but was at par with the IW:CPE ratio of 0.6. The result confirms the finding of Khier *et al.*, (5) in summer cowpea at Junagadh.

The number of seeds pod^{-1} and 1000-seed weight recorded under application of 30 N + 60 P_2O_5 kg ha^{-1} and 20 N + 40 P_2O_5 kg ha^{-1} did not differ significantly, but their number of pods $plant^{-1}$ and 1000-seed weight were significantly higher over the application of 10 N + 20 P_2O_5 kg ha^{-1}

Seed yield

Application of irrigation at 0.8 and 0.6 IW:CPE ratios recorded significantly higher seed yields as compared to crop irrigated at 0.4 IW:CPE ratio. Higher seed yield obtained under 0.8 and 0.6 IW:CPE ratios might be due to significant improvement in yield attributes viz., number of pods $plant^{-1}$, number of seeds pod^{-1} and 1000-seed weight as a result of favourable moisture supply helps in nutrient uptake by the crop. Similar results were reported by Kavitha and Wahab (6) in summer green gram.

The application of fertilizer doses increased the seed yield of summer clusterbean. The seed yield increased significantly with increasing doses of fertilizer but the increase between application of 20 N + 40 P_2O_5 kg ha^{-1} and 30 N + 60 P_2O_5 kg ha^{-1} remained at par (Table 1). The application of 20 N + 40 P_2O_5 kg ha^{-1} increased the seed yield by 12 per cent over the application of 10 N + 20 P_2O_6 kg ha^{-1}. The significant beneficial effect of fertilizer doses on number of pods $plant^{-1}$, number of seeds pod^{-1}, 1000-seed weight was reflected into higher seed yield. The findings are in conformity with those of Tank *et al.* (7) in summer greengram.

Plant height and number of branches plant $^{-1}$

Growth characters like plant height and number of secondary branches $plant^{-1}$ were significantly influenced by different irrigation levels. Regarding irrigation levels, plant height and number of secondary branches $plant^{-1}$ were significantly higher under IW:CPE ratio of 0.8 than that of 0.4 IW:CPE ratio except 0.6 IW:CPE ratio. This is in line with the findings of Kavitha and Wahab (6) in summer greengram. The application of fertilizer doses showed significant influence on plant height and number of secondary branches $plant^{-1}$. Application of 30 N + 60 P_2O_5 kg ha^{-1} and 20 N + 40 P_2O_5 kg ha^{-1} recorded at par and significantly higher plant height and number of secondary branches $plant^{-1}$ over application of 10 N + 20 P_2O_5 kg ha^{-1}.

Straw yield

The highest straw yield was recorded when irrigation was applied at IW:CPE ratio of 0.8 followed by 0.6 and 0.4 and the differences were significant at each level.

Higher straw yield obtained under 0.8 IW:CPE ratio resulted from higher plant height and number of secondary branches $plant^{-1}$. These growth components might have contributed towards higher straw yield. Patel and Saraf (8) reported that under IW:CPE ratio of 0.7 produced significantly higher straw yield of summer cowpea followed by 0.5 and 0.3 IW:CPE ratios. Fertilizer doses significantly influenced on straw yield. Application of 30 N + 60 P_2O_5 kg ha^{-1} and 20 N + 40 P_2O_5 kg ha^{-1} produced significantly higher

Table 1. Effect of summer clusterbean on growth and yield attributing characters, seed yield and water expense efficiency as influenced by irrigation levels and fertilizer doses (Pooled of summer 2001, 2002 and 2003)

Treatments	Seed yield (kg ha^{-1})	Straw yield (Kg ha^{-1})	Plant height (cm)	Secondary branches plant^{-1}	Pods plant^{-1}	Seeds pod^{-1}	1000-seed weight (g)	No. of irrigations	Water applied (mm)	WEE (Kg ha mm^{-1})
IW:CPE ratios										
I_1 : 0.4	952	1854	47.3	2.38	31.6	6.99	27.4	6	300	3.17
I_2 : 0.6	1219	2591	56.8	3.12	40	7.43	28.3	8	400	3.05
I_3:0.8	1238	2848	57.6	3.28	40.5	7.53	28.4	10	500	2.48
S.Em ±	32	64.3	1.8	0.19	1.3	0.08	0.08	-	-	-
CD (.05)	95	191	7.0	0.73	4	0.25	0.2	-	-	-
CV (%)	16.8	15.9	10.1	20.6	21.6	6.8	1.67	-	-	-
Fertilizer doses (kg ha^{-1})										
F_1 : 10N + 20P_2O_5	1038	2197	50.9	2.58	33.9	6.93	27.2			2.60
F_2 : 20 N + 40 P_2O_5	1165	2499	54.6	3.02	38.1	7.34	28.4			2.92
F_3 : 30 N + 60 P_2O_5	1206	2598	56.3	3.14	40	7.68	28.6			3.02
S.Em ±	22.2	49.5	0.95	0.08	0.88	0.12	0.1			
CD (.05)	63	14	2.7	0.22	2.5	0.49	0.3			
CV (%)	11.7	12.2	9.5	16.1	14.1	6.3	1.5			
Interaction	NS	NS	NS	NS	NS	NS	NS			

straw yield over 10 N + 20 P_2O_5 kg ha^{-1}. The role of fertilizer in the promotion of vegetative growth is well established. A perusal of the data on the plant height and number of secondary branches plant^{-1} indicated that there has been significant improvement in this growth attributes due to the addition of fertilizer. The excessive vegetative growth even at the expense of seed production would have resulted in higher yield of straw.

Water expense efficiency

Water expanse efficiency recorded at an IW:CPE ratio of 0.4 (3.17 kg ha-mm^{-1}) was higher than that of 0.6 (3.05 kg ha-mirr^{1}) and 0.8 (2.48 kg ha-mm^{-1}). Depth of water applied was increased on the contrary WEE was decreased may be due to lesser proportionately increase in seed yield than water applied. The irrigation schedule for 0.6 IW:CPE ratio was *viz;* 1st irrigation as pre-sowing, 2nd at 25 DAS and remaining six irrigations at an interval of 8-9 days. Higher water expense efficiency with lower ratio of 0.4 was recorded due to lesser water loss in evapotranspiration under limited water supply condition. The findings are in accordance with those of Tank *et al.* (7) in greengram on clay soil of Junagadh. Successive increased in fertilizer doses from 10 N + 20 P_2O_5 kg ha^{-1} to 30 N + 60 P_2O_5 kg ha^{-1} increased the value of the water expense efficiency from 2.60 to 3.02 kg ha-mm^{-1}. This might be due to better root growth resulting in improved moisture utilization. This trends support to the findings of Tank *et al.* (7).

Interaction effects

No significant interaction was observed between irrigation levels and fertilizer doses on yield, growth and yield attributing characters.

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Effect of antitranspirants on growth and yield of castor (*Ricinus communis* L.) under rainfed conditions

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Abstract

A field experiment was conducted at Regional Research Station, S. D. Agricultural University, Sardarkrushinagar during *kharif* seasons of 2001 to 2004 under rainfed conditions to find out the effect of different concentrations of antitranspirants (Phenyl Mercuric Acid, Kaolin, Cetyle Alcohol, Water spay and Absolute control) on growth and yield of castor. The seed yield of castor was found significantly higher with Kaolin 6 % spray (1298 kg ha^{-1}) which was at par with Kaolin 2% and 4% as well as Cetyle alcohol 0.5 and 0.75% . Plant height, length of main spike, number of capsules and effective branches per plant and biomass per plant were higher with Kaolin 6% .

Keywords : Antitranspirants, castor, seed yield, rainfed

Introduction

Castor (*Ricinus comnumis* L.) is an important cash crop of this region. In Gujarat productivity of rainfed and irrigated castor is 1290 and 2810 kg ha^{-1}, respectively. In rainfed areas, castor generally faces late season drought resulting in low yield. In view of the damage caused by excessive transpiration, there has been much interest in finding way to reduce the rate of water loss and improve the water use efficiency. The possibilities of reducing plant transpiration to alleviate the adverse effect of water imbalance on plant growth holds great importance for water starving situation (1). Methods of reducing transpiration have been aimed without affecting growth adversely. Among the various methods of reducing rate of transpiration, use of antitranspirants is one of the practices to reduce the transpiration in the agricultural ecosystem. A wide range of materials have been tried as antitranspirants (2). Use of antitranspirants was reported in Pearlmillet by Kaushik and Lal (3) and Das and Gautam (4) and in brinjal by Karuppaiah *et. al.* (5). The present study was undertaken to find out the suitable antitranspirants with their concentration for castor under rainfed conditions.

Materials and methods

A field experiment was conducted during *kharif season* of 2001 to 2004 at the AICRP for dryland Agriculture, S. D. Agricultural University, Sardarkrushinagar. The soil of the experimental plot was loamy sand in texture having low in organic carbon (0.30%), available phosphorus (42 kg ha^{-1}) and potash (195 kg ha^{-1}) with pH 8.2. There were eleven treatments viz., phenyl mercuric acid (0.05, 0.10 and 0.15 %), kaolin (2, 4 and 6 %), cetyle alcohol (0.50, 0.75 and 1.0 %) along with water spay, @ 500 l ha^{-1} and no spray as control were evaluated in randomized block design with three replications. Different treatments of antitranspirants were imposed at 45, 75 and 105 days after sowing. Castor GCH-4 was sown on 6th Aug., 1st Aug., 16th July and 2nd Aug. during 2001, 2002, 2003 and 2004, respectively, with inter row spacing of 90 cm and intra row spacing of 60 cm. Uniform fertilizers were applied @ 30 kg N and 30 kg P_2O_5 ha^{-1} as basal and 30 kg N as top dressing at 45 DAS under sufficient soil moisture condition. The rainfall received during 2001, 2002, 2003 and 2004 were 571.1, 201.9, 766.3 and 380.3 mm, respectively. Yield attributes were recorded from five randomly selected

Table 1. Yield attributes and yield of castor as influenced by different antitranspirants

Treatments	Plant height (cm)	Length of Primary spike (cm)	No. of Capsules/ main spike	No. of effective branches/ plant	Biomass prod^{-1} g/plant	Seed yield (Kg ha-^{1})				
						2001	2002	2003	2004	Pooled
T_1: PMA0.05%	54.3	36.0	35.6	2.63	100.7	553	229	1453	1406	910
T_2: PMA0.10%	54.6	35.6	39.0	2.77	92.2	548	224	1633	1180	896
T_3: PMA0.15%	54.9	33.3	36.6	2.67	88.4	546	198	1672	928	836
T_4: Kaolin 2%	61.2	42.2	45.4	2.87	120.8	737	338	1839	1651	1141
T_5: Kaolin 4%	63.6	45.0	47.7	2.78	114.1	763	443	1847	1703	1189
T_6: Kaolin 6%	69.4	47.5	53.0	2.80	125.9	790	453	2070	1880	1298
T_7: Cetyle alcohol 0.50%	62.1	42.1	44.2	2.85	111.3	675	324	1893	1718	1152
T_8: Cetyle alcohol 0.75%	59.4	40.3	41.6	2.77	117.7	763	408	1924	1687	1195
T_9: Cetyle alcohol 1 .0%	61.9	41.4	44.0	2.65	112.3	752	334	1780	1636	1126
T_{10}: water spray	59.0	40.6	43.4	2.66	111.6	710	409	1749	1617	1121
S.Em±						33.9	17.4	69.4	122.8	55.7
C.D. at 5%						99.9	51.4	204.8	362.2	160.9
CV %						8.54	9.06	6.79	13.77	11.67

plants in each treatment. Yield data were also recorded treatment wise and used for statistical analysis.

Results and discussion

The yield was directly influenced by the development of some parameters known as the yield attributing characters. These include length of primary spike, number of branches per plant and number of capsules per main spike and biomass gram per plant. All these characters were better developed in the treatment consisting of Kaolin 6 % (Table 1). Reddy and Khan (6) observed increase growth characters with Kaolin as antitranspirants. Kaolin spray on other hand reduced the transpiration loss by providing a reflective white coating on the leaves. The spray thus increased leaf albedo and reduced the total heat load on the leaves which ultimately resulted in minimization of transpiration loss.

Seed yield increased significantly due to different treatment of antitranspirants in individual years as well as in pooled data (Table 1). Pooled data showed that spray of Kaolin 6% gave significantly higher seed yield (1298 kg ha^{-1}) as compared to PMA (0.05, 0.10 and 0.15%), cetyle alcohol (1%), water spray and absolute control but it was at par with kaolin 2% , 4% as well as cetyle alcohol 0.5 and 0.75% concentration. The increased growth of plants with Kaolin may be attributed due to the increase relative water content of the plants ultimately. The significantly lowest seed yield of castor was recorded in PMA 0.15% (836 kg ha^{-1}) which was at par with PMA 0.05 and 0.10 % concentration. The increase in seed yield was 42.6, 44.9, 55.3 and 22.9 per cent higher in kaolin 6% spray as compared to PMA 0.05, 0.10, 0.15 and absolute control, respectively. The beneficial effect of kaolin spray is in conformity with the findings of Kaushik and Lal (3) and Das and Gautam (4).

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Drip and surface irrigation system in cauliflower *(Brassica oleracea)*

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Abstract

A field experiment was carried out during 1997-98 to 1999-2000 at Regional Research Station, S.D. Agricultural University, Sardarkrushinagar to study the drip and surface irrigation system in Cauliflower. Treatments consisted, four levels of drip (0.4,0.6, 0.8 and 1.0 ADFPE) and four levels of surface irrigation method (0.8, 1.0, and 1.2, IW/CPE ratio and one local check). Crop was sown in paired raw system and drip lateral lines were laid out in middle of pair with 50 cm. dripper distance having 4 LPH dipper discharge. Pooled results revealed that cauliflower crop irrigated through drip at 1.0 ADFPE produced significantly higher curd yield (13554 kg ha^{-1}) which was statistically at par with 0.8 ADFPE through drip and local schedule. Though drip system proved its superiority not only in producing higher curd yield, but also save the water to the tune of 43 and34 per cent inO.8 and LOADFPEthroughdrip as compared to local schedule of irrigation, respectively. Water Use Efficiency was also higher in drip method as compared to surface method of irrigation. The higher net profit of Rs.38242 ha^{-1} was realized under local practices of irrigation.

Keywords : drip, surface, paired row, lateral line, yield

Introduction

Vegetables are the important sources of minerals, vitamins and high caloric values. Among the different group of vegetables, cauliflower *(Brassica oleracea* L.) is an important rabi vegetable crop of North Gujarat. Weather condition, soil type, fertility levels, pre-culti-vation status etc influence the response of cauliflower to water.The available moisture storage capacity of the soil of this region is very low. Water is one of the crucial! input for the crop production. The conventional method of irrigation is not efficient. Large quantity of water 50-80 % is wasted through conveyance, evaporation, field application and distribution losses (1). Maximizing water use efficiency is of prime concern. Drip irrigation could be the best alternative for efficient use of irrigation water, resulting increased yield in addition to water saving in term of labor and energy (2). Drip irrigation has good potential to increase crop yield (3, 4, 5), ave considerable amount of water and increase water use efficiency. Limited research work has been carried out on drip irrigation system in cauliflower. Hence, present study was plannedJe assess feasibility of drip irngation method for cauliflower crop.

Materials and methods

A field experiment was conducted to study the drip and Surface irrigation system for cauliflower during rabi season of 1997-98 to 1999-2000 at the Regional Research Station,S.D. Agricultural University, Sardarkrushinagar on loamy sand soil having pH (1:2.5) 7.8, organic carbon 0.22 %, available nitroen 158 kg ha^{-1}, available phosphorus 49 kg ha^{-1} and available potash 240 kg ha^{-1}. The experimental field had 8.74 % field Capacity, 2.53 % permanent wilting point) and 1.67 g/cc bulk density. Eight treatments consisted ,four levels of drip (0.4,0.6,0.8 and 1.0 ADFPE i.e. alternate day faction pan evaporation) and four levels of surface irrigation method (0.8,1.0 and 1.2 IW/CPE ratio with 50 mm depth and one local schedule 7 to 8 days interval) in randomized block design with four replications. Cauliflower var. Early Snow ball was used for sowing, crop was planted in paired row system 30-60-25 cm spacing. The lateral lines were laid out in

the centre of pair with 50 cm dripper distance. Irrigation water applied through drip at the rate of 4 Lph, with 1.2 kg/cm^2 pressure in alternate day. Surface irrigation was applied as check basin method. Full dose of Phosphorus (37.5 Kg ha^{-1})and Potash (37.5 Kg ha^{-1}) and half dose of nitrogen (37.5 Kg ha^{-1} were applied as basal before t transplanting. Remaining half dose of Nitrogen was applied at 30 days after planting. The crop was sown on 10th, 5th and 19th November during 1997-98,1998-99 and 1999-2000, respectively. Yield data were recorded treatment wise separately for statistical analysis. WUE and economics were also worked out.

Result and discussion

The treatment effect was found significant during individual year as well as in the pooled results (Table-1).The pooled results showed that application of irrigation at 1.0 ADFPE through drip method gave significantly higher curd yield (13554 kg ha^{-1}) but it was at par with 0.8 ADFPE through drip and local schedule of 7 to 8 days interval. Irrigation schedule at 1.2 IW / CPE ratio in surface method did not found superior over local schedule with respect, to curd yield. The drip system proved its superiority in producing higher curd yield by providing a favorable soil moisture

Table 1. Curd yield of cauliflower as influenced by treatments.

Treatments	Curd yield (kg ha^{-1})			Pooled
	1997-98	1998-99	1999-2000	
D_1 : Drip irrigation with 0.4 ADFPE	10694	10704	9318	10238
D_2 : Drip irrigation with 0.6 ADFPE	11839	11792	11624	11752
D_3 : Drip irrigation with 0.8 ADFPE	13139	12592	11889	12540
D_4 : Drip irrigation with 1.0 ADFPE	14241	12874	13548	13554
S_1 : Surface irrigation with 0.8 IW/CPE ratio	6741	8437	8685	7964
S_2 : Surface irrigation with 1 .0 IW/CPE ratio	7435	9911	10072	9139
S_3 : Surface irrigation with 1 .2 IW/CPE ratio	9219	11074	11229	10507
S_4 : Local schedule (7 to 8 days interval)	14009	13341	13274	13541
C. D. at 5 %	1933	2570	2288	1304

Table 2. Effect of different irrigation treatments on cured yield, water applied W.U.E

Treatments	Curd yield (kg ha^{-1})			Pooled
	1997-98	1998-99	1999-2000	
D_1 : Drip irrigation with 0.4 ADFPE	10238	305.17	33.55	61.04
D_2 : Drip irrigation with 0.6 ADFPE	11752	374.73	31.36	52.16
D_3 : Drip irrigation with 0.8 ADFPE	12540	444.33	26.22	43.28
D_4 : Drip irrigation with 1 .0 ADFPE	13554	513.57	26.39	34.44
S_1 : Surface irrigation with 0.8 IW/CPE ratio	7964	416.57	19.09	46.81
S_2 : Surface irrigation with 1 .0 IW/CPE ratio	9139	466.67	19.58	40.42
S_3 : Surface irrigation with 1 .2 IW/CPE ratio	10507	566.67	18.54	27.66
S_4 : Local schedule (7 to 8 days interval)	13541	783.73	17.29	-

Table 3. Relative economics of various treatments

Particulars	Drip method				Surface method	
	0.4 ADFPE	0.6 ADFPE	0.8 ADFPE	1.0 ADFPE	1.2 IW/ CPE	Local schedul
Fixed cost (Rs. ha^{-1})	12400	12400	12400	12400	-	-
Variable cost (Rs.ha^{-1})	12743	13284	13712	14192	14268	15918
Total cost (Rs. ha^{-1})	25143	25684	26112	26592	14268	15918
Curd yield (Q ha^{-1})	102.4	117.5	125.4	135.5	105.1	135.4
Total income (Rs.ha^{-1})	40960	47000	50160	54200	42040	54160
Net Profit (Rs.ha^{-1})	15817	21316	24048	27608	27772	38242
Water applied (mm)	305	374	444	513	566	783
Water saving (%)	61.04	52.16	43.28	34.44	27.66	-
Additional area covered with saved water(ha)	1.6	1.1	0.8	0.5	0.4	-
Net additional income (Rs. ha^{-1})	25307	23447	13238	13804	11808	-
Gross net income (Rs. ha^{-1})	41124	44763	43286	41412	38880	38242

availability for crop growth. Yadav and Batra (6), Bafna *et. al.*,.(7) and Shelke *et. al.* (8) also reported the similar results. Crop irrigated at 1.0 ADFPE through drip system produced 32,15,70,48 and 29 per cent more curd yield than 0.4, 0.6 ADFPE and 0.8, 1.0 and 1.2 IW / CPE ratios respectively. Similar results were also observed in tomato crop by Anonymous(9) and Bogle *et. al.*, (10).

Water use efficiency and water saving

Water use efficiency under drip irrigation method at different levels were found higher around one to two time more as compared to local method (Table 2). Irrigation applied through drip at 0.4 ADFPE recorded higher WUE (33.55 kg/ ha mm), which was 94 % higher than local method. Water saving to the tune of 61,52,43 and 34 per cent wereachieved under drip irrigation at 0.4,0.6,0.8 and 1.0ADFPE, respectively over local method. These results confirm with the finding of Jadhav and Jain (11) in Cabbage.

Economics

The higher net profit of Rs.38242 ha^{-1} was realized under local practices of irrigation (Table 3) but similar yield with saving of 43 per cent water can be produced in drip method at 0.8 ADFPE. Considering the additional area 0.80 ha. which can be covered with the same quantity of water and non-significant yield variation between 0.8 ADFPE through drip and local method. It is estimated that about Rs.13238 additional income can be obtained under O.SADFPE.These findings confirmed by Anonymous (12), Jadav (13) and Khistariya(14).

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Effect of genotypes and fertility levels on seed yield and quality of *brassica* species Indian mustard *(Brassica juncea)* and yellow sarson *(Brassica campestris)*

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Abstract

A field experiment was conducted during the winter season of 2003-04 at Main Castor - Mustard Research Station, SDAU, Sardarkrushinagarto identify promising genotypes and optimum fertility level for seed yield and quality of Indian mustard and yellow sarson. It was observed that among the genotypes, GM-3 of Indian mustard (2823 kg ha^{-1}) and YST 151 of yellow sarson (1759 kg/ha) achieved significantly higher yield. Significant increase in seed yield was recorded upto 100 and 125% RDF in yellow sarson and Indian mustard, respectively. Among the genotypes, Ragini (41.21%) of yellow sarson and CS-52 (38.23 %), GM-3 (37.67 %) and Kranti (37.63 %) of Indian mustard noted significantly higher oH content compared with rest of the genotypes. While, oil yields were maximum in YST-151 (774 kg ha^{-1}) and GM-3 (1064 kg ha^{-1}) of yellow sarson and Indian mustard genotypes, respectively. With each successive increase in fertilizer dose upto 150 % RDE, the oil content decreased significantly and contrary to it oil yield increased upto 100 % (yellow sarson) and 125 % (Indian mustard) RDF, respectively. Significantly highest seed yield was recorded with YST-151 genotype when it was fertilized with 150 % RDF. Genotype CS-614-4-1-4 and CS-52 at 100% and CS-52, GM-3 and Kranti at 75 % of RDF noted higher oil content than rest of the treatment combinations. YST-151 (yellow sarson) and Kranti (Indian mustard) at 125 % RDF and GM-3 at 75 to 150% RDF produced significantly higher oil yield.

Keywords : Genotype, fertility levels, mustard, seed yield

Introduction

Among the oil seeds, rapeseed mustard *(Brassica* species) is contributing 32 % per cent of the total oil seeds production of India and it is the second largest indigenous oil seeds crop after groundnut. Rape seed and mustard occupy an important place in the cropping pattern of Gujarat particular in North Gujarat region. These Brassica spp, are exhaustive in nature with developed root system, due to which their nutritional requirements are higher. Different genotypes of Brassica and different fertility levels may affect the quality (oil content) and seed yield of Brassica and finally affect the oil yield. Hence, it is necessary to evaluate the *Brassica* spp. for their performance with reference to the fertility levels for optimization.

Materials and methods

The experiment was carried out at Main Castor - Mus-tard Research Station, SDAU, Sardarkrushinagar during winter season of 2003. The soil was loamy sand in nature, low in organic carbon (0.17 %) and available N (185 kg ha^{-1}), fairly rich in available P_2O_5 (72.7 kg ha^{-1}) and available K_2O (371 kg ha^{-1}) and low in available sulphur (6.0 ppm) with 7.83 pH. The experiment was laid out in split plot design with three replications, promising genotypes of yellow sarson and Indian mustard were taken as main plot treatment and fertility levels viz; 75%, 100%, 125% and 150% of recommended fertilizer dose (RDF) as sub plot treatment. Indian mustard (CS-614-4-1-4, SAL-7, Kranti, SAL-9, CS-52, GM-3) and yellow sarson

Table 1. Effect of genotypes and fertility levels on the seed yield, oil content and oil yield of Indian mustard

Sr. No.	Genotypes	Fertility levels (% RDF)									
		Seed yield (kg ha^{-1})					Oil yield (kg ha^{-1}) and Oil content (%)				
		75	100	125	150	Mean	75	100	125	150	Mean
1	CS-614-4-1-4	2162	2316	2604	2486	2392	809 (37.44)	855 (39.94)	948 (36.40)	886 (36.18)	875 (36.74)
2	SAL-7	2411	2478	2486	2447	2456	880 (35.42)	895 (35.80)	892 (36.07)	865 (36.46)	883 (35.94)
3	Kranti	2288	2425	2716	2480	2477	884 (38.77)	917 (37.83)	1042 (37.33)	908 (36.56)	938 (37.63)
4	SAL-9	2217	2228	2425	2540	2352	821 (37.12)	824 (36.86)	921 (36.50)	919 (36.22)	871 (36.67)
5	CS -52	2195	2431	2529	2654	2452	852 (38.82)	938 (38.60)	960 (37.90)	998 (37.59)	937 (38.23)
6	GM-3	2628	2835	2853	2977	2823	1019 (38.86)	1074 (37.90)	1070 (37.47)	1090 (36.59)	1064 (37.69)
	Mean	2317	2471	2602	2596	-	878 (37.90)	917 (37.37)	972 (36.90)	944 (36.43)	-

Data in parenthesis indicate oil content (%) in seed

CD at 5%		Seed yield	Oil yield	Oil content
Genotype (G)	:	216	105	0.66
Fertility level (F)	:	100	30	0.19
GxF	:	NS	122	0.77

RDF - Recommended dose of fertilizer

Table 2. Effect of genotypes and fertility levels on the seed yield, oil content and oil yield of yellow sarson

Sr. No.	Treatments: Genotypes	Fertility levels (% RDF)									
		Seed yield (kg ha^{-1})					Oil yield (kg ha^{-1}) and Oil content (%)				
		75	100	125	150	Mean	75	100	125	150	Mean
1	NDYS-2	1712	2125	1748	1720	1826	693	787	688	668	709
							(39.96)	(39.57)	(39.30)	(38.78)	(39.40)
2	PYS-2005	1291	1340	1473	1469	1393	513	528	581	569	548
							(39.72)	(39.42)	(39.41)	(38.79)	(39.34)
3	YST-151	1804	1853	2114	2161	1983	716	728	824	826	774
							(39.66)	(39.34)	(39.02)	(38.29)	(39.08)
4	Ragini	1628	1717	1628	1524	1624	635	672	705	664	669
							(41.68)	(41.37)	(41.04)	(40.77)	(41.21)
	Mean	1609	1759	1741	1718		640	679	699	682	-
							(40.25)	(39.93)	(39.69)	(39.16)	

Data in parenthesis indicate oil content (%) in seed

CD at 5%		Seed yield	Oil yield	Oil content
Genotype (G)	:	102	39	0.90
Fertility level (F)	:	93	37	0.23
GxF	:	185	75	NS

RDF - Recommended dose of fertilizer

(NDYS-2, PYS-2005, YST-151, Ragini) genotypes were sown in the second fortnight of October with the spacing of 45 cm x 15 cm. The crop was fertilized as per treatments. The recommended dose of fertilizer was 75 : 50 :30 kg NPS ha^{-1}. Half dose of nitrogen and full dose of phosphorus (through DAP) as well as full dose of sulphur (through gypsum) was applied as basal before sowing while, remaining half dose of N was top-dressed at 40 DAS as per treatment. The crop received five irrigations (one irrigation immediately after sowing for germination and remaining four irrigations after germination each at 21 days interval). Adequate plant protection measures were taken whenever required. Oil content in seeds was determined using NMR technique. Oil yield was computed from the data on seed yield /ha and oil content.

Results and discussion

Effect of genotypes

Seed yield of Indian mustard and yellow sarson differed significantly due to different genotypes. Among the genotypes GM-3 of Indian mustard and YST-151 of yellow sarson were found significantly superior over rest of the genotypes. The seed yield depend mainly upon growth and yield attributes, respectively (1) which were higher in case of GM-3 and YST-151 hence the yields were higher in both the genotypes.

The data indicated that oil content and oil yield of Indian mustard and yellow sarson differed significantly due to different genotypes. Among the yellow sarson genotypes Ragini recorded significantly maximum oil content while, YST 151 produced significantly maximum oil yield. In case of Indian mustard, genotypes CS-52, GM-3 and Kranti had equally effective and noted significantly higher oil content than rest of the genotypes (Table 2). Genotypes YST 151 (yellow arson) and SAL-7 (Indian mustard) had the lowest oil content. Among the genotypes GM-3 of Indian mustard and YST 151 of yellow sarson recorded significantly maximum oil yield.

Effect of fertility levels

Fertility levels showed increasing trend in seed yield up to 125 % RDF in case of Indian mustard while it was up to 100 % RDF in case of yellow sarson. Application of 125 % RDF to Indian mustard being at par with 150 % RDF achieved significantly higher yield over 75 and 100 % RDF (Table 1). The increase in seed yield at 125 % RDF over 75 and 100 % RDF was 12.30 and 5.30 percent, respectively. In case of yellow sarson 100,125 and 150 % RDF was found of par to each other and registered significantly higher yield over 75 % RDF (Table 1).The seed yield with 100,125 and 150 % RDF was 9.32, 8.20 and 6.77 percent higher over 75 % RDF, respectively. This might be due to the crop receiving the nutrients (N, P and S) in adequate amount from higher doses resulting in enhanced crop efficiency, hence the yield was higher. The results are in conformity with those of Khanpara *et al.* (2). Different fertility levels had significant effect on oil content and oil yield of *Brassica spp.* Higher oil content in seeds was recorded at lower fertility level which was significantly decreased with each successive increase in fertility levels. Application of 75% of recommended fertility level both the species recorded maximum oil content (Table 1 & 2).These findings are in accordance with those of Patel *et al.*(3) and Thanki *et al.*(4). Contrary to oil content, oil yield increased significantly with increasing fertility levels. This may be due to the fact that increasing availability of nitrogen increased the proportion of protein in the seed (5). Since oil yield is the resultant of seed yield and oil content which was increased due to fertilizer application up to 100% of recommended fertility level in yellow sarson and up to 125% of recommended fertility level in Indian mustard because of increased in seed yield. These findings are in confirmity of Kumar (5) and Singh *et al.*(6).

Interaction effect

Interaction effect of genotypes and fertility levels was found to be significant with respect to oil content and oil yield in Indian mustard and for seed and oil yield in yellow sarson. In case of Indian mustard genotype CS-614-4-1-4 at 100% RDF recorded maximum oil content whereas genotype GM-3 at 150% RDF being at par with at 125, 100 and 75% RDF and Kranti at 125% RDF recorded significantly higher oil yield over rest of the treatment combinations. In case of yellow sarson, genotype YST 151 with 150 % RDF obtained significantly higher yield but it was at par with 125 % RDF and NDYS 2 at 100% RDF. Genotype YST 151 at 150 and 125% RDF and NDYS 2 at 100% RDF were found at par to each other and achieved significantly higher oil yield over rest of the treatment combinations.

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Response of sesamum (*Sesamum indicum* L.) to different levels of phosphorus and sulphur under north Gujarat agrociimatic conditions

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Abstract

An investigation was carried out on loamy sand soil at Agronomy Instructional Farm, S. D. Agricultural University, Sardarkrushinagar (Gujarat) during *Kharif*-2006 to examine the response of sesamum (*Sesamum indicum* L.) to different fertility levels of phosphorus and sulphur with nine treatment combinations comprising three levels of phosphorus (0,25 & 50 kg. P_2O_5 ha^{-1}) and three levels of sulphur (0,20 & 40 kg. S ha^{-1}). Significantly higher seed, stover and total biomass yield was recorded with the individual application each of 25 kg P_2O_5 ha^{-1} as well as 40 kg S ha^{-1}. Aplication of 25 kg P_2O_5 ha^{-1} registered maximum growth and yield attributes viz. number of branches per plant.plant height, number of capsules per plant, number of seeds per capsule, seed weight per plant and oil content. Significantly higher harvest index was recorded with 20 kg S ha^{-1} which was at par with 40 kg S ha^{-1}, Aplication of 40 kg S ha^{-1} significantly influenced the oil content.

Keywords: *Sesamum*, sulphur, phosphorus

Introduction

Sesamum is one of the most important oilseed crop grown extensively in India. Among the various factors proper fertilizers with suitable agronomic practices play a vital role. Phosphorus is a constituent of all living organisms. Because of its key role in energy transformation in living tissues, phosphorus is rightly called the mineral of life It is involved in a wide range of plant processes from cell division to development of root system. Besides, Sulphar is recognised as fourth major nutrient after N,P & K. Sulphur is best known for its role in the formation of amino acides and it is also associated with the synthesis of oil, protein and certain vitamins (biotins, thiamine). Keeping these points in view, the present study was undertaken to study the "Response of sesamum *(Sesamum indicum* L.) through different fertility levels of phosphorus and sulphur" during *kharif*-2006-07 at the Agronomy Instructional Farm, S. D. Agricultural University, Sardar krushinagar(B.K.), Gujarat.

Materials and methods

A field experiment was conducted on a loamy sand soil at the instructional Farm, C.P.C.A., S. D. Agril. University, Sardarkrushinagar (B.K.),Gujarat (24° 19' North Latitude and 72° 19' East longitude with an elevation of 154.52 metre above the mean sea level) during *kharif*-2006-07. The soil was slightly alkaline in reaction (pH 7.82) having 0.33 per cent organic carbon and 172, 51 and 258 kg ha^{-1} available nitrogen, phosphorus and potash, respectively. The available sulphur in soil was 8.0 ppm. Nine treatment combinations comprised of three levels of phosphorus viz, 0, 25 and 50 kg $P_2O_5^{-1}$ and three levels of sulphur viz, 0, 20 and 40 kg S ha^{-1} were tested in FRBD with four replications.

Results and discussion

Growth Parameters

Fertility level of 25 kg P_2O_5 ha^{-1} recorded significantly maximum number of branches per plant and plant height at 60 DAS and at hervest over 0 kg P_2O_5 ha^{-1} (control) except plant height at 30 DAS. However, the results are statistically at par with the application of 50 kg P_2O_5 ha^{-1} (P_2). It might be due to slow release of adsorbed phosphatic ions for entire crop growth.

Application of 40 kg S ha^{-1} registered significantly maximum number of branches per plant (3.52) as well as plant height at 30 DAS, 60 DAS and at harvest

Table 1. Response of Sesamum to different levels of phosporus and sulphur

Treatments	Growth Parameters				Yield and yield attributes								
	No. of branches per plant	Plant height (cm)			Capsules per plant	Seeds per Capsules	Seed weight per plant (g)	Test wt. (g)	Seed yield kg ha^{-1}	Stover yield kg ha^{-1}	Total biomass kg ha^{-1}	Harvest index (%)	Oil content (%)
		30 DAS	60 DAS	At Harvest									
PHOSPHORUS													
0kg $P_2O_5ha^{-1}$(control) (P_0)	3.45	14.40	93.80	101.00	44.56	64.98	134.14	2.89	576	1525	2324	27.33	48.87
25 kg $P_2O_5ha^{-1}$ (P_1)	3.92	14.60	97.10	106.00	50.03	71.57	150.91	3.43	743	2333	3083	24.08	50.60
50 kg $P_2O_5ha^{-1}$ (P_2)	3.71	14.50	95.90	102.20	47.20	68.11	144.67	3.26	649	2014	2727	23.35	49.93
S.Em±	0.12	0.30	1.41	1.93	1.06	2.14	4.77	0.03	17	47	65	0.59	0.24
C.D. at 5%	0.34	0.86	4.00	5.48	3.01	6.09	13.57	1.00	49	135	175	1.68	0.67
SULPHUR													
0 kg S ha^{-1} (control) (S_0)	3.17	13.50	90.43	95.47	38.04	64.24	135.53	3.00	527	1669	2199	23.81	48.77
20 kg S ha^{-1} (S_1)	3.45	14.20	93.53	99.42	45.28	69.01	145.57	3.26	632	1850	2483	25.61	50.08
40 kg S ha^{-1} (S_2)	3.52	14.50	93.90	99.98	46.28	69.36	146.35	3.38	644	1895	2568	24.25	50.68
S.Em±	0.09	0.21	0.99	1.36	0.75	1.52	3.37	0.02	12	33	44	0.42	0.17
C.D. at 5%	0.24	0.61	2.83	3.87	2.13	4.31	9.59	0.07	35	95	123	1.19	0.48
INTERACTION													
S.Em±	0.21	0.52	2.44	3.34	1.83	3.71	8.26	0.06	30	82	107	1.02	041
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	12.40	7.41	5.26	6.79	8.48	10.99	11.61	3.64	9.95	9.09	8.83	8.21	1.65

over control. This might be due to lower S status of experimental plot and good response of sesamum to S application. Accelerated growth might be attributed to increased dry matter accumulation and better root and shoot growth through sulphur nutrition. The results confirms the findings of Ghosh *et al.* (1).

Yield and Yield attributes

Significant influence of 25 kg P_2O_S ha^{-1} was noted on all yield attributes except test weight over 0 kg P_2O_5 ha^{-1} Significantly maximum number of capsules per plant, number of seeds per capsule, seed weight per plant, seed yield, stover yield and total biomass yield was registered under the application of 25 kg P_2O_5 ha^{-1} over 0 kg P_2O_6 ha^{-1} (control). However, the results are statistically at par with those recorded with the application of 50 kg P_2O_5 ha^{-1} except seed, stover and total bio mass yield.

Increased values in yield and yield attributes might be due to higher growth under successive fertility level of 25 kg P_2O_5 ha^{-1} (Table.1). It might be attributed to higher uptake of nutrients viz, N, P and K and higher dry matter accumulation and transloca-tion to reproductive plant parts. The results are in confirmity with those reported by Mondal *et al.* (2), Tiwari *et al* (3) and Nakhede *et at.* (4).

Increasing rates of sulphur remarkably influenced yield and yield attributes significantly. Maximum seed, stover and total biomass yield was registered under the application of 40 kg S ha^{-1} which was at par with the treatment S_1 (20 kg S ha^{-1}) except total biomass yield. Increase in seed, stover and total biomass yield might be due to successive increase of these characters under respective treatments. All yield attributing characters viz., capsules per plant, seeds per capsule, seed weight per plant and test weight were significantly higher with the application of 40 kg S ha^{-1} over 0 kg S ha^{-1} (control) which were at par with the application of 20 kg S ha^{-1} (S_1) except test weight. Sulphur plays vital and important role in energy transformation, carbohydrates metabolism and activation of enzymes which in trun accelerated development of yield attributes and ultimately in yield. The results are in accordance with those reported by Mondal *et al. (5)*, Yadav *et al.* (6) and Tiwari *et al.* (7).

Quality Parameters

Remarkable difference in oil content of sesamum was observed under different fertility levels of phosphorus. An application of 25 kg P_2O_5 ha^{-1} secured significantly maximum oil percentage (50.60 per cent) over 0 kg P_2O_5 ha^{-1} which was statistically at par with 50 kg P_2O_5 ha^{-1}. It might be due to more P_2O_5 supply during seed development stage of crop which might have helped in synthesis of oil and protein. Application of 40 kg S ha^{-1} (S_2) recorded significantly the highest oil content (50.68 per cent) over rest of the treatments. Increase in oil per cent under increased fertility levels of Sulphur might be due to requirement of sulphur in the process of synthesis of oil and protein within the plant. The results are in accordance with those reported by Mondal *et al.* (5) and Ghosh *et al.* (1).

The results therefore revealed that application of 25 kg P_2O_5 ha^{-1} + 20 kg S ha^{-1} on S deficient soils of North Gujarat Agroclimatic conditions be recommended for obtaining higher yield of sesamum.

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Toxicity of eco-friendly chemicals to coccinellid predators on mustard

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Abstract

Field experiment was carried out to study the relative toxicity of different groups of chemicals viz. imidacloprid (neonicotinoid), acephate (organophosphate), azadirachtin (botanical), *V. lecanii* and B. bassiana (fungal biopesticides) and combination of imidacloprid and acephate with *V. lecanii* and B. bassiana against predatory coccinellid beetles. The results indicated that imidacloprid and acephate alone were found to be toxic compared to their combination with eco-friendly fungal biopesticides. The treatments azadirachtin and *V. lecanii* were found to be relatively safe to coccinellids.

Keywords : Toxicity, predators, mustard, eco-friendly

Introduction

Mustard is the primary and important oilseed crop and constitutes the major source of edible oil. Insect-pests are one of the limiting factors in the production of mustard crop. Mustard aphid, *Lipaphiserysimiis* one of the common and most serious pest in India and other tropical region in the world. The loss caused by this pest is estimates to the tune of 69.61 per cent (1) Among the natural enemies of the mustard aphid, *Coccinella septempunctata* Linnaeus, *Coccinella transversalis* Linnaeus and *Menochilus sexmaculata* Fabricious are of comparable importance. Chemical insecticides used on mustard for the control of insect pest affect adversely to these coccinellid predators. Hence, a field experiment was conducted to study the relative toxicity of eco-friendly chemicals to coccinellid predators on mustard

Materials and methods

Mustard variety GM-2 was sown at 45 cm x 10 cm spacing in gross plot of 6.0 m x 2.7 m (net plot of 4.5 m x 1.8 m) with three replications in randomized block designduring winter 2005-06. All the agronomical practices were followed for raising the crop. The treatments of imidacloprid 0.005 per cent, acephate 0.05 per cent, *V. lecanii* @ 2.0 kg/ha, *B. bassiana* @ 2.5 kg/ha and azadirachatin 0.000375 per cent and combination of imidacloprid 0.0025 per cent and acephate 0.025 per cent with two fungal biopesticides, *V. lecanii* 1.0 kg/ ha and *B. bassiana* 1.25 kg/ha were applied at peak flowering and podding stages. Two sprays were given at fortnightly interval. The counts predatory beetles, C. *septempunctata, C. trnsversalis* and *M. sexmaculata* present on the ten randomly selected and tagged plants per plot were recorded 24 hours before and 48 hours after each spray. The data recorded on the predators were subjected to $\sqrt{x+0.5}$ transformation for statistical analysis.

Results and discussion

The relative toxicity test of different treatments against coccinellid predators (Table 1 & Fig. 1) revealed that acephate 0.05 per cent and imidacloprid 0.005 per cent alone were found most toxic to the coccinellid predators as they recorded the lowest (1.40 & 1.60) coccilinellids per plant, respectively. The toxic nature of acephate and imidacloprid are in agreement with the findings of Patil and Lingappa (2) who reported the toxicity of acephate and imidacloprid to the larvae of M. sexmaculata. Similarly, Rathod and Bapodara (3) observed the toxicity of imidacloprid to coccilinellid predators.

The moderate toxicity (2.00) coccinellids/plant) observed with *B. bassiana* @ 2.5 kg/ha in present study is in concurrence with Massarat and Humayun (4) who reported moderate toxicity of *B. bassiana* to

Table 1. Toxicity of biopestcide alone and in combination with insecticides to *C. septempuntata* under field condition.

Sr. No.	Treatment	Population of coccinellid predators* (No. per plant)	
		24 hours before spraying	48 hours before spraying
1	*V.lecartii*@ 2.0 Kg/ ha	2.1 2** (4.53)	1.58 (2.50)
2	*B.bassiana*@ 2.5 Kg/ ha	2.17 (4.73)	1.41 (2.00)
3	Imidacloprid 0.005 %	2.34 (5.47)	1.26 (1.60)
4	Acephate 0.05 %	2.32 (5.40)	1.18 (1.40)
5	*V.lecanii*@ 1 .0 Kg/ ha + Imidacloprid 0.0025 %	2.29 (5.27)	1.51 (2.27)
6	*V.lecanii*@ 1 .0 Kg/ ha + Acephate 0.025 %	2.22 (4.93)	1.46 (2.13)
7	*B.bassiana*@ 1.25 Kg/ ha + Imidacloprid 0.0025 %	2.29 (5.27)	1.39 (1.93)
8	*B.bassiana*@ 1 .25 Kg/ ha + Acephate 0.025 %	2.29 (5.27)	1.33 (1.77)
9	Azadirachtin 0.000375 %	2.32 (5.40)	1.60 (2.60)
10	Untreated control	2.31 (5.33)	2.69 (7.27)
	Sem±	0.09	0.06
	C.D. 0.05	NS	0.18
	CV %	6.89	6.92

* Consolidated population of larvae and adults of C. *septempunctata*, *C. transversali* and *M. sexmaculata*

** $\sqrt{x + 0.5}$ transformation

Figures in parentheses are retransformed value

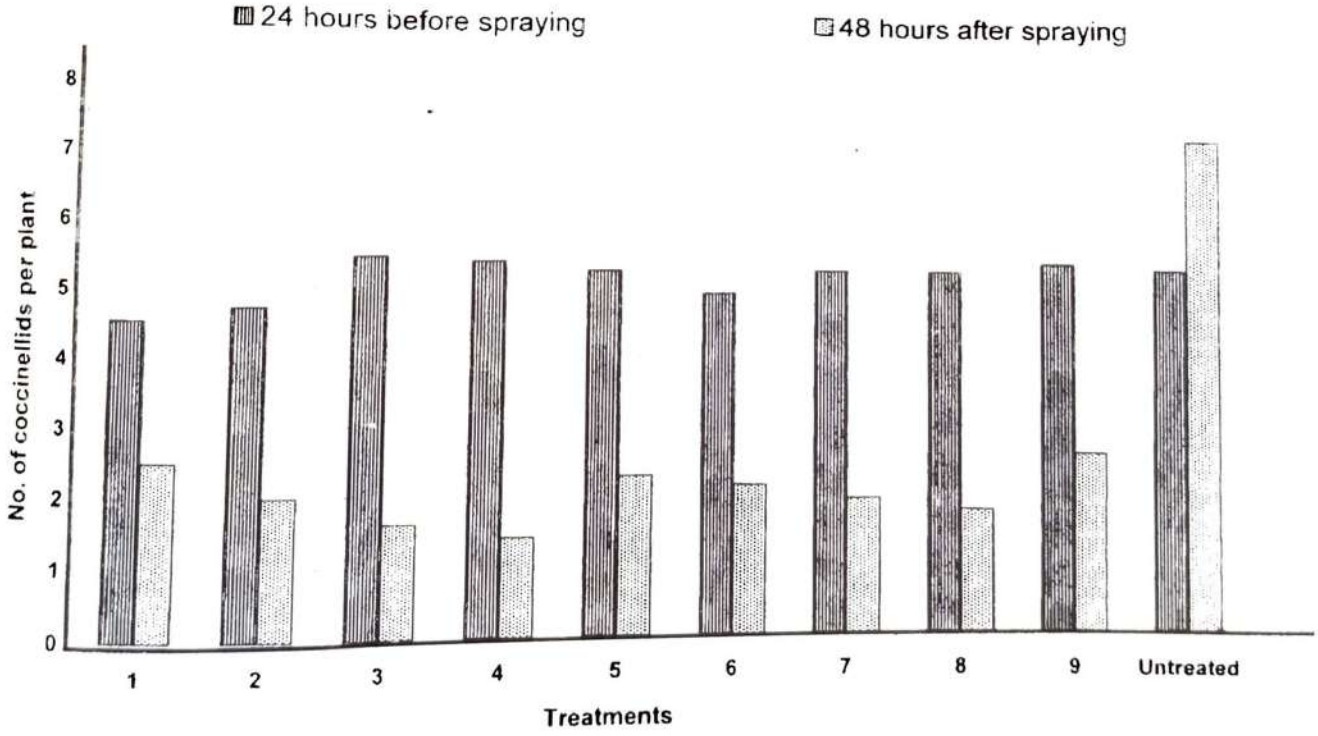

Fig. 1 Toxicity of bio-pesticides with chemical insecticides against coccinellid predators

C. septempunctata. The combination of imidacloprid 0.0025 per cent and acephate 0.025 per cent with *B. bassiana* @ 1.25 kg/ha were also found toxic to coccinellid predators.

Among the treatments, azadirachtin 0.000375 per cent and *V. lecanii* 2.0 kg/ha were found to be least toxic to coccinellid population compared to other treatments as they registered the highest (2.60 and 2.50) coccinellids per plant, respectively. The present results are in concurrence with Babu and Sharma (5) who reported that least toxicity azadirachtin to coccinellid predators. Harparand Huang (6) reported the safety of *V. lecanii* against the larvae of coccinellid predators. The combination of imidacloprid 0.0025 per cent and acephate 0.025 per cent with fungal bio-pesticide *V. lecanii* @ 1.0 kg/ha were slight toxic compared to the individual treatments of imidacloprid 0.005 per cent and acephate 0.05 per cent to the predatory beetles.

The results, thus, indicate the integration of sub lethal doses chemical insecticides with fungal bio-pesticide *V. lecanii* instead of chemical insecticide at recommended dose alone in the management programme of major insect pest of mustard so that residue problem can be minimized and coccinellid predators can be conserved.

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Biology of melon fly, *Bactrocera cucurbitae* Coquillett on little gourd

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Abstract

Biology of melon fly, *Bactrocera cucurbitae* Coquillett was studied on little gourd in the laboratory of C. P. College of Agriculture, Sardarkrushinagar during 2004-05 at room temperature. The average length and breadth of egg was 1.32 ± 0.04 and 0.29 ± 0.02 mm, respectively. The average incubation period was 2.20 ± 0.40 days and 87.61 per cent eggs hatched when adults were reared on little gourd. The average length and breadth of the first, second and third instar maggots were 1.47 ± 0.05 and 0.29 ± 0.03, 6.70 ± 0.93 and 1.24 ± 0.12 and 10.16 ± 0.75 and 1.90 ± 0.18 mm, respectively. The mean duration of corresponding instars was 1.20 ± 0.40,2.24 ± 0.43 and 2.72 ± 0.67 days, respectively. The total maggot period was 6.08 ± 0.95 days. The average prepupal and pupal duration was 0.78 ± 0.25 and 9.52 ± 1.19 days, respectively. Mean eclosion period was 11.42 ± 2.78 minutes and sex ratio of male : female was 1 :1.01. The average pre-oviposition, oviposition and post-oviposition period were 15.90 ± 1.37, 50.40 ± 17.66 and 1.20 ± 0.63 days, respectively. Female laid on an average 198.00 ± 15.55 eggs. The mean longevity of male and female was 44.20 ± 11.47 and 67.50 ±19.10 days, whereas, total life period was 62.90 ± 12.20 and 86.20 ± 18.51 days, respectively.

Keywords : Melon fly, little gourd, biology

Introduction

The little gourd, *Coccinia indica* Wight and Arnott is one of the important gourds cultivated in Gujarat. Its original home is believed to be India (1) and widely cultivated in Central America, China, Ceylon, India, Malaya and Tropical Africa (2). Little gourd is attacked by number of insect pests among which fruit flies, *Bactrocera cucurbitae* Coquillett and *Daccus ciliatus* Loew are the most important (3). The melon fly or cucurbit fruit fly, *B. cucurbitae* infests melons, gourds, pumpkin, cucumbers, *karela* and brinjal (4). The female flies punctue the soft and tender fruits of *C. indica* with their stout and hard ovipositor and lay eggs below fruit rind. On hatching the maggots feed on the pulp of fruit and make the fruit unsuitable for human consumption. The imformation on its biology in North Gujarat Agro - climatic condition is wanting and hence this study was undertaken.

Materials and methods

Studies on biology of *B. cucurbitae* on little gourd was carried out in the laboratory of Department of Entomology, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the year 2004 - 05. During the study period, the average temperature and relative humidity was 24.59 ± 1.47°C and 53.61 ± 6.34 per cent, respectively. The infested fruits of little gourd were collected from field and kept in the rearing glass jars (11 cm length x 9 cm width x 15 cm height) containing 5 cm thick layer of sieved soil to start initial culture. The biology of *B. cucurbitae* was studied adopting the method described by Patel and Patel (5). The observations on shape, size, colour and other morphological characters were recorded and described. The duration of various stages, number of instars, fecundity and per cent hatching of eggs was worked out and presented.

Results and discussion

Eggs

Freshly laid eggs on little gourd were elongate, slightly curved and tapering towards either end. The posterior end being broadly rounded, while the anterior end was more pointed. The surface was sculptured with

numerous longitudinal ridges and grooves. Observations on measurement (Table 1) revealed that the length of eggs varied from 1.25 to 1.38 (Av. 1.32 ± 0.04) mm, while the breadth varied from 0.28 to 0.36 (Av. 0.29 ± 0.02) mm. Similar results were also reported by Patel (6). Incubation period varied from 2 to 3 (Av. 2.20 ± 0.40) days at an average room temperature of 24.59 ± 1.47°C and relative humidity of 53.61 ± 6.34 per cent, while hatching percentage of the eggs laid in little gourd was 87.61 (Table 2).

Larvae

First instar

The first instar maggots were elongate and oval in shape, translucent and white in colour with brownish to dark black mouthparts. The internal organs were visible through integument. The head was pointed and slightly bent downward at anterior end with a pair of very small mandibular hooks. The length varied from 1.38 to 1.54 (Av. 1.47 ± 0.05) mm, while the breadth varied from 0.23 to 0.36 (Av. 0.29 ± 0.03) mm (Table 1). The duration of first instar ranged between 1 and 2 (Av. 1.20 ± 0.40) days (Table 2).

Second instar

The second instar maggots were elongate, ellipsoidal in shape and creamy white in colour having semi-transparent integument. The length varied from 4.50 to 8.20 (Av. 6.70 ± 0.93) mm, while the breadth varied from 0.90 to 1.30 (Av. 1.24 ± 0.12) mm. The duration of second instar varied from 2 to 3 (Av. 2.24 ± 0,43) days.

Third instar

The cephalic end of the third instar maggots was slightly pinkish and pointed ,while posterior end was creamy white and blunt. All the mouthparts were retractile and black coloured mouth hooks extended out side the mouth during the process of feeding. The full grown third instar maggots had the peculiar habit of jumping. The maggot formed a ring or loop by holding its posterior end with mouth and then released it with a jerk, which resulted in a short jump in the air. By jumping, maggot changed its place. This may be to find the suitable site for pupation. The length of third instar maggot varied from 8.50 to 11.10 (Av. 10.16 ± 0.75) mm and the breadth varied from 1.70 to 2.30 (Av. 1.90 ± 0.18) mm (Table 1), while its duration varied from 2 to 4 (Av. 2.72 ± 0.67) days.

Total maggot period

The total maggot period of *B. cucurbitae* varied from 5 to 8 (Av. 6.08 ± 0.95) days. Patel (6) also reported more or less similar total larval period of *D. cucurbitae* on bitter gourd and bottle gourd.

Prepupa

The full grown third instar maggot left the fruit and formed a quiescent stage before pupation. The maggot remained stationary, become sluggish, stopped

Table 1. Measurement of different stages of *B. cucurbitae* reared on little gourd

Stage	Length (mm)			Breadth (mm)		
	Min.	Max.	Av. ± S.D.	Min.	Max.	Av. ± S.D.
Egg	1.25	1.38	1.32 ± 0.04	0.28	0.36	0.29 ± 0.02
Larva (Maggot)						
I Instar	1.38	1.54	1.47 ± 0.05	0.23	0.36	0.29 ± 0.03
II Instar	4.50	8.20	6.70 ± 0.93	0.90	1.30	1.24 ± 0.12
III Instar	8.50	11.10	10.16 ± 0.75	1.70	2.30	1.90 ± 0.18
Pupa						
Prepupal	6.00	8.30	7.14 ± 0.65	1.50	2.30	1.94 ± 0.25
Pupal	5.00	6.00	5.44 ± 0.35	1.80	2.60	2.13 ± 0.22
Adult						
Male	5.20	7.00	6.24 ± 0.43	10.3	13.50	11.74 ± 0.96
Female	7.90	10.20	9.10 ± 0.90	12.50	17.30	16.01 ± 1.16

Table 1. Measurement of different stages of *B. cucurbitae* reared on little gourd

Stage	Duration (Days) Range (Av. ± S.D.)	
Egg	2-3 (2.20 ± 0.40)	
Larva (Maggot)		
I Instar	1 - 2	(1.20 ± 0.40)
II Instar	2 - 3	(2.24 ± 0.43)
III Instar	2 - 4	(2.72 ± 0.67)
Total Maggot period	5 - 8	(6.08 ± 0.95)
Prepupal	0.5 - 1	(0.78 ± 0.25)
Pupal	8 - 12	(9.52 ± 1.19)
Adult		
Pre-oviposition period	14 - 18	(15.90 ± 1.37)
Oviposition period	21 - 72	(50.40 ± 17.66)
Post-oviposition period	0 - 2	(1.20 ± 0.63)
Male	30 - 62	(44.20 ± 11.47)
Female	36 - 91	(67.50 ± 19.10)
Total life period		
Male	46.5 - 82	.(62.90 ± 12.20)
Female	56 - 110	(86.20 ± 18.51)
Hatching percentage (%)	87.61	
Eclosion period (Minutes)	6 - 15	(11.42 ± 2.78)
Sex ratio (Male : female)	1 : 1.01	
Fecundity (eggs / female)	187 - 209	(198.00 ± 15.55)
Temperature (°C)	21.60 - 27.75	(24.59 ± 1.47)
Relative Humidity (%)	42.50 - 69.00	(53.61 ± 6.34)

feeding, contracted antero-posteriorly and attained spiral form assuming prepupal stage. The length and breadth of prepupal stage varied from 6.00 to 8.30 (Av. 7.14 ± 0.65) and 1.50 to 2.30 (Av. 1.94 ± 0.25) mm, respectively (Table 1). The prepupal period varied from 0.5 to 1 day with an average of 0.78 ± 0.25 day (Table 2). The present observations on prepupal period are in close agreement with the report of Shivankar and Dumbre (7).

Pupa

The freshly formed pupae were yellowish white to deep reddish yellow but later on changed to light brown to brownish grey in colour, segmented and barrel or cylindrical in shape. The length and breadth of pupa varied from 5.00 to 6.00 (Av. 5.44 ± 0.35) mm and 1.80 to 2.60 (Av. 2.13 ± 0.22) mm (Table 1). The pupal period varied from 8 to 12 (Av. 9.52 ± 1.19) days (Table 2). These findings are in agreement with those reported by Patel(6).

Process of eclosion

In the laboratory, it has been observed that before emergence of adult, the pupa started vibrating. The anterior portion of the puparium was broken open and head portion of the adult appeared first. Thereafter, the adult pulled out its rest of the body from the puparium by expanding and contracting its body which facilited eclosion process. The eclosion period ranged between 6.00 and 15.00 (AV. 11.42 ± 2.78)minutes (Table 2). Similarly, Patel and Patel (5) observed that *D. ciliatus* required 16.52 ± 7.75 minutes to complete eclosion.

Adult

The adults of *B. cucurbitae* were moderate in size, yellowish grey to reddish brown with a curved lemon yellow coloured vertical markings on the thorax and possessed fuscous shadings on the outer margin of the wings. Greyish brown patches on the apical margin of the wing and black bands on the radiomedial

veins were present. Males were smaller in size than the females. The female was distinguishable easily by the presence of a tapering abdomen ending in a pointed ovipositor, while the abdomen of male was blunt. The length and breadth of the male fly varied from 5.20 to 7.00 (Av. 6.24 ± 0.43) and 10.30 to 13.50 (Av. 11.74 ± 0.96) mm, while that of female fly varied from 7.90 to 10.20 (Av. 9.10 ± 0.90) and 12.50 to 17.30 (16.01 ±1.16) mm, respectively (Table 1). Similar morphological characters and measurement of the adult of B. *cucurbitae* have also been reported by Narayanan and Batra (8).

Sex *ratio*

The sex ratio of male : female reared on little gourd was found to be 1 : 1.01 (Table 2). In past, Patel (6) observed similar sex ratio of D. *cucurbitae* reared on bitter gourd and bottle gourd.

Pre-oviposition, oviposition and post-oviposition period

The results presented in table 2 indicated that the pre-oviposition, oviposition and post-oviposition period varied from 14 to 18 (Av. 15.90 ±1.37), 21 to 72 (Av. 50.40 ± 17.66) and 0 to 2 (1.20 ± 0.63) days, respectively. The pre-oviposition period was reported as 13 to 14 days (9) on pumpkin, oviposition period reported as 49.33 days (10) on cucurbit and post-oviposition oviposition period as 1 to 2 (Av. 1.20 ± 0.42) days (6) on bottle gourd are in close confirm ity with the present findings.

Fecundity

The egg laying capacity of the female of 6. *cucurbitae* varied from 187 to 209 (Av. 198.00 ±15.55) eggs in little gourd wich was very close to 200 eggs per female reported by Butani(11) on melons.

Adult longevity

The males were short lived (30 to 62: (Av. 44.20 ±11.47 days) than females (36 to 91: Av. 67.50 ± 19.10 days) (Table 2). The adult longevity was some what longer when fed on juices of cucurbits (8) and melon (11).

Total life period

Total life period from egg to death of adults occupied on an average of 62.90 ± 12.20 (46.5 to 82) days in male and 86.20 ± 18.51 (56 to 110) days in female (Table 2). Patel (10) reported the average total life period of 6. cucurbitae as 50.45 days which is very close to the pesent findings.

Acknowledgement

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Comparative bionomics of fruit and shoot borer, *Earias vittella* (Fabricius) on okra and cotton

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Abstract

Studies on bionomics of *E. vittelle* was carried out during the year of 2003-04 at average minimum and maximum room temperature 27.14 ± 1.01 and 32.9 ± 1.23, respectively, while the relative humidity was 86.17 %. There were four larval instars. The mean total larval period was 8.98 ± 1.72 and 10.72 ± 3.24 days on okra and cotton respectively. The pupal duration was 8.08 ± 0.70 and 9.16 ± 0.89 days on okra and cotton, respectively. The average longevity of male was 11.10 ± 2.81 days on okra and 12.60 ± 2.59 days on cotton, where as that of female was 12.90 ± 2.91 days on okra and 13.50 ± 3.10 days on cotton. The duration of total life span(egg to death of adult) for male and female was 29.90 ± 2.73 and 30.40 ± 4.12 days on okra and 30.10 ± 3.90 and 32.10 ± 3.14 days on cotton, respectively. The average fecundity of a female moth was 362.3 ± 187.43 eggs on okra and 285.2 ± 196.82 eggs on cotton. The hatching percentage of eggs on was 76.90 ± 4.18 and 75.80 ± 4.52 % on okra and cotton, respectively. The average pre oviposition, oviposition and post-oviposition periods were 2.50 ± 0.53,6.90 ± 1.73 and 3.20 ± 1.25 days on okra and 2.40 ± 0.84, 7.40 ± 2.32 and 3.70 ± 0.95 days on cotton, respectively. The sex ratio of male: female was 1: 0.923 and 1: 1.083 on okra and cotton, respectively.

Keywords : Bionomics, fruit and shoot borer, okra, cotton

Introduction

The spotted boll worm, *Earias vittella* (Fabricius) is a serious pest of okra and cotton crop. The larvae of this pest not only damage the fruits but the also the shoots of the plant. The eggs are laid on bud, fruit or tender part of the plant. The newly hatched larvae crawl over the tendar parts for about two hours before entering the top shoot or fruit. It has been reported that larvae causes 67% damage to fruits (1) and 50% loss to fruit yield (2). In view of the serious nature of the pests, some important biological aspects were studied at Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) during the year of 2003-04.

Materials and methods

The initial culture of *E. vittella* was established in the laboratory by collecting large number of larvae from the infested okra fruits as well as cotton bolls from the okra and cotton crops, grown at College Farm. These collected larvae were reared on fresh tender fruits of okra and bolls of cotton, separately in Petri dishes (10 cm diameter). Small pieces of fresh okra fruits and cotton bolls were provided in morning until pupation. The pupae as they formed were placed in an insect rearing cage for the emergence of adults. The adults, thus obtained were paired individually into separate glass jars for further studies. The okra fruits and cotton bolls were placed in the jar to facilitate the oviposition. The cotton swab dipped into 5 per cent honey solution was kept at the top of the cage so as to provide food to the adults. The okra fruits and cotton bolls bearing eggs were substituted every day in the morning by replacing fresh food and eggs were collected for studying the biological aspects of this pest.

The studies on the colour, shape, size and periods of eggs, larva, pupa and adults were examined. The pre-oviposition, oviposition and post-oviposition periods, sex ratio and longevity of adults were also studied.

Results and discussion

The egg

The eggs were laid singly or scattered in small groups on okra fruits (Plate 1 C) and cotton bolls as well as

on muslin cloths tied over the jar. The eggs were bluish green in colour and changed darker as the time advanced. The eggs were small in sized, spherical in shape and the chorion of egg was white and transparent with lines and crown like projection on it. On the second day, a brown ring like structure was developed behind the crown of egg. However, the colour of eggs remained unchanged and shriveled next day instead of development of crown ring. The larva came out from the egg by making a hole through the egg shell which later presented a white colour. The measurements of 50 eggs of *E. vittella* varied from 0.49 mm to 0.56 mm with an average of 0.53 ± 0.02 mm in length and 0.49 mm to 0.56 mm with an average of 0.53 ± 0.02 mm in breadth, when larvae were reared on okra, whereas it varied from 0.49 mm to o.56 mm with an average of 0.52 ± 0.02 mm in length and 0.49 mm to 0.55 mm with an average of 0.51 ± 0.02 mm in breadth, when larvae were reared on cotton bolls (Table 1 & Fig. 1).

The incubation period(Table 2) and hatching percentage of the eggs(Table 3), when larvae were reared on okra fruits as well as on cotton bolls, were worked out under laboratory conditions (temperature range of 24.9 to 31.9° C and relative humidity 80 to 95 per cent) during August, 2003.

The results presented in Table 2 and depicted in Figure 1 indicates that the incubation period varied from 3 to 5 days with an average of 3.66 1 0.75 days on okra fruits and 3 to 5 days with an average of 3.70 ± 0.79 days on cotton bolls. The hatching percentage ranged from 72 to 82 with an average of 76.90 ± 4.18 and 70 to 82 with an average of 75.80 ± 4.52 on okra fruits and cotton bolls, respectively(Table 3). This variation in per cent hatching may be due to the difference in food on which larvae were reared.

The larva

First instar larva

The freshly hatched larva was tiny creamy white in colour with dark brown head capsule. The head was longer and broader as compared to the body size, which narrowed down posteriorly. The larva had three pairs of true legs on thoracic segments, while each of the third to sixth abdominal segment carried a pair of prologs and the tenth segment a pair of anal legs. Nine pairs of spiracles were noticed on the prothorax and first eight abdominal segments (Plate 2).

Table 1. Measurement of different life stages of *E. vittella* reared on okra and cotton.

Stage		Host plant	Number observed	Length (mm)			Breadth (mm)		
				Min.	Max.	Av. ± S.D.	Min.	Max.	Av. ± S.D.
Egg		Okra	50	0.49	0.56	0.53 ± 0.02	0.49	0.56	0.53 ± 0.02
		Cotton	50	0.49	0.56	0.52 ± 0.02	0.49	0.55	0.51 ± 0.02
Larva	I instar	Okra	50	1.30	2.20	1 .61 ± 0.26	0.25	0.40	0.33 ± 0.04
	II instar	Okra	50	1.83	3.10	2.33 ± 0.39	0.25	0.50	0.38 ± 0.07
	III instar	Okra	50	5.80	7.20	6.31 ± 0.41	1.10	1.25	1.17 ± 0.05
	IV instar	Okra	50	10.60	17.00	13.80 ± 2.32	2.60	4.25	3.26 ± 0.53
	I instar	cotton	50	1.30	2.15	1.58 ± 0.20	0.25	0.35	0.31 ± 0.03
	II instar	Cotton	50	1.80	3.10	2.17 ± 0.41	0.25	0.45	0.35 ± 0.06
	III instar	Cotton	50	5.10	6.80	5.96 ± 0.52	0.95	1.15	1.10 ± 0.06
	IV instar	Cotton	50	9.95	16.80	12.76 ± 1.93	2.15	3.95	3.08 ± 0.52
Pupae		Okra	50	9.50	11.60	10.39 ± 0.57	3.00	3.70	3.42 ± 0.19
		Cotton	50	8.95	10.80	9.55 ± 0.38	2.75	3.60	3.11 ± 0.21
Adult	Male	Okra	10	8.60	10.10	9.67 ± 0.51	19.60	23.00	21.41 ± 1.45
	Female	Okra	10	9.10	13.10	11.63 ± 1.42	21.70	24.90	23.19 ± 1.15
	Male	Cotton	10	8.60	10.05	9.29 ± 0.54	19.30	22.50	20.69 ± 1.05
	Female	Cotton	10	9.05	12.90	11.10 ± 1.35	19.40	23.60	22.06 ± 1.52

Table 2. Period of various life stages of E. vittella reared on okra and cotton.

Stage		Host plant	Number observed	Period (days)		
				Min.	Max.	Av. ± S.D.
Egg		Okra	50	3	5	3.66 ± 0.75
		Cotton	50	3	5	3.70 ± 0.79
Larva	I instar	Okra	50	1	3	2.12 ± 0.75
	II instar	Okra	50	1	2	1.40 ± 0.49
	III instar	Okra	50	1	3	2.08 + 0.83
	IV instar	Okra	50	2	5	3.38 ± 0.92
	I instar	Cotton	50	1	3	2.34 ± 0.72
	II instar	Cotton	50	1	3	1.74 ± 0.66
	III instar	Cotton	50	2	5	2.60 ± 0.93
	IV instar	Cotton	50	3	7	4.40 + 1.23
Total larval Period		Okra	-	5	12	8.98 + 1.72
		Cotton	-	7	18	10.72 ± 3.24
Pupae		Okra	50	7	9	8.08 + 0.70
		Cotton	50	7	10	9.16 + 0.89
Longivityof adult	Male	Okra	10	7	15	11.10 + 2.81
	Female	Okra	10	8	17	12.60 ± 2.91
	Male	Cotton	10	8	15	12.60 + 2.59
	Female	Cotton	10	8	18	13.50 ± 3.10
Entire life span	Male	Okra	10	24	34	29.90 + 2.73
	Female	Okra	10	27	40	30.40 ± 4.12
	Male	Cotton	10	23	36	30.10 ± 3.90
	Female	Cotton	10	27	36	32.10 ± 3.14

The average measurements of body length and breadth as well as head capsule width of first instar larva were 1.61 + 0.26, 0.33 + 0.04 and 0.32 ± 0.02 mm, respectively, when larvae were reared on okra fruits while they were 1.58 ± 0.20, 0.31 ± 0.03 and 0.30 ± 0.01 mm, respectively, when larvae were reared on cotton bolls(Table 1 and Fig. 2).

Second instar larva

The second instar larva morphologically resembled the first instar larva except that it was bigger in size. However, the body colour changed to light brown with white dots on the dorsal surface. Spiracles became more prominent. The prolegs became fleshy conical and bear a hook like structure at their tip (Plate 2). The average length and breadth of second instar larva were 2.33 ± 0.39 mm, 2.17 ± 0.41 mm and 0.38 ± 0.07 mm, 0.35 ± 0.06 mm on okra and cotton, respectively. The mean head capsule width was 0.46 ± 0.03 mm and 0.41 ± 0.01 mm when larvae were reared on okra fruits and cotton bolls, respectively(Table 1 and Fig. 2).

Third instar larva

The size of third instar larva was bigger than the second instar larva. The body colourwas darker with more prominent white spots and orange spots on the dorsal side with light orange spots on both the lateral sides. The colour of head capsule was dark brown and legs were creamy white(Plate 2).

The mean length, breadth and head capsule width of third instar larva, when reared on okra fruits, were 6.31 ± 0.41 mm, 1.17 + 0.05 mm and 0.86 + 0.04 mm, respectively. While they were 5.96 + 0.52, 1.10 + 0.06 and 0.82 ± 0.05 mm, respectively, when larvae were reared on cotton bolls(Table 1 and Fig. 2).

Fourth instar larva

The fourth instar larva was more stout, spindle shaped with dark purple in colour. The head was blackish in colour with well developed mouth parts. The first thoracic segment was white in colour with brown markings and an orange colour spot on either side

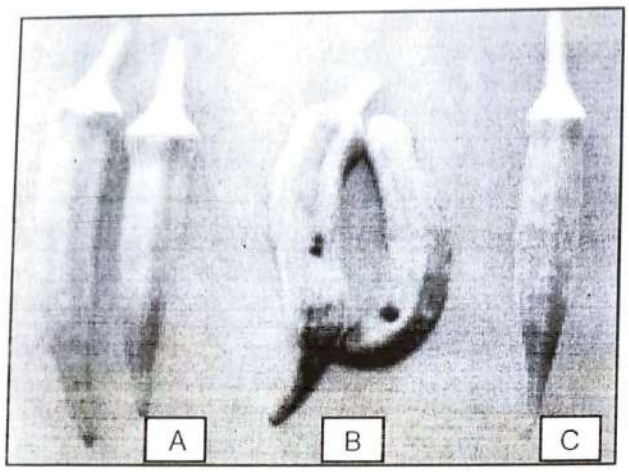


Plate : 1 . (A & B) Healthy and demaged okra fruits.
(C) Okra fruit with eggs of *E.vittella*.

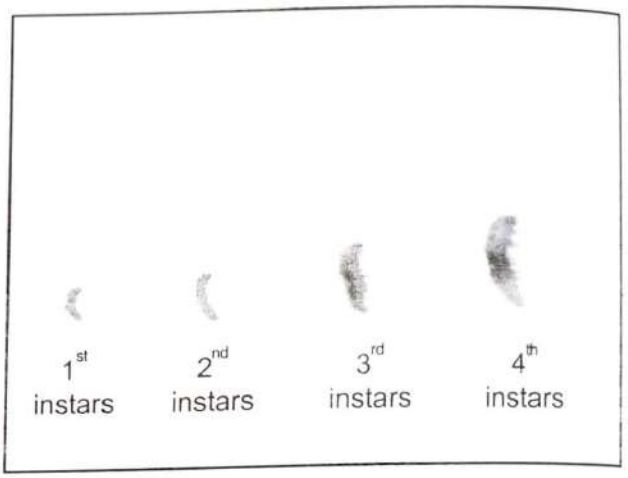


Plate : 2. Different larval instars of *E.vittella*.

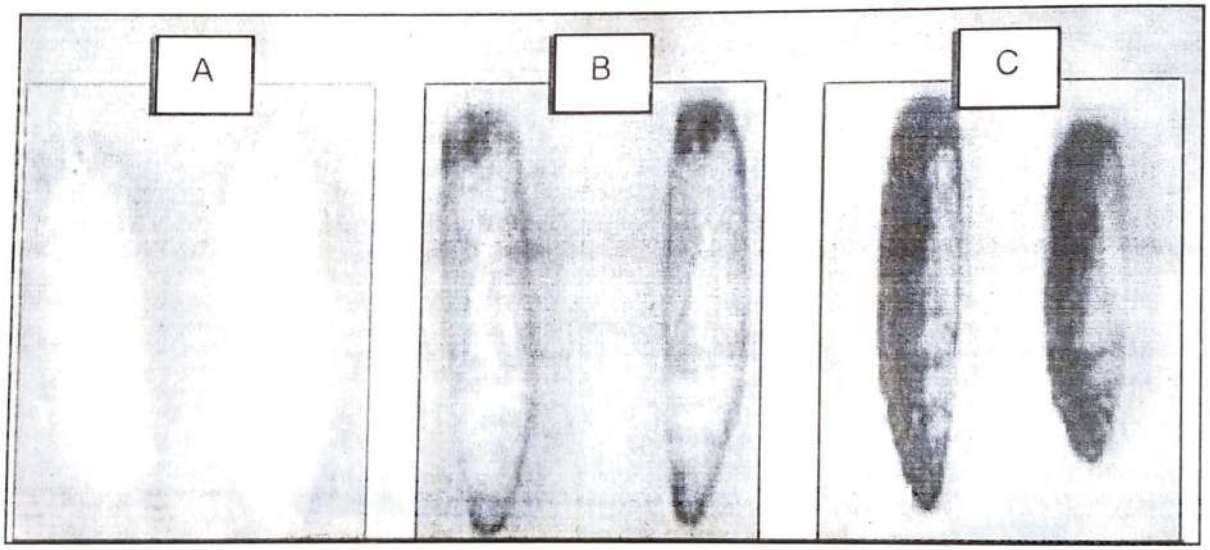
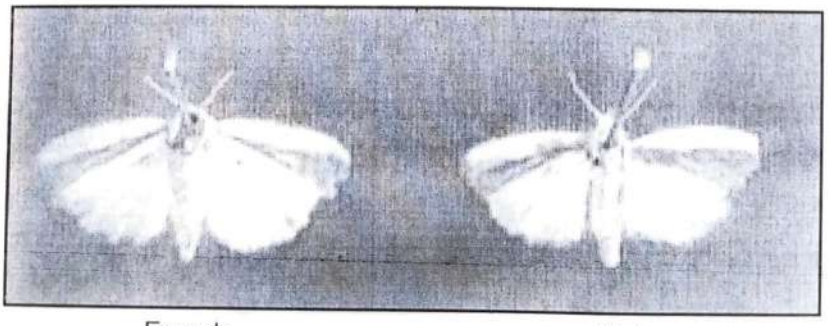


Plate : 3. Pupae of *E. vittella* (A) Pupae with cocoon, (B) Pupae without cocoon-ventral view
(C) Pupae without cocoon-dorsal view



Female Male

Plate : 4. Adults of *E.vittella*

Table 3. Pre-oviposition, oviposition, post-oviposition, fecundity and hatching percentage of *E. vittella* reared on okra and cotton.

Particular	Host plant	Number of observed	Min.	Max.	Av. ± S.D.
Pre-oviposition period	Okra	10	2	3	2.50 ± 0.53
	Cotton	10	1	3	2.40 ± 0.84
Oviposition period	Okra	10	4	10	6.90 ± 1.73
	Cotton	10	4	12	7.40 ± 2.32
Post-oviposition period	Okra	10	1	5	3.20 ± 1.23
	Cotton	10	2	5	3.70 ± 0.95
Fecundity	Okra	10	74	560	362.3 ± 187.43
	Cotton	10	110	615	385.2 ± 196.82
Hatching (Percentage)	Okra	50	72	82	76.90 ± 4.18
	Cotton	50	70	82	75.80 ± 4.52

Table 4. Growth index value, per cent adult emerged and sex-ratio of *E. vittella*, When reared on okra and cotton.

Host plant	Number observed	Growth index value	Per cent adult emerged	Sex-ratio
Okra	50	9.354	90	1 : 0.923
Cotton	50	7.463	86	1 : 1.083

near the spiracles, while the second and third thoracic segments were of orange coloured with white spots on them. There were continuous white markings from second to eighth segments of the abdomen. These white markings were more on fourth and eights segments with brown dots in the middle and orange coloured spots on either sides. These spots of different colours have given the name "Spotted bollworms" to the larva(Plate 2).

This full grown larva measured on an average 13.80 ± 2.32, 3.26 ± 0.53 and 1.36 ± 0.06 mm in body length, width and head capsule width, respectively, when larvae were reared on okra fruits. While they were 12.76 ± 1.93, 3.08 ± 0.52 and 1.22 ± 0.06 mm, respectively, when larvae were reared on cotton bolls(Table 1 and Fig. 2).

Number and duration of larval instars of *E. vitella*

The average duration of first, second, third and fourth larval instars was 2.12 ± 0.75, 1.40 ± 0.49, 2.08 ± 0.83 and 3.38 ± 0.92 days, respectively on okra fruits while it was 2.34 ± 0.72,1.74 ± 0.66, 2.60 ± 0.93 and 4.04 ± 1.23 days, respectively, when larvae were reared on cotton bolls. The average total larval duration was 8.98 ± 1.72 and 10.72 ± 3.24 days, when larvae were reared on okra fruits and cotton bolls, respectively(Table 2 and Fig. 1).

Growth index-values on okra and cotton

The data revealed that maximum (9.354) growth index value was obtained on okra, while it was minimum (7.463) on cotton. Thus, it was concluded that the okra is comparatively more preferred host as compared to the cotton(Table 4).

The pupa

After finding a suitable place out side the okra fruits and cotton bolls, the larvae spun the dirty white to light brown, silken, boat shaped cocoon and pupated inside it (Plate 3). The pre-pupal stage was marked by sluggish movement, absence of feeding and more contracted form. Pupa was light brown to dark brown in colour, but the colour was changed from grey to greenish grey as the time advanced. It is evident from the data (Table 1 and Fig. 3) that the length and breadth of pupa were observed more incase of okra ranging from 9.50 to 11.60 mm (average 10.39 ± 0.57 mm) and 3.00 to 3.70 mm (average 3.42 ± 0.19 mm), respectively, while these measurements were recorded comparatively less on cotton and they were ranged from 8.95 to 10.80 mm (average 9.55 ± 0.38 mm) in

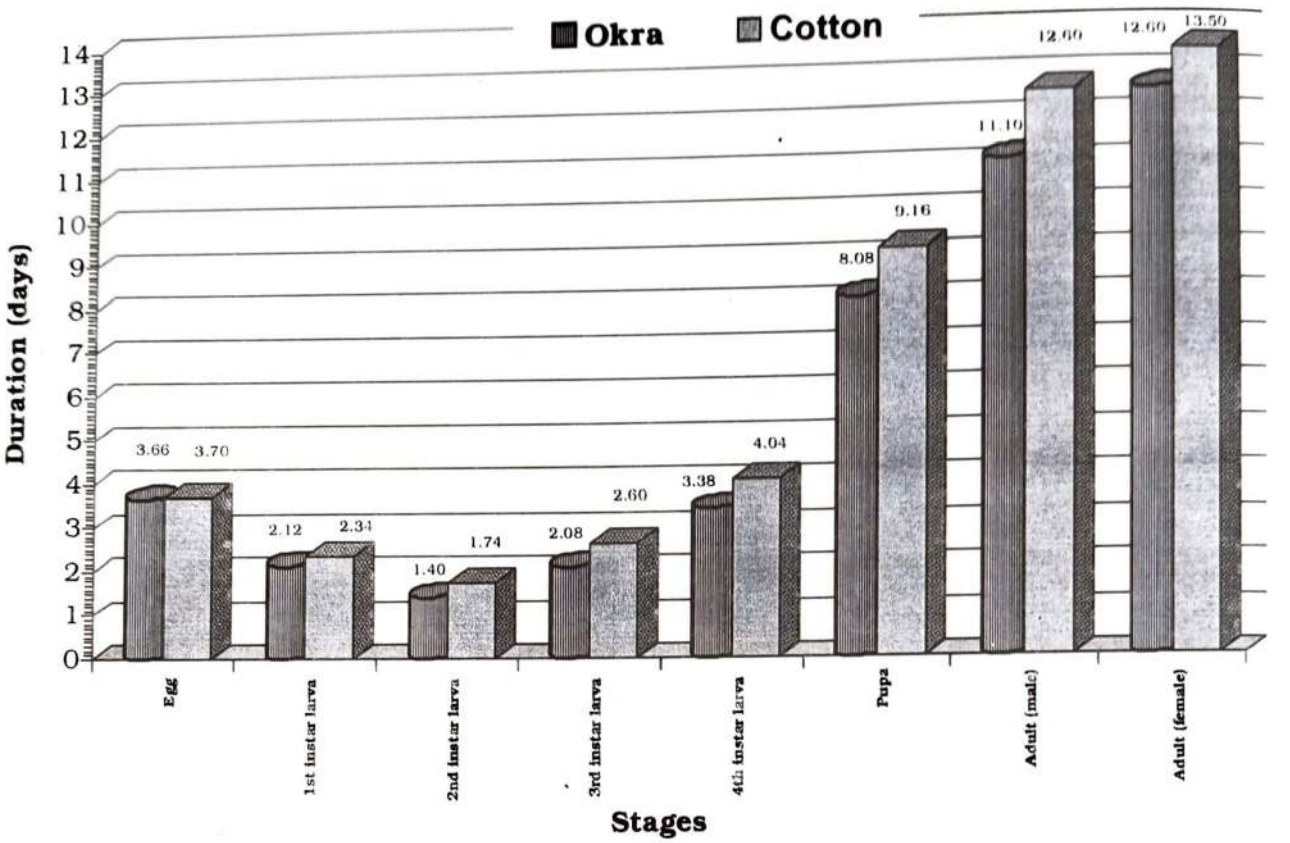


Figure 1: Comparative duration of various stages of *E. vittella* on okra and cotton

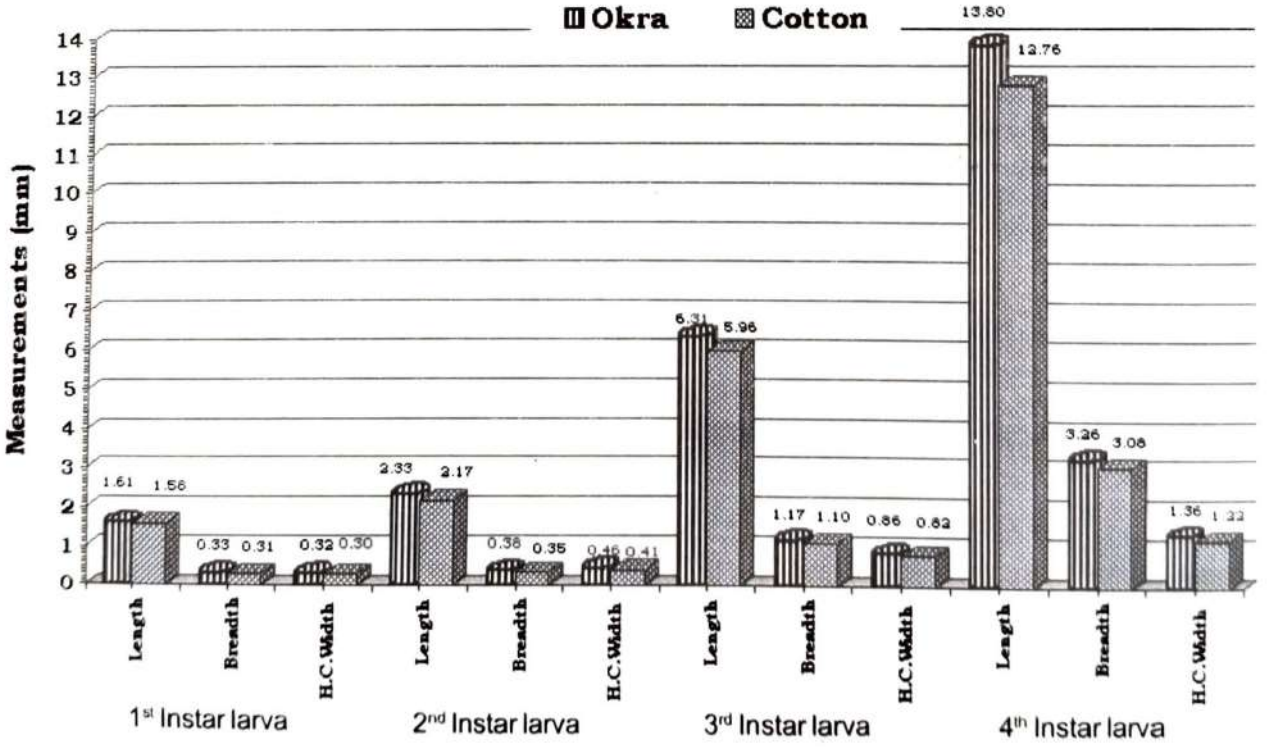


Figure 2: Comparative measurements of different larval instars of *E. vittella* on okra and cotton.

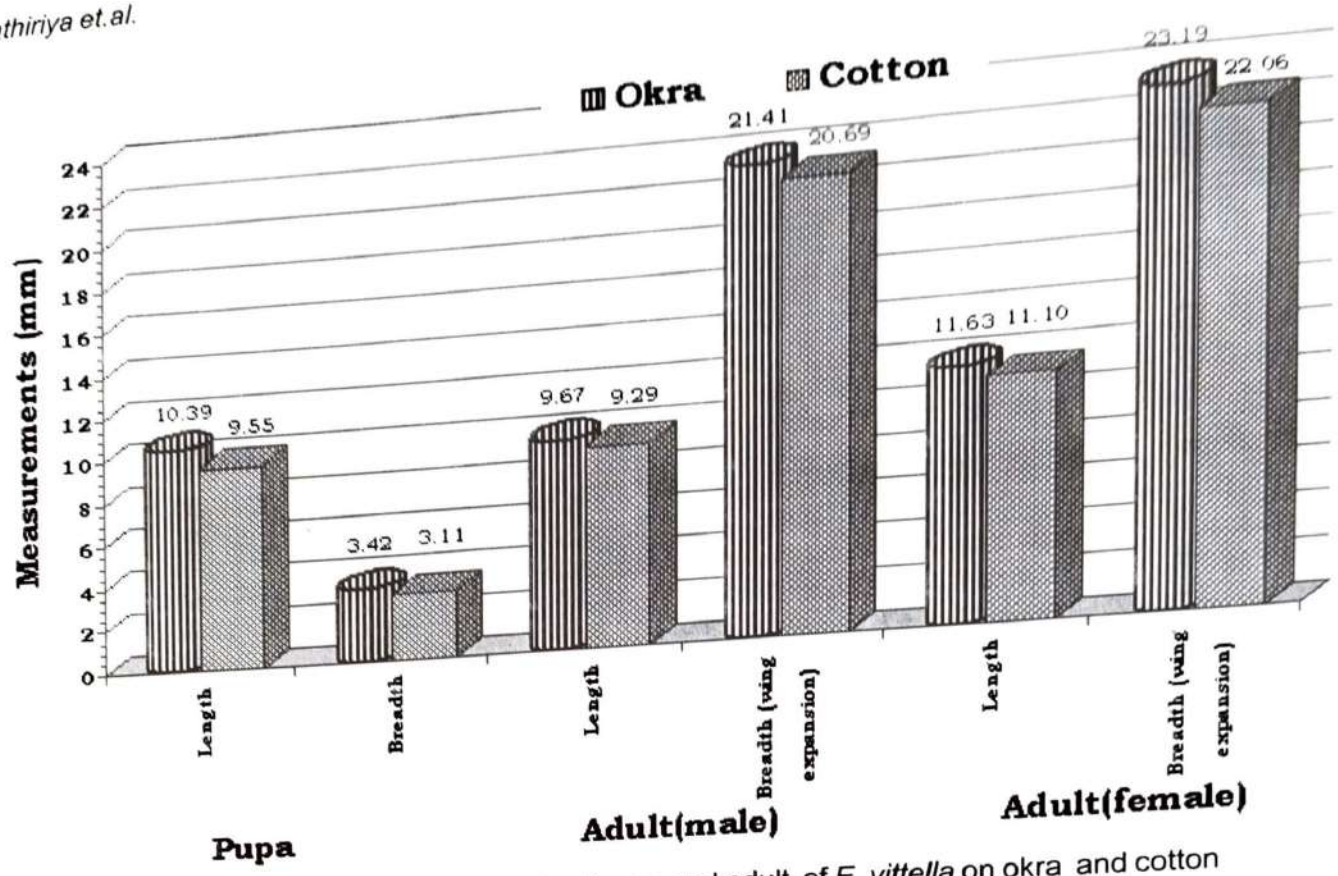


Figure 3:Comparative measurements of pupa and adult of *E. vittella* on okra and cotton

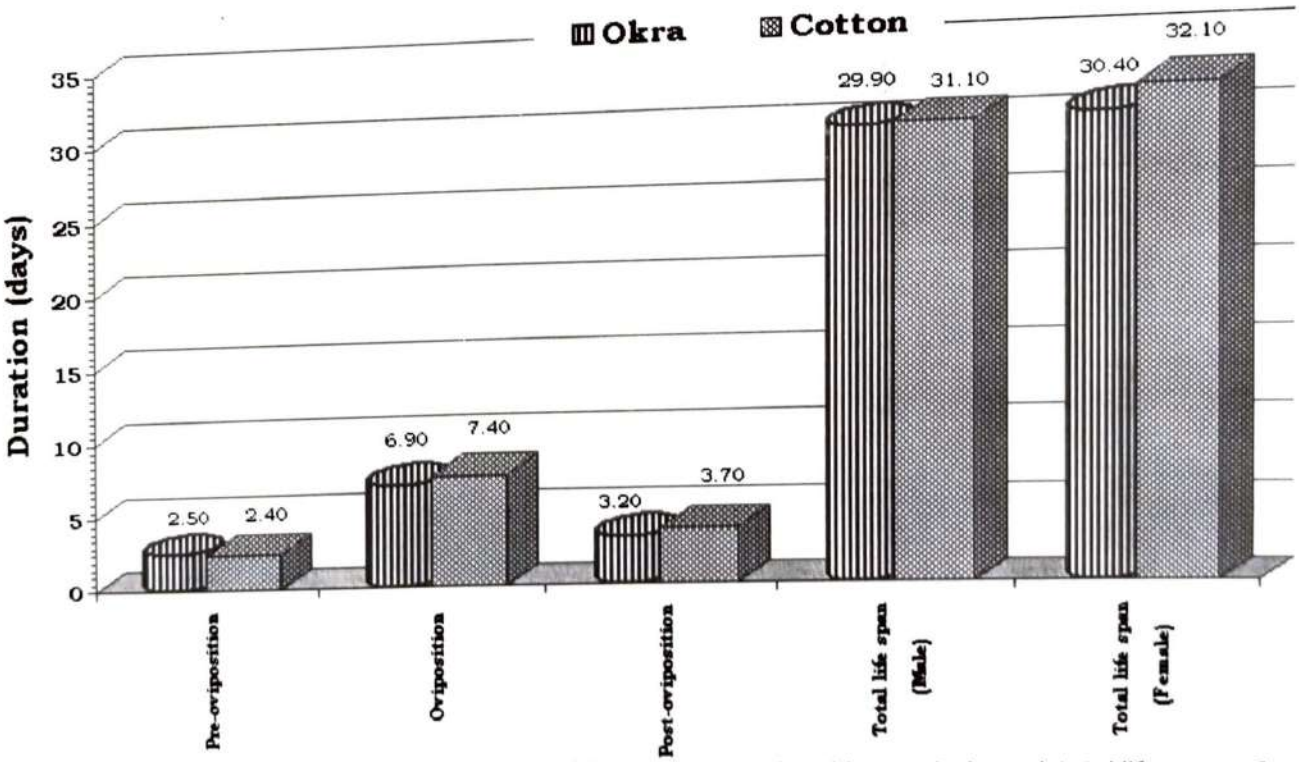


Figure 4: Comparative pre-oviposition, oviposition and post-oviposition periods and total life span of *E. vittella* on okra and cotton

length and 2.75 to 3.60 mm (average 3.11 ± 0.21 mm) in breadth.

Pupal duration, percentage of adult emerged and sex ratio; A close perusal of data presented in Table 2, Table 4 and Figure 1 indicates that the average pupal duration, irrespective to male female, was observed to be 8.08 ± 0.70 days and 9.16 ± 0.89 days on okra fruits and cotton bolls, respectively.

The adult

The adults of both the sexes were pale white in colour with a green longitudinal wedged shaped bend in the middle of their forewings. Hindwings were pale white, transparent with a light brown marking and smaller than forewings. The head was smaller than thorax. Eyes were black in colour. Antennae were filiform and yellowish grey in colour. The entire head region was covered with creamy white hairs, whereas the thorax was covered with pale green hairs with a prominent green marking in the centre. The female could be distinguished from the male by the presence of tuft of hairs on the last abdominal segment (Plate 4). The length and width with a wing expansion averaged as 9.67 ± 0.51 and 21.41 ± 1.45 mm of male and of 11.63± 1.42 and 23. 19 ± 1.15 mm of female moths when larvae were reared on okra fruits, while such dimensions were averaged as 9.29 ± 0.54 and 20.69 ± 1.05 mm in male and 11.10 ± 1.35 and 22.06 ± 1.52 in female when larvae were reared on cotton bolls. It can be seen from the data (Table 1 and fig. 3) that the size of moth was larger, when larvae were reared on okra fruits than that of cotton bolls. The data further indicated that female moth was larger than male moth on both the hosts.

Longevity

It is evident from the data (Table 2 and fig. 1) that the male and female survived longer, when larvae were reared on okra as compared to cotton. The male and female moths lived for 7 to 15 days (average 11.10 ± 2.81 days) and 8 to 17 days (average 12.60 ± 2.91 days) on okra fruits, respectively whereas it was ranged from 8 to 15 days (average 12.60 ± 2.59 days) and 8 to 18 days (average 13.50 ± 3.10 days) on cotton bolls, respectively during *kharif* season.

Oviposition duration

The data (Table 3 and Fig. 4) indicated that the average pre-oviposition, oviposition and post-oviposition periods were 2.50 ± 0.53,6.90 ± 1.73 and 3.20 ± 1.23 days on okra and 2.40 ± 0.84, 7.40 ± 2.32 and 3.70 ± 0.95 days on cotton, respectively. The data thus suggested that the pre-oviposition period was less whereas oviposition and post-oviposition periods were more, when E. *vittella* larvae were reared on okra fruits as compared to cotton bolls.

Oviposition potential (fecundity)

It is observed that the number of eggs laid per female varied from 74 to 560 (average 362.3 ± 187.43) on okra fruits and 110 to 615 (average 385.2 ±196.82) on cotton bolls. Thus, slightly higher fecundity was recorded on cotton as compared to okra. This indicated that cotton bolls are the more suitable for this pest as compared to okra fruits for egg laying (Table 3).

Entire life span

The shorter life span ranging from 24 to 34 days (average 29.90 ± 2.73 days) in case of male and 27 to 40 days (average 30.40 ± 4.12 days) in case of female was observed on okra fruits. The longer life span was recorded on cotton, which ranged from 23 to 36 days (average 30.10 ± 3.90 days) in case of male and 27 to 36 days (average 32.10 ± 3.14 days) in case of female(Table 2 and Fig. 4).

The present findings are more or less agreement with the results of Puri (3); Ambegaonkar and Bilapate (4) and Ratanpara (5).

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Information source utilisation behaviour of shrimp farmers on shrimp farming technologies

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Abstract

Shrimp farming has emerged as an important sector of the Aquaculture industry in the recent times. The present study focuses to find out the sources of information utilized by the Shrimp farmers; about the improved Shrimp farming technologies and constraints faced by them in Shrimp farming. A total of 60 Shrimp farmers drawn from 6 villages belonging to 3 blocks of Nagapattinam district of Tamilnadu were selected randomly by using multi stage random sampling method. The constraints, disease incidence, poor quality of seeds, price fluctuations and lack of information on market prices, lack of co-operation among fellow farmers and lack of quality control agencies were the most important constraints faced by the majority of the respondents and ranked I to V according to their importance. The fellow farmers were rated as the third important source of information, since they passed the information to their press by word of mouth. The government sources such as the State Department of fisheries came only next in order. The farmers were of the view that the research institutions, government departments and subject matter specialists were difficult to access, and hence they were unable to utilize them effectively for technical information. The extension wing of the state fisheries department should be revamped and more number of technically qualified and trained personnel should be appointed at the grass root level to render timely and important information the Shrimp farmers. As far the constrainto expressed by the Shrimp farmers. The government should undertake the setting up of disease diagnostic centers in each district, followed by setting of seed certifying agencies and quality control agencies for regulating the quality of chemicals. The experiences of the government in the agriculture sector such as use of quality control accreditation methods such as Agmark, setting of market information cells, and provision of free electricity can be suitably examined and emulated for the benefit of the Shrimp industry also.

Keywords : Shrimp farmers, behaviour, aquaculture

Introduction

Shrimp farming has emerged as an important sector of the Aquaculture industry in the recent times. Cultured Shrimps contribute about 50 per cent of the total Shrimp exports from India. (1).

The success behind the increased production of cultured Shrimps has been attributed to the production, dissemination and adoption of a number of improved technologies. The information sources and communication channels utilized by Shrimp farmers for building up their knowledge base ultimately leading to the diffusion and adoption process is of vital importance in furthering the development of the Shrimp Industry. The present study focuses to find out the sources of information utilized by the Shrimp farmers about the improved Shrimp farming technologies and constraints faced by them in Shrimp farming.

Methodology

A total of 60 Shrimp farmers drawn from 6 villages belonging to 3 blocks of Nagapattinam district of Tamilnadu were selected randomly by using multi stage random sampling method. The data was collected using a well-structured interview schedule. The information sources utilized by the farmers and the constraints faced by them were assessed through simple percentage analysis, and were ranked in order of their importance. The information source utilization behaviour of the shrimp farmers of Nagapattinam, were studied, and the results are presented in Table 1.

A perusal of Table 1 revealed the information source utilization by shrimp farmers of Nagapattinam. It is seen from the table that private consultants are the first hand source of information utilized by 86.67

percent of the respondents, followed by feed dealers and fellow farmers utilized by 81.67 percent and 78.33 percent respectively.

Next in order, the BFDA, which is the extension agency of the State Department of Fisheries, is the source of information for 36.67 percent of the farmers. The BFDA prepares projects, helps in identification of site and project preparation; and distributes subsidies to shrimp farmers.

MPEDA was utilized by 35.00 percent of the respondents as the source of information as it was a promoter of shrimp farming and also provided technical assistance, imparted training and PCR testing facilities to shrimp farmers.

The Research Institutions and printed literature were the next important sources of information utilized by 31.67 percent and 30.00 percent of the shrimp farmers respectively.

From the observation of the above table, the findings clearly indicate the lack of extensive and intensive involvement by the government extension machineries such as the BFDA, MPEDA and research institutions. As far as the utilization of print media was concerned, it was observed durkig the course of the survey that some progressive farmers were subscribers of aquac-ulture journals like Aqua star, Fishing chimes, reports and guides, folders and leaflets from feed companies; and these farmers in turn diffuse the information to the rest of their fellow farmers.

These findings bear a striking similarity to the findings of Kumaran *et al.* (2) who reported that feed and input dealers, and fellow farmers were the main sources of information, and that the involvement of government departments like the state fisheries department, was meager.

Constraints faced by shrimp farmers of nagapattinam in shrimp culture

The constraints faced by shrimp farmers of Nagapattinam were studied analyzed and the results presented in Table 2.

It could be seen from Table 2 that among the constraints, disease incidence, poor quality of seeds, price fluctuations and lack of information on market prices, lack of co-operation among fellow farmers and lack of quality control agencies were the most important constraints faced by the majority of the respondents and ranked I to V according to their importance.

Disease incidence was the first and foremost constraint faced by the respondents (93.33%). This might be because the major disease in the study area was White Spot Syndrome Virus (WSSV), and the occurrence of this disease can cause heavy mortality of the crop. Though no complete control measures have been developed so far, for control of WSSV, the occurrence of the disease has been tacked to some extent by instituting preventive measures such as screening of shrimp seeds through technologies such as PCR (poly-merase chain reaction) tests.

These PCR tests are done by many private shrimp hatcheries and companies, as well as by governmental agencies like MPEDA, though they are lesser in number. However there is no seed certifying agency which can guarantee that the PCR tested seeds are free of the virus; as sometimes random samples may not be used. Hence the need for a seed certifying agency operated by the State Fisheries Department was felt among the shrimp farmers.

This finding is in line with the findings of Kumaran *et.al.*(3) who reported that disease incidence was the major constraint faced by shrimp farmers of East Godavari district in Andhra Pradesh.

Next to disease incidence, poor quality of seeds was a constraint, expressed by 90.00 percent of the respondents. Lack of an appropriate seed certifying agency might be the reason for poor quality seeds.

Price fluctuations and lack of information on market prices was a constraint reported by 83.33 per cent of the respondents. Since cent per cent of the cultured shrimps are meant for the export market in Nagapattinam, the price of the shrimp is determined in the international market; of which few of the shrimp farmers are aware of, often the price of shrimp is settled through direct dealings between the farmer and exporter. Price fluctuations, do not ensure a stable remunerative price for the farmer.

Lack of co-operation among fellow farmers was the next constraint expressed by 78.33 per cent of the respondents. This might be because though majority of the shrimp farmers were members of registered shrimp farmers association, there is a lack of active

involvement by the farmers, in adopting appropriate management practices such as Disease management and culture operations, together. Lack of credit and insurance facilities were a constraint expressed by 73.33 per cent of the respondents.

The farmers are of the opinion that the government should revive its policies for providing credit and insurance facilities which were previously present; during the initial phase of popularisation of the technologies. Lack of government support was a constraint faced by 71.66 percent of the respondents. The shrimp farmers are of the opinion that the field level workers; visit the shrimp farms occasionally, and are not technically proficient in delivering the technologies as they are not qualified personnel.

Since the shrimp farmers invest lakhs of Rupees in this venture, they want immediate, and timely technical assistance; and hence mostly turn to private aquac-ulture consultants who are mostly graduates in fisheries sciences, and also feed dealers who regularly visit their farms and render assistance, based on hands on experience.

Suggestions of Shrimp Farmers of Nagapattinam To Overcome the Constraints

The suggestions offered by the shrimp farmers of Nagapattinam to overcome the constraints were studied, analyzed and the findings presented in Table 3.

It could be observed from Table 3 that majority of the respondents (95.00 percent) have suggested the setting up of disease diagnostic centres in each district, for early detection and control of diseases such as white spot virus syndrome and other viral diseases affecting shrimp.

These centres may be on the lines of Aquaculture clinics which have come up in several districts of Andhra Pradesh as reported by Dixitlu (4) who reported that such clinics help their client farmers by regularly checking the condition of shrimps under culture, checking of water quality and suggesting timely remedial measures to farmers where necessary.

Provision for creation of seed certification agencies was suggested by (90.00 per cent) of the respondents; as a remedial measure for poor quality seeds used by farmers. Creation of market intelligence cell in State Fisheries Department as well as communication of day to day information of prices through mass media was a suggestion offered by 86.67 per cent of the respondents.

The fourth important suggestion offered, was the setting up of quality control agencies to regulate the quality of chemicals, by 83.33 per cent of the respondents. This must be because shrimp culture makes use of a large amount of chemicals such as Probiotics and Immunostimulants, which do not have any regulatory authorities set up by the government, to certify their quality. Hence there is a need to set up quality control agencies or National accreditation of certification Bodies and issue the recognized stamp mark of ISO 9002, similar to the ones issued for assuring the quality of Agrochemicals, in the agriculture sector. Next in order of importance, strengthening shrimp farmers associations and formation of aquaclubs was a suggestion given by

Table 1. Information source utilization by shrimp farmers of Nagapattinam (n=60)

S. No.	Information Source	Number	Percent	Rank
1.	Private Consultants	52	86.67	I
2.	Feed dealers	49	81.67	II
3.	Fellow farmers	47	78.33	III
4.	State Fisheries Department (Brackish water fish farmers development agency- BFDA)	22	36.67	IV
5.	Marine products export development authority - MPEDA	21	35.00	VI
6.	Research Institutions	19	31.67	
7.	Printed literature	18	30.00	VII

Table 2. Constraints faced by shrimp farmers of Nagapattinam, in shrimp culture (n=60)

S. No.	Information Source	Number	Percent	Rank
1.	Disease Incidence	56	93.33	I
2.	Poor quality of seeds	54	90.00	II
3.	Price fluctuations and lack of information on market prices	50	83.33	III
4.	Lack of co-operation among fellow farmers	47	78.33	IV
5.	Lack of quality control agencies	45	75.00	V
6.	Lack of credit and insurance facilities	44	73.33	VI
7.	Lack of government support	43	71.66	VII

* Multiple responses and hence percentage may exceed 102.

Table 3. Suggestions offered by the respondents to overcome the constraints in shrimp culture

S. No.	Information Source	Number	Percent	Rank
1.	Setting up of disease diagnostic centres in each district.	57	95.00	I
2.	Provision for creation of seed certification agencies	54	90.00	II
3.	Creation of market intelligence cell in state fisheries department as well as communication of day to day information of price, through mass media.	52	86.67	III
4.	Setting up of quality control agencies to regulate the quality of chemicals	50	83.33	IV
5.	Strengthening shrimp farmers associations; and formation of aqua clubs	48	80.00	V
6.	Government support in the form of credit and insurance facilities	45	75.00	VI
7.	Lower tariff rates for electricity	42	70.00	VII
8.	Changing the status of shrimp culture from that of industry to agriculture.	28	46.67	VIII

* Multiple responses and hence percentage may exceed 100.

80.00 per cent of the respondents. Joint disease management, water management war rants the co-operative efforts of all the neighboring farmers in order to maintain a healthy crop. This co-operative effort can be promoted only through shrimp farmer's association. Although at present there is a registered shrimp farmers association called "Nagapattinam Aqua Farmers Association" in the study area, the active involvement of the member farmers is lacking. Setting up of Aqua clubs on the lines of Andhra Pradesh state can be taken up for co-operative action in respect of water intake, and water release.

The sixth important suggestion was the support of the government in the form of credit and insurance facilities given by 75.00 per cent of the respondents. Such facilities were given initially by Nationalised banks like NABARD, and government insurance agencies, but later stopped due to poor repayment and false claims of crop loss. Lower tariff rates for electricity was a suggestion offered by 70.00 per cent of the respondents. This might be because a lot of expenditure was incurred by way of operation of pump sets, and for setting up of lighting facilities in the farm during night, to avoid theft and pilferage. Lastly it could

be observed from Table 3 that 46.67 per cent of the respondents wanted to change the status of shrimp culture from that of an Industry to that of agriculture. This could be because of the Supreme Court decision of 1996 conferring on shrimp culture, the status of an industry, thereby restricting aquaculture operations within the coastal regulation zone. The supporters of shrimp aquaculture would prefer to consider the status of agriculture for shrimp because agricultural activities are not prohibited within the CRZ and besides the shrimp farmers want to avail of benefits like tariff reduction in electricity or free electricity which is available to agricultural sector in states like Andhra Pradesh.

Conclusion

It could be inferred from the study that the private consultants were mainly graduates in fisheries science and they represented the private extension service. These consultants visited the Shrimp farms regularly and offered all round technical assistance on the package of practices to be followed for Shrimp culture. Due to their proximity easy accessibility and trust worthiness, they were the primary credible sources of information for Shrimp farmers. The fellow farmers were rated as the third important source of information, since they passed the information to their press by word of mouth. The government sources such as the State Department of fisheries came only next in order. The farmers were of the view that the research institutions, government departments and subject matter specialists were difficult to access, and hence they were unable to utilize them effectively for technical information. The extension wing of the state fisheries department should be revamped and more number of technically qualified and trained personnel should be appointed at the grass root level to render timely and important information the Shrimp farmers. As far the constraints expressed by the Shrimp farmers were concerned the government should undertake the setting up of disease diagnostic centers in each district, followed by setting of seed certifying agencies and quality control agencies for regulating the quality of chemicals. The experiences of the government in the agriculture sector such as use of quality control accreditation methods such as Agmark, setting of market information cells, and provision of free electricity can be suitably examined and emulated for the benefit of the Shrimp industry also.

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Scale to measure beneficiaries' attitude toward watershed crop production technology (WCPT)

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Abstract

The present study was taken up to develop a score to measure attitude towards Watershed Crop Production Technology (WCPT). The final format of the scale to measure attitude of farmers towards WCPT consisted of the 20 statements. It is statistically inferred that the judges/experts were equally consisted about the content/subject of the present study. The validity and reliability of the scale were significant. While, executing the scale to the 200 respondents, it was found that majority of the beneficiaries possessed moderately favourable attitude towards WCPT.

Keywords : Attitude, validity, reliability, item analysis, beneficiary

Introduction

The Government of India has launched the centrally sponsored scheme "National Watershed Development Project in Rainfed Areas (NWDPRA) in the year of 1987-88. As the scheme is continued since last 19 years, it was felt necessary to know the attitude of beneficiary farmers towards watershed crop production technology. Attempt has therefore been made to develop a scale to measure beneficiaries' attitude towards Watershed Crop Production Technology (WCPT).

Attitude scales have been proved to be useful tools to measure the attitude of large number of individual towards specific areas. The success or failure of many social reforms or development projects would mainly depend upon the people's attitude towards it. Thurstone (1) defined an attitude as the degree of positive or negative association with some psychological object.

Methodology

As a corollary of this and non-availability of suitable scale, the investigator inspired to develop a standardized scale to measure the attitude of beneficiary farmers towards WCPT. An attitude scale was developed by researcher using Likert's summated rating technique (2).

Development of attitude scale

Two major components *viz.*, soil and water conservation technologies and crop production technologies of WCPT related to the problem were identified with the help of literature. This two components formed total matter of WCPT towards which attitude of the beneficiary farmers was determined.

Item collection

A large number of items specifying each of the two major components of WCPT were collected with the help of literature, discussion with subject matter experts as well as office bearers and personnel involved in implementation of the project. Atentative list of items for each of the major component was prepared keeping in mind the suitability of items to the area of study. Items were screened in the light of criteria suggested by Thurstone (1).

Classification of items

The items were developed in such a way that they expressed the positive or negative attitude. Afive point scale of attitude measurement was used, ranging from 'Strongly agree' to 'Strongly disagree.'

The items collected regarding each of the major components of WCPT were then distributed to 20 judges consisting of extension and technical personnel working under watershed programme. They

were asked to check each of the items very carefully and minutely for being favourable or unfavourable attitude towards WCPT. They were also requested to check whether each of the selected items were easy to understand. Further, they had a liberty to make any modification or suggest any change in each item. After receiving the criticism and comments from the judges, finally a total number of 32 items were retained. Efforts were made to select equal number of items indicating favourable and unfavourable attitude.

Item selection

Item analysis is the next phase for selecting the important items to construct a precise scale. To do so, 32 items were administered to the group of 121 judges involving extension experts and technical personnel working under watershed programme in various parts of the country. The judges were asked to respond to each statement in terms of their own agreement or disagreement on a five point rating method, *viz.*, strongly agree, agree, undecided, disagree and strongly disagree. For favourable statement, the strongly agree response was given a weight of 5, the agree response a weight of 4, the undecided response a weight of 3, the disagree response a weight of 2 and strongly disagree response a weight of 1. For unfavourable statements, the scoring system was reversed. The response from 76 judges was received of which, response of 68 was considered as eight being incomplete. For each judge, a total score was obtained by summing the score for the individual item. For the purpose of item-analysis, 17 subjects with the highest total score and also 17 subjects with the lowest total score *i.e.*, 25 per cent each were selected. These two groups provided the criterion group in terms of which item analysis was conducted. The response of the high and low group to each statement was then analyzed by working out T value. Twenty statements with significant T value were selected and given in Table1.

Table 1. A scale to measure farmers' attitude towards Watershed Crop Production Technology (WCPT)

Sr. No.	Attitudinal statements
1.	Watershed crop production technology (WCPT) are easy to understand (+)
2.	In developing WCPT, farmer's suggestions are not incorporated (-)
3.	In WCPT, indigenous knowledge have no place (-)
4.	WCPT are less practicable for the farmers in their local situation (-)
5.	WCPT encourages dry land farmers to take proper care of degraded soil (+)
6.	Spending money for soil and water conservation in dry land is wasteful (-)
7.	Contour bunding is easy and useful technique to prevent soil erosion (+)
8.	Gully plugging is a costly affairs (-)
9.	Farm pond is useful for dry land farmers under low rainfall condition (+)
10.	Farm pond is not feasible in sandy soil due to leaching of rain water (-)
11.	Well recharging is feasible (+)
12.	Well recharging requires many labours demanding high cost (-)
13.	During initial stage WCPT could not give any return to the farmers (-)
14.	The certified fruit plants are easily available (+)
15.	Planting of forest plants in wasteland has increased the income of farmers (+)
16.	WCPT have made it possible to cultivate at least, a single crop under drought condition (+)
17.	Contour vegetative hedges are difficult to raise (-)
18.	The grass production has increased due to adoption of WCPT in pasture land (+)
19.	WCPT are suitable only for the farmers having irrigation facilities (-)
20.	Only those farmers having tractor and other costly implements can adopt the WCPT (-)

The Farmers' attitude toward each statement shall be majored on five point continum viz. Strongly Agree, Agree, Undicided, Disagree and Strongly Disagree with the scores of 5, 4, 3, 2 and 1 respectivaly for positive statement. In case of negative statement the scoring Procedure will be reversed.

Reliability of the scale

Test - retest technique was used for measuring the reliability of the scale. The scale was administered to the group of 20 non-sampled respondents and later on the same scale was repeated after a gap of 15 days to the same respondents. The score obtained from the two applications of the same scale was compared by means of correlation coefficient. The calculated value of correlation coefficient was 0.7902 which was significant at 0.01 level of significance. Thus, the scale was found to be reliable.

Validity of the scale

The content of the scale was developed from a large number of items and experts' opinion. Thus, it was assumed that the scores obtained by administering the attitude scale of this study will measure what was intended to measure. Further, the T value was significant for all the 20 items finally selected. Hence, it was assumed that the scale was valid. The scale is appended as Table 1.

Application of the scale

The scale consisted of 20 statements was administered to 200 beneficiary farmers. They were asked to exerts their reaction in terms of their agreement or disagreement with each item by selecting any one of five response categories; *viz.*, strongly agree, agree, undecided, disagree and strongly disagree. The scores given for the positive statements were 5,4, 3, 2 and 1 respectively. For negative statements the scoring procedure was reversed. The total attitude score for each respondent was obtained by adding the weights of his responses made to the different scale items.

Beneficiaries' attitude

The data pertaining to beneficiaries' attitude toward Watershed Crop Production Technology is presented in Table 2.

Table 2. Distribution of the respondents according to their level of attitude towards WCPT

Sr. No.	Level of attitude	Frequency	Per cent
1.	Less favourable (Up to 38 score)	29	14.50
2.	Moderately favourable (39 to 67 score)	132	66.00
3.	High favourable (Above 67 score)	39	19.50
	Total	**200**	**100.00**

Mean ($\bar{X}$) = 52.5150; S.D. = 14.3932

Table 2 shows that 66.00 per cent respondents had moderately favourable attitude towards WCPT. On the other hand, 19.50 and 14.50 per cent respondents had highly favourable and less favourable attitude towards WCPT, respectively.

Conclusion

The final format of the scale to measure the attitude of beneficiary farmers towards Watershed Crop Production Technology (WCPT) consisted 20 statements. It is statistically inferred that the judges/ experts were equally consistent about the content/ subject of the present study. The validity and reliability of the scale were highly significant. While executing the scale to the 200 respondents, it was found that majority of the beneficiaries possessed moderately favourable attitude towards Watershed Crop Production Technology.

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Seroprevalence of bovine brucellosis in semi-arid zone of North Gujarat

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Abstract

A total 436 bovine serum samples were screened for antibodies against *Brucella abortus* using dot-ELISA, RBPT, MPAT and STAT. The overall seroprevalence of brucellosis in bovine was 9.40 per cent detected by dot-ELISA. Rural picture studied by MRT covering 464 villages of Banaskantha district showed 13.79 per cent incidence of the disease.

Keywords : Seroprevalence, bovine, brucellosis

Introduction

Brucellosis is an important infectious zoonotic disease of farm animals, that inflicts economic losses in dairy animals. The losses incurred due to reproductive disorders and reduced production. The seroprevalence of brucellosis has been studied in different states of India (1, 2,3, 4, 5). The present study was conducted with an aim to determine serological status of bovine brucellosis in the semi arid zone of North Gujarat.

Materials and method

The study covered screening of 436 bovine sera sample (229 from cattle and 207 from buffaloes) collected from different parts of semi arid region of North Gujarat as well as pooled milk samples from 464 villages of Banaskantha district of North Gujarat which included 346 cow milk and 458 buffalo milk samples. Serological tests are the most widely used method for the diagnosis of Brucella infections, since bacterial isolation techniques is a tedious and time taking process (6). The serum samples were subjected to standard procedures viz, dot-Enzyme Linked Immunosorbent Assay (dot-ELISA) (7), Rose Bengal Plate Agglutination Test (RBPT) (8), Microtitre Plate Agglutination Test (MPAT), Standard Tube Agglutination Test (STAT) (8) and Milk Ring Test (MR/I) (8).

Brucella abortus plain antigen, colored antigen and MRT antigen were procured from the Institute of Animal Health and Veterinary Biological, Hebbal, Bangalore. The litres were expressed in International Unit (I.U). The animals with STAT and MPAT titre of 40 IU and above were considered positive. Standard protocol of the dot-ELISA kit provided by the manufactures was followed.

Results and discussion

In the present study, the positivity of brucellosis as detected by dot-ELISA, RBPT, MPAT and STAT was 10.90 , 8.29, 6.98 and 6.11 per cent, respectively in cattle and thatjn case of buffalo was 5.31,4.83,4.34 and 7.72 per cent, respectively. Test wise, species wise and sex wise prevalence found were mentioned in the table 1.

Out of 804 pooled milk samples collected from 464 villages, 69 were found positive by MRT giving incidence of bovine brucellosis to be 8.59 per cent in Banaskantha district. The rural scenario of the infection in the dairy animals of Banaskantha district by MRT showed that 13.79 per cent villages were found affected. Detailed results are given in table 2 and 3.

In present study seroprevalence in cattle and buffaloes was found to be 10.90 and 7.72 per cent, respectively by dot-ELISA. Similarly Sethi and Singh (9) reported 11.29 per cent cattle and 7.20 per cent buffaloes were positive for brucellosis in Uttar Pradesh. The findings of the present investigation were are in close agreement with observations of Nawathe and Bhagwat (10) as well as Batra and Agrawal (11), who reported 9.70 per cent and 7.99 per cent prevalence in bovine populations. However higher prevalence of 15.37 per cent in bovines was reported by Sharma *et al.*(12). In present study sero prevalence of 20.8 per cent was

Table 1. Seroprevalence of brucellosis in cattle and buffaloes

Species	Sex	Total No. of serum samples tested	Number of sera found positive by			
			dot-ELISA	RBPT	MPAT	STAT
Cattle	Female	223	24 (10.76)	18 (8.07)	15 (6.72)	13 (5.82)
	Male	6	1 (16.66)	1 (16.66)	1 (16.66)	1 (16,66)
	Total	229	25 (10.90)	19 (8.29)	16 (6.98)	14 (6.11)
Buffalo	Female	189	12 (6.34)	8 (4.23)	7 (3.70)	7 (3.70)
	Male	18	4 (22.22)	3 (16.66)	3 (16.66)	2 (11.11)
	Total	207	16 (7.72)	11 (5.31)	10 (4.83)	9 (4.34)
Overall	Female	412	36 (8.73)	26 (6.31)	22 (5.33)	20 (4.85)
	Male	24	5 (20.8)	4 (16.66)	4 (16.66)	3 (12.50)
	Total	436	41 (9.40)	30 (6.88)	26 (5.94)	23 (5-27)

* Figures in parentheses indicate percent values

Table 2. Prevalence of brucellosis in dairy animals detected by Milk Ring Test

Total number of villages	Total number of milk samples	Species						Overall prevalence	
		Cattle			Buffalo				
		Number tested	+ve	Per cent	Number tested	+ve	Per cent	Number tested	Per cent
464	804	346	44	12.71	458	25	5.45	69	8.58

Table 3. Rural status of brucellosis detected by Milk Ring Test

Total No. of villages tested	Number of villages found positive	Per cent
464	64	13.79

observed in male bovine which was higher than earlier report of Sharma *et al.* (12) who noted 1.3.84 per cent infection in males. This might be due to smaller sample size of male animals in the present work. Looking to the infection rate in female bovine findings of Sharma *et al.* (12) were quite higher (16.19 %) than the present results (8.73 %). This is a good sign for people dwelling in Banaskantha district of Gujarat as milk is considered to be the chief cause for human cases of brucellosis in the community.

Comparative low prevalence of 8.58 per cent of rural brucellosis on the basis of MRT test in Banaskantha district of North Gujarat was observed. Gumer *et al.* (13) recorded that 15.46 per cent milk samples in Punjab State were positive in one study whereas Maickam and Mohan(14) found 10.00 per cent posi-tivity of the infection by MRT in Coimbatore district of Tamil Nadu. The probable reason for low prevalence in the present study may be due to scientific management and hygienic practices in dairy husbandry fields.

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Sulphur-Phosphorus interactions on yield and their utilization by mustard

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Among various oil yielding crops grown in India, mustard occupies a prominent position. The average yield of mustard is low in India (9.94 q ha^{-1}). The main causes for low production are large acreage under of marginal lands, which a deficient in major nutrients and imbalanced nutrient management. The highest levels of P application on a deficient to marginal soil under irrigated conditions not only improves grain yield of mustard but also enhances its S requirement. Sulphur fertilization improves both yield and quality of crops. Sulphur and phosphorus fertilizers were found to have an antagonistic effect on yield and uptake of S and P by moong (1). On the other hand a strong synergistic relationship between P and S in wheat was observed by Kumar and Singh (2). Recent studies have show that the nature of P - S relationship depends on their rates of application and crop species (3, 4). It can be synergistic at low moderate levels of P application and antagonistic only at high rates of P usually at 60 or more kg P_2O_5 ha^{-1} for field crops (5).

A field experiment was conducted at Anand during *rabi* season of 1995 - 96 in factorial randomized block design on an alluvial soil *(Ustocrept)* testing pH - 8.16, Low available N (164.64 kg ha^{-1}), medium available phosphorus (19.06 kg ha^{-1}) and potassium (235.00 kg ha^{-1}) and deficient in available sulphur (14.00 ppm). All possible combinations of three levels of P (0, 25 and 50 kg P_2O_5 ha^{-1}) and three levels of S (0, 20 and 40 kg ha^{-1}) were applied through DAP and gypsum respectively. At maturity, the plants were harvested, dried and grain weight recorded. Grain samples were digested in a di-acid mixture (HNO_3 + $HClO_4$) and total P in the digest was determined by Vando-molybdate phosphate yellow colour method (6) and total S was determined turbidimetrically (7).

Application of successive rates of fertilizer P upto 50 kg ha^{-1} increased the seed yield of mustard significantly. Individual application of 20 and 40 kg S kg ha^{-1} resulted on a significant increase in seed yield. When P and S were applied together seed yield increased further and the highest yield of 19.77 kg ha^{-1} was obtained with the combined application of 50 kg P_2O_5 ha^{-1} and 40 kg S ha^{-1}. The interaction was favourable at lower rates of P. Similar combined effect of P and S also reported by Joshi *et al.*, (8).

Interaction effect of P x S was significant in influencing P uptake by seed. A combination of P_2S_2 resulted in significantly higher P uptake by seed than rest of the combinations. Maximum P uptake of 16.79 kg ha^{-1} by seed was obtained under P_2S_2 combination. These findings are in accordance with the one reported by Desai (9) and Patel (10).

Table 1. Effect of P and S on seed yield and uptake of P and S by mustard

S rates (kg ha^{-1})	Seed yield (q ha^{-1})								
	P rate (kg ha^{-1})			P rate (kg ha^{-1})			P rate (kg ha^{-1})		
	P_0	P_{25}	P_{50}	P_0	P_{25}	P_{50}	P_0	P_{25}	P_{50}
S_0	11.84	12.85	12.29	8.16	9.49	9.96	16.41	18.10	17.42
S_{20}	13.66	14.91	15.52	9.68	11.31	12.90	21.66	23.36	25.12
S_{40}	17.46	17.72	19.77	12.53	13.62	16.79	29.19	30.11	33.96
CD at 5%		0.26			0.36			0.78	

The combined effect of P x S on S uptake by seed was found significant. The highest S uptake (33.86 kg ha^{-1}) by seed was observed under P_2S_2 and that of the lowest S uptake (16.41 kg ha^{-1}) was noted under no application of P and S (P_0S_0) combination. Similar results were also noted by Joshi and Seth (11) and Kumar and Singh (2) in loamy sand soil.

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Short communication

Integrated nutrient management using zinc enriched manures and fertilizer on yield and nutrient uptake by fodder maize

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Integrated nutrient management means the supply of plant nutrients through the mixing of organic manure and chemical fertilizers. The role of integrated nutrient management is very important particularly in fodder maize ecosystem. Integrated nutrient management maintains soil fertility and adjusts the supply of plant nutrients at an optimum level to sustain the desired crop productivity acquiring benefits from all possible sources of plant nutrients in an integrated manner. The process of enrichment of organic manures with nutrients not only enhances the use efficiency of applied nutrients but improving the soil organic matter and maintaining soil fertility (1). Nutrient uptake data, a valuable estimate of the nutritional requirement of crop under varying soil and climate conditions necessarily would help in formulating a sound fertilizer management schedule for realizing high crop productivity.

A pot experiment was conducted at the Department of Agriculture Chemistry and Soil Science, B. A. College of Agriculture, Anand, Gujarat during summer 2002. The soil (Horticulture farm) is alluvial in nature, light brown in colour and locally known as *Goradu* soil. The texture is loamy sand (Typic Ustochrept) in Inceptisol. The soil is deficient in Av. P_2O_5, K_2O. All the fertilizer and manurial treatments were given to pots as per the requirement. The source used for different nutrients were urea, DAP, ammonium sulphate and zinc sulphate in different treatment combinations. After giving the treatments, 6-8 seeds per plot of maize variety (Gujarat Maize-3) were sown in each pot and irrigation was given immediately through deionized water. The crop was harvested at flowering stage. Immediately after harvest, green fodder yield per pot were recorded. The stored plant samples were subjected to further chemical analysis.

It was observed from the data presented in table that the green fodder yield of maize was significantly higher under T_6 and was at par with T_{13}, T_{14} and T_{19}. The increase in green fodder yield due to Te treatments was to the tune of 39.55 per cent over control (T_1). Similar results of application of enriched manures on yield have been reported by Devarajan and Krishnasamy (2).

The uptake of N, P, K, S and Zn on fodder maize were significantly influenced by various levels of Zn enriched organic manures and other treatments and varied from 170.0 to 464.3 mg pot^{-1} for nitrogen, 60.67 to 89.78 mg pot^{-1} for phosphorus, 197.88 to 452.74 mg pot^{-1} for potassium, 31.20 to 74.25 mg pot^{-1} for sulphur and 0.74 to 2.57 mg pot^{-1} for zinc, respectively.

Maximum N, P, K, S and Zn removed by fodder maize under T_6 treatment, was significantly highest over the rest of the treatments. Similar results were reported for nitrogen (3, 4), phosphorus (5), potassium (6), sulphur (7) and for zinc (8, 9).

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Table 1. Effect of zinc enriched organic manures and other manorial treatments on green fodder yield and nutrient uptake by maize

Treat. No.	Treatment description	Green fodder yield (gm)	Uptake (mg P pot^{-1})				
			Zn	N	P	K	S
T_1	RDF	132.33	0.74	170.03	60.67	197.98	31.20
T_2	RDF+ Zn 25	145.67	1.54	222.52	65.13	299.27	52.67
T_3	RDF+SO_4 equivalent to Treat. No. 2	136.67	0.91	199.79	66.58	222.37	49.75
T_4	$^1/_2$ N- IF + $^1/_2$ N FYM E-with Zn 25	155.33	1.69	351 .72	73.93	344.70	58.31
T_5	$^1/_2$ N- IF + $^1/_2$ N CC E-with Zn 25	140.67	1.76	309.03	62.91	318.96	50.18
T_6	$^1/_2$ N- IF + $^1/_2$ N PM E-with Zn 25	184.67	2.57	464.26	89.78	452.74	74.25
T_7	$^1/_2$ N- IF + $^1/_{2_2}$ N BGS E-with Zn 25	159.67	1.90	351 .76	70.99	347.72	53.74
T_8	$^1/_2$ N- IF + $^1/_2$ N FYM E-with Zn 12.5	154.67	1.49	299.88	68.54	315.28	43.86
T_9	$^1/_2$ N- IF + $^1/_2$ N CC E-with Zn 1 2.5	152.33	1.69	264.00	66.89	310.13	45.00
T_{10}	$^1/_2$ N- IF + $^1/_2$ N PM E-with Zn 1 2.5	160.00	1.96	367.06	76.56	362.23	51.46
T_{11}	$^1/_2$ N- IF + $^1/_2$ N BGS E-with Zn 12.5	154.67	1.75	317.00	71.46	329.08	44.63
T_{12}	$^1/_2$N- IF + $^1/_2$N FYM + Zn 25	160.67	1.39	284.39	68.69	311.09	42.26
T_{13}	$^1/_2$ N- IF + $^1/_2$ N CC + Zn 25	170.00	1.79	289.14	75.39	338.93	47.71
T_{14}	$^1/_2$ N- IF + $^1/_2$ N PM + Zn 25	169.67	1.91	344.49	74.96	356.75	48.39
T_{15}	$^1/_2$ N- IF + $^1/_2$ N BGS + Zn 25	171.00	1.81	278.77	72.95	351 .55	46.83
T_{16}	$^1/_2$N- IF + $^1/_2$ N FYM	153.33	1.23	238.57	73.33	280.86	39.78
T_{17}	$^1/_2$N-IF + $^1/_2$NCC	156.67	1.22	238.76	74.35	291 .56	41.42
T_{18}	T $^1/_2$ N- IF + $^1/_2$N PM	153.33	1.53	262.81	76.01	297.39	43.01
T_{19}	$^1/_2$ N- IF + $^1/_2$ N BGS	151.33	1.26	209.10	69.32	262.40	38.27
	SEm±	5.84	0.13	22.30	4.58	19.58	3.46
	CD at 5 %	16.74	0.37	63.93	13.12	56.11	9.91
	C.V. %	6.49	14.29	13.44	11.09	10.75	12.61

RDF= Recommended Dose of Fertilizer
PM= Poultry Manure
E= Enriched with 25/12.5 kg $ZnSO_4$

FYM = Farm Yard Manure
BGS = Biogas Slurry

CC = Castor Cake
IF = Inorganic Fertilizer

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Short communication

Vulvo-vaginal occlusion in a pregnant crossbred heifer - A case report

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In cattle dystocia results due to the various developmental defects of genital organs. Double cervix, fibrous band in the vagina or cervix, constricted hymen, infantile, hypoplastic, small vulva are some of the developmental defects resulting in dystocia. However, failures to separate the vulvar lips are rare and hence the present case is reported.

Case History

Twenty-three months old Kankrej x HF crossbred heifer with 8 months pregnancy was presented at the clinical camp, organized by Sabar Dairy, Sabarkantha District Co-operative Milk Producers' Union Ltd. at Adpodra village of Sabarkantha District. The history revealed that since birth the vulvar lips were fused. However, due to the space available in a form of small one finger sized opening at the ventral commisure of vulvar lips, the animal could urinate without difficulty. Artificial Insemination was carried out through the same opening before 8 months by AI technician. Animal was diagnosed as pregnant by per-rectal examination at 2.5 months of gestation. The owner presented the cow to separate the fused vulvar lips surgically so as to prevent the basic cause of dystocia at the time of parturition.

On clinical examination it was found that both the vulvar lips were adhered leaving a small opening at both ventral and dorsal commisure (Fig. 1) Animal was otherwise healthy and active with 8 months of pregnancy.

Fig.1. Figure showing the fused vulvar lips leaving a small opening at dorsal and ventral commisure

Surgical Management

The perineal area was prepared aseptically for surgical interventions. Epidural anesthesia was achieved by injection of 4 ml. of 2% lignocaine hydrochloride solution at sacro-coccygeal space. Artificial Insemination sheath was inserted between the two opening and margin of fusion was identified. A sharp vertical incision with the help of BP blade was made on the fusion line keeping the finger inside for guide. After dissecting with scissor the patency of vagina with the vulvar opening was established. The mucous membrane and skin portion of each vulvar lip was identified and sutured together using cotton thread by simple interrupted sutures after instilling antibiotic powder. The end of three sutures on each vulvar lips were left long enough so as to facilitate fastening of the gauze piece at the end of suturing. The vaginal cavity was flushed with antiseptic solution (20 ml of povidone iodine mixed in 500 ml of normal saline). Finally the gauze piece was fastened to the long ends of cotton thread so as to prevent the close proximity of recently operated area. (Fig. 2).

Inj. long acting Tetracycline-30 ml, i/m, inj. Meloxicam-10 ml., i/m and inj. Pheneramine

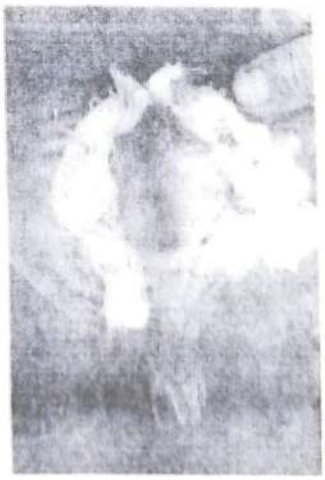

Fig.2. Showing the patency of vulva and vagina and application of gauze piece after surgical correction.

melate-10 ml, i/m was injected. Owner was advised for daily dressing of surgical wound. The sutures were removed at 10th day post-operative and uneventful healing was noticed. Animal delivered normal male fetus after the completion of gestation period by the normal delivery. The placenta was expelled within 2 hrs. post-partum.

Atresia of vulva has been described by Noakes *et al.* (1) as a cause of dystocia in Frisian and jersey heifers. Mohammed *et al.* (2) reported a completely closed vulva and vaginal opening in a month old nondescript female calf. They have also separated the lips surgically and observed normal healing forming the patent vulva and vagina.

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Short communication

Occurrence of *E. coli* in poultry farms

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Escherichia coli is a component of gut flora of man and animals including birds. Escherich isolated organisms from infant faeces for the first time in 1885, hence the generic name *Escherichia* was given to this bacteria. Majority of *E. coli* strains are harmless but some have pathogenic potential. In young animals and in birds systemic colibacillosis is a chief state of disease whereby the organism invades various tissues to cause infections of lower respiratory tract and other vital body organs. The present study was conducted in Banaskantha District of Gujarat to assess the presence of E. *coli* on poultry farms as well as poultry meat specimens collected from meat shops in Palanpur, the Head Quarter of the district. The investigation was carried out in the laboratory of Veterinary Public Health department, College of Veterinary Science & Animal Husbandry, S. D. Agricultural University, Sardarkrushinagar.

After aseptic collection of samples, they were brought to the departmental laboratory on the same day maintaining cold chain. Primary isolation of *E. coli* was made on Mac Conkey Agar (MCA), whereas Eosin Methylene Blue (EMB) agarwas used as a selective medium. The standard procedures as described by Edwards and Ewing (1), Cruickshank *et al.* (2) and Quinn *et al.* (3) were used during the investigation.

All the samples were initially inoculated on MCA and incubated at 37°C overnight. Smears from lactose fermenting isolates were stained with Gram's staining method and observed under medical microscope for morphology of the organisms. The lactose fermenting colonies from MCA plates were picked up and sub-cultured on EMB agar to view nucleated metallic sheen which is an identification feature of *E. coli* organisms. The cultures thus obtained were stored in Brain Heart Infusion (BHI) slants for further studies. Subsequently, to find the presence of highly pathogenic food borne serotype O157: H7 among the cultures showing metallic sheen on EMB agar isolated from meat samples, isolates were inoculated on MUG EC O157 agar. Total 444 samples were collected from 45 poultry farms as well as 11 poultry meat shops.

Table 1 and 2 present the findings of isolation and identification practiced on 444 samples collected from 45 poultry farms as well as 11 poultry meat shops.

Table 1. Isolation of *E. coli* from different sources

Sources			Total poultry farm and meat shops	Number of samples processed		Number found sample positive	
Sample collection	Number of samples	Sample collection		Farm	Meat shop	Farm	Meat shop
Sample brought once	30	8	38	236	64	23	30
Sample brought repeatedly	15	3	18	120	24	35	10
Total	45	11	56	356	88	58	40

Table 2. Isolation of E. *coli* from sample processed

Sr. No.	Type of sample	Total number	Positive sample number
1.	Water	56	02
2.	Equipment washing	56	20
3.	Hand washing	56	08
4.	Litter	56	15
5.	Feed	56	05
6.	(a) Saw scrapping	11	03
	(b) Farm soil	45	04
7.	(a) Market meat	22	12
	(b) Autopsied organs	90	29
	Totals :-	**444**	**98**

E. coli recovered from 60 per cent autopsied organs of poultry as well as 40 per cent poultry meat specimens. During the study a total of 98 samples yielded E. *coli,* which included 2 water samples, 20 equipment washings, 8 hand washings, 15 samples of litter, 5 samples of poultry feed, 3 saw scrapings, 4 samples of farm soil, 12 specimens of poultry meats and 29 autopsied organs. Earlier studies' reports included that of Hojovec and Fiser (4) who isolated the pathogen from dust deposits in broiler houses; Arunachalam *et al.* (5) from organs like heart, liver, intestine; Kulshrestha and Kumar (6) from respiratory tract lesions and heart blood and Blanco *et al.* (7) recovered *E. coli* isolates even from healthy chicken. The findings envisaged that healthy birds as well as farm environment play important role in transmission of such infections if care is not taken in the farm hygiene. Proper hygienic measures should be observed to limit such infections on farms.

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