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Breeding cowpea for disease resistance

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Abstract

Cowpea is a all pervasive crop grown on around 15 m ha of area mainly in South Africa. Nigeria, Brazil and India. About five dozens diseases caused by fungi, viruses, bacteria and nematodes are one of the major impediments in enhancing cowpea production. Among these, cowpea mosaic virus, *anthracnose, cercospora* leaf spot and bacterial leal blight are widely spread dreaded disease. Empirically the seed yield in cowpea may be bogged down by different restrictions that may be explained with 4's of productivity; Absolute. Attainable. Affordable and Actual. The breeding for disease resistance aims at sustainability and affordability by reducing the gap between the attainable and actual yield. Therefore, breeder's job is just like hitting a moving target to enhance and sustain the incompatible relationships of host and pathogen in ever changing milieu among them. Every disease is peculiar and warrants breeding methodology and screening techniques on its merit. The screening methods may comprise artificial inoculations or creation of artificial epiphytotic conditions either under field or laboratory / glass house conditions. Germplasm collections comprising wild, old / new varieties and new promising breeding materials can serve as potent sources of resistance. Different breeding methods like selection, back cross breeding, mutation breeding has proved effective in imparting resistance in cowpea. However, the choice of breeding method hinges entirely on type of gene action that in turn is quite subjective to the breeding materials in hand. Potential donors evincing incompatible relationships have been idenfied for incorporating and pyramiding genes for multiple and durable resistance. For the genetic enhancement of disease resistance in cowpea, the augmentation, characterization and utilization of available germplasm for precise identilication of donors / linked traits for resistance to diseases may play a pivotal role. For this, reliable efficient screening techniques inclusive biotechnological interventions need crop specific honing up.

Key words : Cowpea, screening techniques, disease resistance

Introduction

Cowpea [*Vigna unguiculata* (L.) Walpers.] has multifarious utilities with every part having one or the other use as food, feed, fodder, vegetable and soil fertility enhancing component. Consequent up on one forth of the seed constitutions comprises protein besides containing important minerals (Ca, P and Fe) and vitamins [ß-carotene, thiamine, riboflavin, vitamin-A, niacin, folic acid and ascorbic]; the seed may be termed as "live nutrition tablet" for alleviating malnutrition with out any side effects. It is grown in over 65 countries on over 15 m ha with around half of the acreage in Africa. South Africa, Nigeria, Brazil and India are the major cowpea growing countries.

Diseases are one of the major impediments in enhancing cowpea production. About five dozens diseases caused by fungi, viruses, bacteria and nematodes attack cowpea. Among these, cowpea mosaic virus, anthracnose, cercospora leaf spot and bacterial blight are wide spread while others like the one inflicted by nematodes are of local occurrence. These diseases perpetuate in varying degrees every year and cause huge quantitative and qualitative losses. Diseases spread has always been subjective bearing immense significance in selection of screening techniques. whereas diseases like bacterial blight and mosaic complex are seed borne, they may be spread through air borne insect vectors too. Contrarily leaf spots are in general spread by air borne spores. The *modus operandi* of disease development can be simulated to the subjective area of a triangle with host, pathogen and environment as the three sides of the triangle. It can be appreciated that the three sides are the prerequisite for the very

existence of a triangle and disease is the function of the length of its sides. Initial inoculums (X_0), rate of multiplication [r] and time [t] are three components of inoculums build up. As the resistant genotypes restrict all these components, it can be conclusively held out that breeding for resistant varieties have not only predominantly contributed to enlarging production bowl of cowpea but also has equally kept the pathogens under leash that otherwise could have taken toll on anything susceptible available.

Empirically the seed yield in cowpea is the function of variety, soil, water, package technology and the weather conditions. However, on plant basis it is the function of pods/plant, seeds/pod and seed weight. On ground realities, the yield may be bogged down by different restrictions that may be explained with 4A's of productivity; Absolute (no limiting factor except genetic potential), Attainable (limit is imposed by environmental conditions), Affordable (impose economic restrictions) and Actual (the limit imposed by pests/diseases & such other hazards). The basic focus of the any breeding programme should aim at enhancing the absolute yield. Contrarily the breeding for disease resistance aims at sustainability and affordability by reducing gap between the attainable and the actual yield. On the extreme side of not employing genetic resources adequately to take biotic problems by horns, we might be inviting occasional but potentially devastating epidemics leaving us with no defense, no reserves and no back up prospective. There could be three approaches to thwart epidemics (i) defensive i.e. employing resistant varieties with adequate cultural practice and technologies to prevent the pathogens (ii) offensive i.e. spraying chemicals to control once they evince their existence and (iii) integrated i.e. the combination of two inclusive bio-agents and bio-pesticides for managing them. All these approaches but development of resistant varieties involve massive recurring expenditure besides unmanageable methods, environment pollution and above all the ever looming risk that it might lead to development of resistance in pathogens.

From breeding for disease resistance point of view cowpea as host and the pathogens are two independent genetic systems such that pest tends to maintain more virulent genes and the host tends to acquire genes for resistance in a balanced polymorphic system. As such the threat of genetic vulnerability always loom large due to ever-capricious weather conditions that might trigger cyclic alterations in genetic polymorphism. Disease resistance is the phenotypic expression of the incompatible relationship (VR) between the host and pathogen genetic system; all other combinations (Vr, vR & vr) being compatible and hence evince susceptible reactions. Therefore, breeders' job is just like hitting a moving target to enhance and sustain the incompatible relationships of host and pathogen in ever changing milieu among them. Further every disease is peculiar and warrants breeding methodology and screening technique on its merit.

Breeding for disease resistance in cowpea as in any crop may be accomplished by three mechanisms: (i) *Disease Escape* where in the relationship between the host and parasite does not take place. One or any of the three phases of disease development *viz.* contact, penetration and establishment are avoided or omitted in this mechanism. Development of early varieties, physiological hindrances (thick cuticle, waxy bloom etc) and production of phyto-toxins are some of the examples that can be cited here. (ii) *Disease tolerance* that may be ascribed as ability of the host to withstand the rigors of the pathogen after it has contacted/penetrated/established on the host. (iii) *Disease resistance* is the true genetic endurance/ defense of the host to preclude the pathogenic invasion.

Screening techniques

Screening techniques for disease resistance are pivotal in breeding programme as they facilitate distinguishing resistant plants from the susceptible ones and pseudo/moderately resistant ones from the more resistant ones. The screening methods may comprise artificial inoculations or creation of artificial epiphytotic condition (sick plot) either under field or laboratory /glass house conditions. The hot target spots may also be exploited for rationale screening for disease resistance. For soil borne diseases like root rot, wilt etc; the screening is done in diseases sick plots. For air borne diseases like leaf spot the screening is done either by dusting the spores or by spraying the spore suspension on the healthy plants. Planting of highly susceptible varieties after few rows and on borders of test materials is useful for building ample load of inoculums. In case of seed borne diseases, dry spores are dusted on the seeds or the seeds are soaked in the spore suspension. In case of insect transmitted diseases like cowpea mosaic virus, the insect from susceptible variety may be collected and released on healthy plants.

Identifying sources of resistance

Germplasm collections comprising wild, old/extract/ new varieties and new promising breeding materials can serve as potent sources of resistance. Evaluations of germplasm have suggested that resistance is associated with collections from particular region (1). Characterization of the germplasm lines of cowpea collected from various parts of the country and abroad for different traits inclusive disease resistance evinced that indigenous materials have better potential as donors for disease resistance. 153 lines were completely free from cowpea yellow mosaic virus, cercospora leaf spot, bacterial blight and powdery mildew under field and epiphytotic conditions (2). Further the resistant genes were more common and concentrated in *unguiculata* than *cylindrical*. The donors identified from Gujarat materials and from germplasm elsewhere are presented in Table 1 and Table 2, respectively. Despite exotic materials too have yielded good donors for resistance to various diseases (3). Further, exotic collections from Nigeria, Zimbabwe and USA were found better for aphid resistance and there by indirectly imparting resistance to mosaic complex. Out of 7000 exotic lines characterized for various traits, 719, 685, 537 and 208 were found resistant to at least one, two, three and four diseases, respectively. Out of these 28 lines evinced resistance at target sites too (4). Attempts to mine genes from the other *Vigna* species *(umbellata, mungo, radiata, accontifoli* and *angularis)* have been unsuccessful due to poor crossability. Its crosses with *V. pubescence* and *V. vexillata* have been tried with tissue culture technique too but with limited success. However, its success as also insertion of exotic genes in cowpea genome cannot be ruled out through biotechnology.

Table 1. Donors identified for various diseases of cowpea in Gujarat

Disease	Donor identified
Yellow mosaic virus, Cowpea leaf curl virus, Cowpea aphid borne virus, Root rot and Leaf spot	GC-0011 GC-0012
Yellow mosaic virus and Cowpea leaf curl virus	GC-9714, GC-9732, GC-5, GC-3, TC 99-1
Cowpea aphid borne virus, Leaf spot	GC-5
Cowpea leaf curl virus	GC-102, TC 2000-4
Root rot	GC-9040, GC-125
Cowpea aphid borne virus	GC-3

Table 2. Donors for disease resistance identified from cowpea germplasm

Traits	Donor lines identified
YMV resistance	C 159, C 244, C 355, C 422, C 566, C 685, C 722, C 1018, C 1270, C 1300, C 1308
Leaf blight resistance	C 61, C 269, C 541, C 543, C 648
Leaf crinkle resistance	C 13, C 98, C 192, C 215, C 358
Rust resistance	C 38, C 76, C 370, C 425
Web blight resistance	C 10, C 11, C 49, C 139, C 140

Breeding methodology

The choice of breeding methods hinges entirely on type of gene action that in turn is quite subjective to the breeding materials in hand (5). Genetic studies in cowpea are very scanty. The initial attempts for breeding for disease resistance in cowpea were confined to selection among local materials that resulted in development of materials like C 152, Chharodi, GC 1 etc that were resistant to the prevailing diseases of the region in general and viral diseases in particular. This followed the hybridization phase that resulted in many modern varieties. However, selection method has provided more number of varieties as compared to hybridization mainly because the bud drop and consequent less setting has deterred the breeders from taking up voluminous crossing programme. Back cross has also been used for transferring the desirable resistance gene from exotic donors to the other wise locally adopted genotypes (6). A cowpea variety CB 5 was developed way back in mid forties in California using California Blackeye as recurrent parent and the accession Iron as resistance to root knot nematodes (7). The transfer of dominant gene is relatively easy and quick in the back cross method as the back cross progeny can be detected easily for progressive back crossing to recover the genotype of recurrent parent. However, when the resistance is governed by recessive gene the back cross progenies are selfed in each generation to detect homozygous individuals carrying the recessive gene before giving additional back cross

dose. The efficiency of back cross breeding can be enhanced using natural off-season nurseries or raising the materials in phytotron. The back cross breeding is likely to be more important breeding method than employing exotic materials or wide crosses due to consideration of economic characters and practical difficulties. The SSD method can also be used as an advantage by cyclic bulking of a single seed from each plant and then screening the bulk under target/hot spot location for disease resistance.

Mutation breeding has been quite successful for breeding for disease resistance in cowpea. Both chemical and physical mutagens have churned good number of donors and varieties among which V-16 (Amba), V-38 (Swarana) and V-240 (Rambha) and V 585 (Sampada) are conspicuous for resistance to major fungal, bacterial and viral diseases. They have been developed following DMS (0.8%) treatment to Pusa Phalguni (8). Similarly, a CYMV and cercospora leaf spots resistant variety Cowpea 88 was developed irradiating first generation of Cowpea 74 x H-2 with gamma rays. Mahadevu *et al.* (9) isolated *Pythium* root rot resistant mutants (5% mortality) from cowpea variety KBC 1 (87% mortality) following gamma rays radiation. Similarly an induced mutant tolerant to seed borne mosaic virus diseases was identified by Choulwar and Borikar (10).

Multiple resistance, gene deployment and pyramiding

Several potential donors evincing incompatible relationships have been identified that can be used for incorporating and pyramiding gene for multiple and durable disease resistance (11). The donors for multiple resistance developed at IITA (Table 3) can also be exploited for breeding programme of cowpea improvement.

Genetic enhancement of diseases resistance in cowpea

The augmentation, characterization and utilization of germplasm for identification of donors/linked traits for resistance to diseases may play a pivotal role. For this reliable efficient screening procedures inclusive biotechnological methods need honing. The embryo rescue techniques can be used for gene mining and transfer of disease resistance in cowpea from wild and allied species (12). Selection for disease resistance is a function of congenial environment, which is seldom optimum and hence unreliable. Ascertaining possible morphological and molecular markers for disease resistance will definitely reduce the environmental influence culminating in enhancement of selection efficiency. The indirect selection through markers/MAS in early segregating population can help in the identification of individual plants carrying the trait of interest at initial stages of crop growth (13).

Table 3. Pyramiding genes for disease resistance in cowpea.

Disease	Donors for multiple resistance					
	Ife brown	TVx 3236	IT82D – 716	IT84S – 2246	IT90K – 59	IT90K – 76
Anthracnose	S	R	R	R	R	R
Cercospora	S	R	R	MR	R	R
Bacterial blight	MR	MR	MR	MR	R	MR
Web blight	S	MR	MR	MR	MR	R
Yellow mosaic virus	S	S	R	R	R	R
Aphid borne mosaic	S	S	R	R	R	R
Golden mosaic	R	R	R	R	R	R

R=Resistant, MR=Moderately resistant, S=Susceptible
Source: Singh *et al.* (13)

References

1. **Ahmed, S.T., Magoon, M.L. and Mehra, K.L.** 1972. Screening of a World collection of a cowpea for field resistance to leaf spot and virus diseases, SABRAO Newsl. **4** : 103-106.

2. **NBPGR** 1987. National Bureau of Plant Genetic Resources. Achievements-A Decade (eds; K.P.S. Chandel and B.M. Singh) New Delhi, India. *Sci. Monogr.* 11 pp. 170.

3. **Kumar, D. and Singh, N.B.** 2004. Cowpea in India. Scientific Publishers, Jodhpur, India.

4. **IITA.** 1974. International Institute of Tropical Agriculture Grain Legume Improvement Program. Report for 1973, Ibadan, Nigeria.

5. **Russell, G. E.** 1978. Plant Breeding of Pest and Disease Resistance. Butter-Worths, London, Boston

6. **Ehlers, J.D. and Foster, K.W.** 1993. Introgression of Agronomic characters from exotic germplasm in to blackeye bean. *Field Crops Res.* **35** : 43-50.

7. **Mackie, W.W.** 1946. Blackeye beans in California. Univ. California Agr. Expt. Sta. Bulletin. 696, California.

8. **Kharakwal, M.C., Jain, H.K. and Sharma, B.** 1988. Induced mutation for improvement of chickpea, lentil, pea and cowpea. In : Proceeding of Workshop, Pullmal, 1-5 July, 1986, on Improvement of Grain Legume Production using Induced Mutation, 89-109 Pp. IAEA-Vienna.

9. **Mahadevu, P., Thimmaiah, S.K. and Kulkarni, R.S.** 1998. A pithium rot resistance mutant of cowpea [*Vigna anguiculata* (L.) Walp.] cv. KBC-1. (In.) DAE-symposium on induced mutations and molecular techniques in improving crop productivity and quality. Oral presentation-50. Chennai.

10. **Choulwar, S.B. and Borikar, S.T.** 1986. Induced tolerance in seed borne mosaic virus of cowpea. *J.of Maharastra agric. Univ.* **11** : 244-245.

11. **Sharma, B., Mishra, S.K., Tyagi, M.C. and Choudhary, A.B.** 1999. Cowpea genetic resources. Paper presented at 15th Group Meet of All India Coordinated Projects on Arid Legumes, 28-29, May, 1999, CAZRI, Jodhpur.

12. **Fatokun, C.A. and Singh, B.B.** 1987. Interspecific hybridization between *Vigna pubescens* and *Vigna unguiculata* (L.) Walp, through embryo rescue. *Cell Tissue Organ Cult.* **9** : 229-233.

13. **Singh, B.B., Chambliss, O.L. and Shrama, B.** 1997. Recent advances in cowpea breeding. In : Advances in Cowpea Research (Eds. B.B. Singh, D.R. Mohan Raj, K.E. Dasniell and L.E. N. Jackai). IITA/JIRCAS, IITA, Ibadan, Nigeria, pp. 30-49.

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Variability studies in chickpea

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Abstract

Thirty six diverse genotypes of chickpea were grown in a randomized complete design for variability studies during *rabi* 1998-99 at the College Farm, Guajrat Agricultural University, Navsari. A wide range of variation was apparent for all the characters. The gentic coefficient of variation was highest for number of secondary branches per plant followed by number of primary branches per plant, number of pods per plant and seed yield per plant. High heritability coupled with high genetic advance was exhibited by number of primary branches per plant, number of secondary branches per plant and number of pods per plant. Thus, phenotypic selection would be effective for genetic improvement in these traits.

Keywords : Variability, Chickpea, heritability

Introduction

Genetic improvement in crop plants depends upon the nature, extent and magnitude of geneitc variability present in the matieral and the extent to which it is. heritable. More the variability greater is the scope for improvement.

Materials and methods

The experimental material consisted of 36 diverse varieties of chickpea. They were grown in randomized block design with three replications keeping three raws of each entry in each replication during rabi 1998-99 at the College Farm, Gujarat Agricultural University, Navsari. Each plot consisted of 2m length and spacing between row was 30 cm and plant to plant distance was 10 cm. Observations were recorded on five randomly selected plants in each entry and in each replication for days to 50% flowering, days to maturity, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, plant height, number of seeds per pod, 100-seed weight, seed yield per plant and harvest index. The mean, range, heritability (broad sensu), genotypic and phenotypic coefficient of variation and expected genetic advance as percentage of mean were calculated by the method proposed by Johnson *et al.* (1), Burton (2) and Allard (3).

Results and discussin

Analysis of variance revealed significant genotypic differences for all the characters under study. Variability parameters such as genotypic variance, phenotypic variance, gcv, pcv, heritability and genetic advance as percentage of mean are presented in Table 1. The σ^2g and σ^2p were observed to be very high for most of the characters indicating existence of wider variability for these characters. Differences between gcv and pcv were observed to be comparatively low for all characters which suggested all these characters had less influenced of environment, thus, confirming the results of Mishra *et al.* (4). The existence of very high magnitude of genetic variability was also evidenced through high value of gca and pcv for majority of characters. The genotypic coefficient of variation was highest for number of secondary branches per plant followed by number of primary branches per plant, number of pods per plant and seed yield per plant indicating maximum amount of genetic variability was observed for these characters. The genetic variability was observed low for days to maturity and days to 50 percent flowering and moderate for the remaining characters.

Estimation of gcv and pcv alone do not assess the amount of heritable variation which can be studied by estimating heritability. Heritability estimates were high

Table 1. Variability parameters for different characters in gram.

Sr. No.	Characters	Range	Mean	σ^2p	σ^2g	pcv	gcv	Heritability (%)	Genetic advance as per cent of mean
1.	Seed yield per plant	15.40-40.10	25.37	65.96	56.68	32.01	29.67	85.93	56.66
2.	Days to 50 per cent flowering	46.67-64.00	51.16	11.08	9.51	6.51	6.03	85.87	11.51
3.	Days to maturity	113.234-140.20	121.12	32.23	30.67	4.68	4.57	95.16	9.18
4.	Number of primary branches per plant	2.00-10.70	5.73	5.00	4.76	39.04	38.08	95.18	76.54
5.	Number of secondary branches per plant	6:00-38.80	18.97	78.73	74.44	46.76	45.47	94.86	91.10
6.	Plant height	25.00-65.20	43.92	154.53	145.93	28.30	27.51	94.43	55.06
7.	Number of pods per plant	10.00-64.10	36.13	185.93	169.45	37.74	36.03	91.13	70.85
8.	Number of seeds per pod	21-2.00	1.44	0.05	0.03	15.78	11.48	52.92	17.20
9.	100-seed weight	12.30-30.20	20.67	26.27	18.65	24.79	20.89	71.02	36.27
10.	Harvest index	31.00-63.70	42.75	76.79	57.34	20.50	17.72	74.68	31.54
11.	Protein content	19.25-28.21	22.21	6.92	5.80	11.85	10.84	83.78	20.44

for number of primary branches per plant, days to maturity, number of secondary branches per plant, plant height, number of pods per plant, seed yield per plant and days to 50 per cent flowering. According to Burton (2) a character having high gcv value with high heritability would be more valuable in the selection programmes. Here high heritablity values coupled with high to moderate gca values were observed for number of primary branches per plant, number of secondary branches per plant, number of pods per plant and seed yield per plant, there by indicating less environmental influence on these characters.

Johnson *et al.* (1) suggested that heritability estimates in conjuction with genetic advance were reliable in predicting the resultant effect for selecting the best individuals. Ramanujam and Tirumulachar (5) also reported the limitations of estimating heritability in broad-sense as it include both additive as well as epistatic gene reliable only if accompanied by high genetic advance. The expected genetic advance expressed in percentage of mean was high for characters such as number of secondary branches per plant, number of pods per plant, seed yield per plant and plant height while days to 50 per cent flowering and days to maturity had low expected genetic advance expressed in percentage of mean.

Based on these findings it was suggested that more emphasis should be given to number of primary branches per plant, number of secondary branches per plant and number of pods per plant in selection programmes aiming to improve seed yield in chickpea.

References

1. **Johnson, H.W., Robinson, H.F. and Comstock, R.E.** 1955. Genotypic and phenotypic correlation in soyabean and their implication in selection. *Agron. J.* **47**:244-483.

2. **Burton, C.W.** 1952. Quantitative inheritance hi grasses. Proc. 6th Int. Grassland Congr., **1** : 277-283. (Fide : 1242, Pl. Breed. Abst., 24 : 229).

3. **Allard, R.W.** 1960. Principles of plant Breeding. John Willey and Sons. Inc.,New York.

4. **Mishra, R., Rao, S.K. and Koutu, O.K.** 1988. Genetic variability, correlation studies and their implication in selection of high yielding genotypes of chickpea. *Indian J. agric. Res.* **22**: 51-57.

5. **Ramanujam, S. and Trumalachar, D.K.** 1967. Genetic variability of certain characters in red piper (Capsicum annum L.). *Mysore J. Sci.* **1** : 30-36.

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Genetic divergence in mungbean [*Vigna radiata* (L.) Wilczek] under rainfed conditions

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Abstract

Forty five genotypes of mungbean comprising of nine parents and their thirty six hybrids were grown in a complete randomized block design with three replications at Sardarkrushinagar during *Kharif*-2002 under rainfed conditions. Observations with characters viz., grain yield/plant, days to flowering, days to maturity, plant height, branches/plant, clusters/plant, pods/plant, pod length, seeds/pod, 100-seed weight, harvest index, protein content, leaf area index and dry matter efficiency were recorded. Genetic divergence was computed following Mahalanobi's D^2 statistics. The grouping of genotypes into clusters was made by Tocher's method. The genotypes were grouped in 13 clusters. The clustering pattern, in general, indicated that geographical origin can not be taken as sole criterion of genetic diversity, as the genotypes belonging from different origin were grouped in together in the single cluster. The maximum number of genotypes were grouped in cluster I (18) followed by cluster II (10) and cluster V (7). The remaining 10 clusters had solitary genotype. The maximum intra-cluster distance was observed in cluster V (3.88). the inter-cluster distances were observed in cluster XI and cluster XII (7.25) followed by cluster VI and cluster XI (6.63) and cluster XI and cluster XIII (6.56). The parents, TM-9850 (cluster III), GM-9301 (cluster VIII) and TM-9458 (cluster XIII) forming solitary cluster having high genetic diversity from each other may be utilized in crossing programme for further exploitation under drought conditions. It was suggested from the results that while selecting the genotypes from different clusters for hybridization, the inter and intra-cluster distances, cluster means for yield and its components and *per se* performance should be taken in to consideration. The analysis also revealed that protein content (26.77 %), 100-seed weight (14.55 %) and pod length (10.91 %) contributed maximum towards total genetic divergence.

Key Words: Genetic divergence, D^2 statistics, clusters, mungbean

Introduction

The D^2 statistics proposed by Mahalanobis (1) is one of the potent techniques of estimating the genetic divergence based on multivariate analysis (2). This technique measures the forces of differentiation at two levels, viz., intra-cluster and inter-cluster levels, and thus, helps in the selection of genetically divergent parents for exploitation in hybridization programme. In addition to that, D^2 statistics measures the degree of diversification and determines the relative contribution of each component character to the total divergence. The genotypes grouped together are less divergent than the ones which are placed in different clusters. The clusters which are separated by the greatest statistical distance show the maximum divergence. The present study, therefore, aims in order to assess the genetic diversity present among the 45 different genotypes of mungbean under rainfed conditions.

Materials and methods

Forty five different genotypes of mungbean were grown at Sardarkrushinagar during *Kharif* 2002 in a randomized block design with three replications under rainfed conditions. The material was grown in a single row plot of 4 m length with a spacing of 45 x 15 cm. Observations with characters viz., grain yield / plant (g), days to flowering, days to maturity, plant height (cm), branches / plant, clusters / plant, pods / plant, pod length (cm), seeds / pod, 100-seed weight (g), harvest index, protein content (%), leaf area index and dry matter efficiency were recorded.

Genetic divergence was estimated using Mahalanobis's D^2 statistics and the populations were grouped on the basis of minimum generalized distance using the method described by Tocher (3).

Results and discussion

The analysis of variance revealed highly significant differences among the genotypes of all the characters studied indicating thereby the existence of genetic variability among the genotypes. Wilk's criterion suggested highly significant differences among the genotypes for the aggregates of 14 characters studied. The results on clustering of 45 genotypes carried out following Tocher's method are presented in Table 1. Overall, thirteen clusters were formed. Cluster-I was found to be the largest with 18 genotypes indicating genetic closeness among the genotypes and having less genetic diversity. Cluster-II and cluster V were the second and third largest cluster with 10 and 7 genotypes, respectively. The remaining 10 clusters had solitary genotype.

The clustering pattern of the genotypes (Table 1) revealed that genetic diversity was not always related with geographical diversity. Murthy and Arunachalam (4) have stated that genetic drift and selection in different environments might cause greater diversity among genotypes than geographical distance. Malhotra *et al.* (5) in greengram, Dikshit *et al.* (6) in rajmash found no parallelism between genetic diversity and geographical origin. Therefore, geographic diversity is not adequate as an index of genetic diversity. The grouping of the genotypes from heterogeneous sources in one cluster is to be expected in the study because of free exchange of breeding material among different regions, as a consequence, the character con-stellation that might be associated with particular region, in nature, loose their individually under human interference.

Intra and inter-cluster distances (D) were computed between all pairs of thirteen clusters (Table 2). The intra cluster distances ranged from 0.00 in ten clusters to 3.88 in cluster V. The inter cluster distances ranged from 2.83 between cluster III and cluster VIII to 7.25 between cluster XI and cluster XII. High inter cluster distances were also observed between cluster VI and cluster XI (6.63) and cluster XI and cluster XII (6.56). All the clusters showed low to moderate inter-cluster distances. However, genotypes from different clusters, showing maximum inter-cluster distances may be selected for hybridization to generate statistical variability for grain yield / plant and its components under rainfed conditions. The parents, TM-9850 (cluster III), GM-9301 (cluster VIII) and TM-9458 (cluster XIII) forming solitary cluster having high genetic diversity from

Table 1. Composition of different clusters in mungbean

Clusters	Number of genotypes	Genotype No.
I	18	GM-3 x HUM-1, HUM-1 x GM-8904, HUM-1 x AKM-9602, TM-9850 x HUM-1, GM-4 x HUM-1, TM-9850 x GM-9301, TM-9850 x GM-8904, Co-5 x GM-3, TM-9850 x GM-4, TM-9458 x GM-8904, TM-9850 x GM-3, Co-5 x AKM-9602, GM-4 x GM-9301, Co-5 x GM-8904, TM-9458 x HUM-1, TM-9458 x Co-5, AKM-9602 x GM-8904, Co-5 x HUM-1
II	10	HUM-1, TM-9458 x GM-3, TM-9458 x GM-9301, GM-3, AKM-9602, GM-4, GM-8904, Co-5 x GM-4, Co-5, TM-9458 x AKM-9602
III	1	TM-9850
IV	1	Co-5 x GM-9301
V	7	GM-9301 x HUM-1, GM-3 x GM-8904, GM-3 x AKM-9602, GM-4 x AKM-9602, GM-9301 x GM-8904, GM-4 x GM-3, GM-4 x GM-8904
VI	1	TM-9850 x Co-5
VII	1	TM-9850 x AKM-9602
VIII	1	GM-9301
IX	1	TM-9458 x GM-4
X	1	GM-9301 x GM-3
XI	1	GM-9301 x AKM-9602
XII	1	TM-9458 x TM-9850
XIII	1	TM-9458

Table 2. Average intra (diagonal)and inter-cluster distances observed in mungbean under rainfed conditions.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XII
I	3.09	4.16	3.86	3.74	4.19	3.94	3.89	5.07	4.57	4.36	5.38	4.27	3.95
II		3.16	3.88	5.12	5.25	3.98	4.34	4.32	4.02	5.51	5.65	5.31	5.01
III			0.00	4.96	4.07	4.94	3.71	2.83	3.28	4.64	3.24	5.66	4.83
VI				0.00	4.53	5.59	5.93	6.89	5.43	4.67	5.98	5.81	5.11
V					3.88	5.55	4.67	4.98	5.38	4.52	4.81	4.96	4.90
VI						0.00	3.62	5.22	5.04	5.21	6.63	3.65	4.13
VII							0.00	3.98	4.94	4.37	4.96	3.48	4.36
VIII								0.00	3.89	5.91	4.27	5.76	5.42
IX									0.00	5.50	5.45	6.11	4.25
X										0.00	5.91	4.08	4.25
XI											0.00	7.25	6.56
XII												0.00	3.89
XIII													0.00

Table 3. Per cent contribution of different characters to total genetic divergence under rainfed condition.

Character	Number of lines appearing first in ranking	per cent of total times character contributed highest to total genetic divergence
Grain yield / plant	44	4.44
Days to flowering	45	4.55
Days to maturity	43	4.34
Plant height	8	0.81
Branches / plant	19	1.92
Clusters / plant	56	5.66
Pods / plant	34	3.43
Pod length	108	10.91
Seeds / pod	53	5.35
100-seed weight	144	14.55
Harvest Index	54	5.45
Protein content (%)	265	26.77
Leaf area index	58	5.86
Dry matter efficiency	59	5.96

each other may be utilized in crossing programme for further exploitation under drought conditions.

The cluster means for different characters are presented in Table 4. All the clusters, in general, exhibited moderate to high mean values for different characters studied. The cluster III depicted the highest mean values for grain yield / plant (6.78) followed by cluster VIII (6.01) and cluster V (5.91) indicated that for the improvement of grain yield / plant, the genotypes from the above clusters should be selected for utilization in breeding programme under drought conditions. Cluster III also exhibited the high mean values for pods / plant, cluster-VIII for branches / plant and cluster-V for harvest index (Table 4). Cluster I exhibited the lower mean values for days to flowering and cluster XIII for days to maturity.

The per cent contribution of 14 characters towards total genetic divergence was estimated to assess the relative significance of individual traits in determining the inter-cluster distances (Table 3). Protein content (26.77 %), contributed maximum towards total genetic divergence followed by 100-seed weight (14.55 %) and pod length (10.91 %). Other remaining characters cause divergence with very low percentage. This results are contrary to the findings of Malhotra and

Table 4. Intra cluster mean values (D) for different characters in mungbean

Character / Cluster	GY	DF	DM	PH	BP	CP	PP	PL	SP	TW	HI	P	LAI	DME
I	4.88	39.43	62.28	29.94	3.13	4.46	13.70	6.98	5.24	3.47	30.89	22.60	1.45	0.48
II	5.26	38.70	62.47	32.85	3.28	4.25	14.80	6.94	5.17	3.31	26.90	24.47	1.59	0.48
III	6.78	39.33	62.33	28.73	3.50	5.23	19.07	7.25	4.80	3.06	32.00	23.11	1.48	0.50
IV	5.31	39.33	61.67	30.57	2.43	3.73	14.93	7.27	5.33	3.36	30.00	20.77	1.74	0.45
V	5.91	40.67	63.14	29.08	3.16	4.59	16.56	5.85	4.55	3.22	34.52	21.97	1.54	0.60
VI	4.00	39.67	60.33	25.17	3.77	4.00	11.73	6.84	5.73	3.85	25.33	24.71	1.44	0.39
VII	4.33	40.33	62.61	28.73	3.93	5.83	12.73	6.82	4.73	3.54	28.67	24.18	1.67	0.50
VIII	6.01	40.67	64.61	31.43	4.03	5.27	16.93	6.08	4.80	3.04	29.33	24.36	1.21	0.58
IX	5.40	38.33	62.00	32.00	4.03	4.57	15.47	7.48	5.10	3.50	27.00	23.06	1.39	1.49
X	4.59	38.67	62.33	26.87	3.33	4.83	16.73	6.41	3.93	3.53	26.33	21.83	1.52	0.43
XI	5.39	42.00	60.67	27.83	3.30	5.50	15.27	7.04	3.80	2.38	29.33	22.40	1.63	0.39
XII	4.13	40.67	63.33	28.75	3.47	4.63	12.67	5.69	4.67	4.21	28.33	23.61	1.37	0.43
XIII	4.23	40.00	60.00	28.39	3.07	4.47	14.20	6.26	5.73	3.74	31.33	22.57	1.15	1.48

Where, GY= Grain yield / plant (g/plant), DF= Days to flowering, DM= Days to maturity, PH= Plant height (cm), BP= Branches / plant, CP= Clusters/ plant, PP= Pods/plant, PL= Pod length (cm), SP= Seeds / pod, TW= 100-seed weight (g), HI= Harvest index, P= Protein content (%), LAI= Leaf area index and DME= Dry matter efficiency.

Singh (7) in blackgram, where grain yield largely contributed the genetic divergence. However Murty and Arunachalam (4) hold the opinion that divergence can be on the basis of characters other than yield. This may be attributed to high intensity of selection practiced for these traits for the improvement in mungbean under rainfed conditions.

References :

1. **Mahalanobis, P.C.** 1936. On the generalized distance in statistics. *Pro. Nat. Inst. Sci.* India. **2** : 49-55.

2. **Moll, R.H., Salhuana, W.S. and Robinson, H.F.** 1962. Heterosis and genetic diversity in varietal crosses of maize. *Crop Sci.* **2** :197-198.

3. **Rao, C.R.** 1952. Advanced Statistical Methods in Biometrical Research. Edn. I. John Wiley and Sons, Inc., New York, pp. 337-363.

4. **Murthy, B.R. and Arunachalam, V.** 1966. The nature of genetic divergence in relation to breeding system in crop plants. *Indian J. Genet.*, **26A** : 188-198.

5. **Malhotra, V.V., Singh, S. and Singh, K.B.** 1975. Relation between geographic diversity and genetic divergence and relative role of each characters toward maximizing divergence in greengram. *Indian J. Agric. Sci.* **44** : 811-15.

6. **Dixit, H.K., Gupta, S.R., Asthana, A.N. and Devraj.** 1999. Genetic parameters and diversity in Rajmash.*Legume Res.* **22** : 198-200.

7. **Malhotra, R.S. and Singh, R.B.** 1971. Multivareate analysis in blackgram (*Pheseolus mungo* Roxb.). *Indian J. Agric. Sci.* **41** : 757.

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Genetic divergence study over locations in mustard

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Abstract

Mahalanobis D^2 statistics was employed to measure the genetic divergence of 66 genotypes for 14 different characters. Sixteen different clusters were formed with a considerable range of intercluster distance (7.52 to 23.52) suggesting considerable diversity among the genotypes. Clustering pattern indicated that genotypes were clustered irrespective of their eco-geographical regions. D^2 analysis also revealed that siliquae length, test weight, seeds per siliquae and oil content contribute maximum towards the total genetic divergence. Because of presence of substantial genetic diversity among the parents, they may be utilized in hybrid breeding programme for the improvement of yield in mustard.

Keywords : Mustard, genetic divergence, D^2 statistics

Introduction

The choice of the parents is of paramount importance in any breeding programme. Genetic divergence analysis is attempted to identify the parents for realizing high heterosis and superior recombinations in segregating generations (1). The D^2 statistics proposed by Mahalanobis (2) is one of the potent techniques of measuring genetic divergence based on multivariate analysis (3, 4). This technique measures the forces of differentiation at two levels, *viz.*, intracluster and intercluster levels, and thus, helps in the selection of genetically divergent genotypes for exploitation in hybridization programme. In addition to aiding in the selection of divergence parents for hybridization, D^2 statistics measures the degree of diversification and determines the relative contribution of each component character to the total divergence. The genotypes grouped together are less divergent than the ones which are placed in different clusters. The clusters which are separated by the greatest statistical distance show the maximum divergence. In the present study, Mahalanobis D^2 statistics was computed using the data pooled over four environments for 14 different characters and for all the possible pairs of populations in order to assess the genetic diversity present among the 66 different genotypes consisting of 11 parents and their 55 hybrids produced by diallel mating design excluding reciprocals.

Materials and methods

The experimental material comprised 66 genotypes consisting of 55 F_1 hybrids were obtained through mating of 11 parents (GM 1, GM 2, SKM 9927, RH 9322, JYM 1, Jawahar Mustard 1, RN 539, BIO 902, TM 40, TM 24 and BPR-6-166-24-3) in all possible combinations excluding reciprocals following diallel mating design. The experiment was grown in randomized block design with three replications in four environments during *rabi* 2003-04 at Main Castor-Mustard Research Station, S. D. Agricultural University, Sardarkrushinagar. The environments were created by the combinations of two sowing dates (8.10.2003 and 23.10.2003) and two nitrogen levels (50 and 100 kg N/ha). Each genotype was grown in a single row of 5 meter length. The inter and intra row distances were kept 45 cm and 15 cm, respectively, which accommodated 33 plants per plot. All recommended agronomical practices were followed for raising the good crop. However, the plant protection measures were not adopted. The observations were recorded on five randomly selected plants for each treatment in each replication and in each environment for seed yield per plant and its components.

The Mahalanobis D^2 statistics was used to measure the genetic divergence as suggested by Rao (5). The clustering of genotypes into different groups was done according to Tocher's method.

Results and discussion

Clustering of 66 genotypes was carried out following Tocher's method (5). Overall sixteen clusters were formed and their composition is presented in Table 1. Cluster-II followed by cluster-I, cluster-V, cluster-VI and cluster-XI were found to be largest with 20, 10, 8, 7 and 7 genotypes, respectively indicating genetic closeness among the genotypes and having less genetic diversity. Other eleven clusters had having single genotype.

Out of 16 clusters formed, 4 parents *viz.*, 3, 4, 5 & 7 and 2 parents *viz.*, 6 & 8 were grouped in cluster-II and XI, respectively, whereas remaining 5 parents were grouped in separate clusters (Table 1). Similarly, in cluster-II, along with the parent SKM 9927, originated from Gujarat, three parents *viz.*, RH 9322, JYM 1 and RN 539 originated from Haryana, M.P. and Rajasthan, respectively. Similarly, two parents *viz.*, Jawahar Mustards 1 and BIO 902 originated from M.P. and New Delhi, respectively grouped in the same cluster-VI.

The other parents like GM 1 and GM 2 (Gujarat), TM 40 and TM 24 (BARC, Mumbai) and BPR-6-166-24-3 (Rajasthan) grouped in separate clusters i.e., cluster XIV, V, I, VI and XII, respectively. Thus, clustering pattern, in general, indicated that geographical distribution cannot be taken as the sole criterion of

Table-1. Composition of different clusters based on D^2 values of 66 genotypes of mustard

Clusters	Number of genotypes	Genotype Name
I	10	TM 40, RH 9322 x TM 24, JYM 1x BIO 902, JYM 1x Jawahar M 1, RN 539 x BPR 6-166-24-3, GM 2 x JYM 1, GM 2 x RH 9322, BIO 902 x TM 24, GM 1 x SKM 9927, RH 9322 x BPR 6-166-24-3
II	20	RH 9322 x Jawahar M 1, Jawahar M 1 x TM 24, Jawahar M 1 x TM 40, GM 1 x JYM 1, RN 539 x TM 24, GM 1 x TM 24, JYM 1x TM 24, SKM 9927 x BPR 6-166-24-3, GM 1 x TM 40, RH 9322 x RN 539, RN 539, BIO 902 x BPR 6-166-24-3, SKM 9927 x JYM 1, SKM 9927, BIO 902 x TM 40, SKM 9927 x BIO 902, RH 9322 x TM 40, SKM 9927 x TM 40, JYM 1, RH 9322
III	1	GM 1 x RH 9322
IV	1	RH 9322 x BIO 902
V	8	GM 2 x SKM 9927, GM 2 x BIO 902, GM 2, GM 1 x RN 539, Jawahar M 1 x BIO 902, Jawahar M 1 x RN 539, RN 539 x BIO 902, GM 1 x BIO 902
VI	7	JYM 1x TM 40, JYM 1x BPR 6-166-24-3, GM 1 x BPR 6-166-24-3, TM 40 x BPR 6-166-24-3, TM 24 x BPR 6-166-24-3, RH 9322 x JYM 1, TM 24
VII	1	GM 1 x GM 2
VIII	1	GM 2 x TM 40
IX	1	GM 2 x BPR 6-166-24-3
X	1	RN 539 x TM 40
XI	7	Jawahar M 1, Jawahar M 1 x BPR 6-166-24-3, SKM 9927 x Jawahar M 1, BIO 902, JYM 1x RN 539, TM 40 x TM 24, GM 2 x Jawahar M 1
XII	1	BPR 6-166-24-3
XIII	1	GM 2 x TM 24
XIV	4	GM 1, SKM 9927 x TM 24, SKM 9927 x RH 9322, GM 1 x Jawahar M 1
XV	1	SKM 9927 x RN 539
XVI	1	GM 2 x RN 539

Table 2. Average intra and inter cluster distances, D (D= $\sqrt{D^2}$)

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
I	7.61	10.60	8.23	13.87	12.85	12.19	8.80	13.97	8.52	15.16	17.22	13.05	9.09	11.29	11.39	16.38
II		7.57	8.96	11.07	13.42	12.61	12.94	9.52	9.64	10.01	11.52	9.69	14.77	15.84	14.13	14.31
III			0.00	12.02	12.50	13.28	11.70	12.93	8.39	12.56	15.12	10.76	9.37	13.76	7.52	12.39
IV				0.00	9.47	18.54	17.54	9.61	11.34	8.47	12.48	15.56	16.81	20.86	16.63	10.40
V					8.92	19.49	15.54	14.61	10.39	12.46	17.21	17.84	13.35	19.20	15.45	11.33
VI						10.05	13.17	14.01	14.26	17.99	17.59	12.48	16.22	13.00	16.95	22.62
VII							0.00	17.45	9.54	18.34	18.96	15.91	11.43	9.46	14.24	20.30
VIII								0.00	11.76	8.40	10.31	12.40	18.66	19.29	17.67	15.93
IX									0.00	11.37	14.68	14.85	11.36	13.74	12.18	13.62
X										0.00	9.67	13.27	18.63	21.67	16.84	10.59
XI											9.77	14.12	22.15	22.22	20.44	16.91
XII												0.00	16.25	17.20	14.26	16.65
XIII													0.00	12.62	8.62	16.04
XIV														11.43	15.27	23.52
XV															0.00	14.38
XVI																0.00

genetic diversity. Genetic drift and selection in different environments might cause greater diversity than geographical distance. Moreover, free exchange of seed material among different geographical regions changes the character constellation associated with particular region (6). Absence of parallelism between genetic diversity and geographical origin was reported previously by Anand *et al.* (7), Dubey (8) and Anand and Rawat (9) in *Brassica*.

Divergence among the parents has been greatly emphasized in the heterotic response of the hybrids. The parents which had high genetic diversity among each other *viz.*, GM 1, GM 2, TM 40, TM 24 and BPR-6-166-24-3 may produce the heterotic hybrids for future exploitation. Because, hybrid BIO 902 x TM 24 exhibited 105.18 % heterobeltiosis for seed yield per plant; the D^2 between its parents was 353.75. Similarly, hybrids expressing significant positive heterobeltiosis for seed yield per plant *viz.*, GM 1 x BPR-6-166-24-3 (86.13%), Jawahar M 1 x TM 24 (82.99%), Jawahar M 1 x BIO 902 (80.21%) and GM 1 x Jawahar M 1 (64.11%), the D^2 values between its parents were, 255.90, 64.80, 139.73 and 482.50, respectively. Thus, high D^2 values observed between the parents involved in these crosses conceivably caused significant heterobeltiosis for seed yield per plant. However, heterosis is known to increase with increased divergence only within a limited range of divergence and extremely divergent cross may result in decreased heterosis due to sterility, incompatibility, etc. (4). Nevertheless, the probability of realizing a large number of heterotic hybrids is high, if the parents selected for hybrid breeding is fairly diverse (1).

Intra and inter-cluster distances (D) were computed between all pairs of sixteen clusters (Table 2). The intra cluster distances ranged from 0.00 in ten clusters to 11.43 in cluster XIV. The inter cluster distances ranged from 7.52 between cluster III and cluster XV to 23.52 cluster XVI and cluster XIV. High inter cluster distances were also observed between cluster-VI and cluster-XVI (22.62), cluster-XI and cluster-XIII (22.15) and cluster-II and cluster-X (17.67). All the clusters showed moderate to high inter-cluster distances. However, accessions from different clusters showing maximum inter-cluster distances may be selected for hybridization to generate statistical variability for seed yield per plant and its components. In the present study, parents *viz.*, GM 1, GM 2, TM 40, TM 24 and BPR-6-166-24-3, showing greater diversity and maximum inter-cluster distances may

Table 3. Per cent contribution of different characters to total genetic divergence in mustard

Sr. No.	Character	Number of times appearing first in ranking	Per cent contribution (%)
1.	Seed yield per plant	14	0.65
2.	Days to 50 percent flowering	0	0.00
3.	Plant height	1	0.05
4.	Length of main branch	6	0.28
5.	Number of primary branches per plant	20	0.93
6.	Number of secondary branches per plant	5	0.23
7.	Number of siliquae per main branch	4	0.19
8.	Number of siliquae per plant	3	0.14
9.	Siliqua length	779	36.32
10.	Number of seeds per siliqua	420	19.58
11.	1000-seed weight	675	31.47
12.	Biological yield per plant	17	0.79
13.	Harvest index	0	0.00
14.	Oil content	201	9.37

be selected for hybridization and also selection in segregating generation to get better hybrids for future exploitation.

The per cent contribution of 14 characters towards total genetic divergence was estimated to assess the relative significance of individual traits in determining the inter-cluster divergence (Table 3). Siliquae length (36.32%) contributed maximum towards total genetic divergence followed by test weight (31.47%), seeds per siliquae (19.58%) and oil content (9.37%). This may attributed to high intensity of selection practiced for these traits.

The results indicated that there is substantial genetic diversity in the material studied and genetically diverse parents may be used in hybrid breeding programme for further improvement of yield in mustard.

References :

1. **Arunachalam, V.** 1981. Genetic distance in Plant Breeding. *Indian J. Genet.* **41** : 226-236

2. **Mahalanobis, P.C.** 1936. On the generalized distance in statistics. *Pro. Nat. Inst. Sci.* India, **2** : 49-55.

3. **Moll, R.H., Salhuana, W.S. and Robinson, H.F.** 1962. Heterosis and genetic diversity in varietal crosses of maize. *Crop Sci.* **2** : 197-198.

4. **Bhatt, Dipika and Reddy, T.P.** 1987. Genetic divergence and heterosis in castor (*Ricinus communis* L.), *Indian J. Bot.* **10** : 21-26.

5. **Rao, C.R.** 1952. Advanced Statistical Methods in Biometrical Research. Edn. I. John Wiley and Sons, Inc., New York, pp. 337-363.

6. **Murthy, B.R. and Arunachalam, V.** 1966. The nature of genetic divergence in relation to breeding system in crop plants. *Indian J. Genet.* **26A** : 188-198.

7. **Anand, I. J., Singh, J.N. and Khanna, P.P.** 1975. Inter relationships and diversity in Indian coiza. *Indian J. Agric. Sci.* **45** : 253-258.

8. **Dubey, R.N.** 1976. Genetic divergence in Indian rye (*B. juncea* (L.) Czern & Coss). *Indian J. Hered.* **8** : 33-40.

9. **Anand, I. J., and Rawat, D.S.** 1984. Genetic diversity, combining ability and heterosis in brown mustard. *Indian J. Genet.* **44** : 226-234.

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Study of heritability and genetic advance in maize composite

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Abstract

The present research work was carried out during 2004 - 2005 with a view to study the heritability in narrow sense and expected genetic gain in Mahidhawal population of maize. The mean values for nine traits in Mahidhawal population showed that environment E was more favourable for manifestation of genetic worth of the genotypes than environment E_2 The estimates of heritability in narrow sense for different traits recorded low (15-40 per cent) to moderate values (41-65 per cent) and it estimates varied from 1 to 96 per cent. Estimates of heritability for grain yield per plant were lower in magnitude as compared to those of yield component traits. The estimates of genetic gain for yield components traits viz., ear length, ear girth,, kernel rows per ear and 100-grain weight were of lower in magnitude as compared ta yield itself. The expected genetic gain for grain yield per plant through full sib family selection was 1.76 to 2.80 times greater than those of estimates from mass selection.

Keywords : Maize, heritability, expected genetic gain.

Introduction

Maize *(Zea mays* L.) is one of the most important crop which has been used extensive for genetic improvement through numerous breeding methodologies ranging from recurrent selection scheme to hybrid breeding Vasal and Gonzalez (1). The main objective in developing composites was to strengthen hybrid programme by using improved composites / populations as the base material for extraction of more productive inbred lines as well as to serve the farmers by providing superior performing composite seed. The genetic advance in a given population through a selection scheme depends upon the level of available phenotypic variability, heritability of the character and the selection intensity. Therefore, precise estimation of component of variance will help us in choosing an efficient selection scheme for obtaining greater degree of genetic advance in a given population. The present investigation was carried out to study the genetic architecture of widely grown large random mating maize composite Mahidhawal through using North Carolina Design-I to derive information on heritability in narrow sense and expected genetic gain through full sib family selection and mass selection at both high and low levels of nitrogen.

Material and methods

To generate the experimental material of present investigation, crossing programme was undertaken during *rabi* 2003-04 at research farm of the Department of Plant Breeding and Genetics, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, as per North Carolina Design-1 by Comstock and Robinson (2, 3) in a large ran-dom mating heterozygous population of maize composite Mahidhawal. To develop half sib and full sib families, each 64 randomly chosen male plants were crossed with four randomly chosen female plants. Sixty four male groups of this population were assigned to 16 sets, with each set comprising four male groups. Each set of four male groups will have sixteen progenies (full sibs) in it. A total of 256 progenies were evaluated in incomplete block design with two replications during 2004 - 2005. The full sib progenies were evaluated in two different environments, created by two levels of fertility (i) 120 : 60 : 0 kg NPK/ha (E_1) (ii) 60 : 60 : 0 kg NPK/ha (E_2). The mean values were used to compute the analysis of variance for individual environment by Comstock and Robinson (3), pooled analysis over the environments by Robinson *et al.* (4), estimates of heritability in narrow sense by Hallauer and Miranda (5) and expected genetic advance by Robinson *et al.* (6).

Results and discussion

Study of mean values for all characters in composite Mahidhwa revealed that environment E_1 (120 kg N/ha) was more favourable for the manifestation of genetic worth of the genotypes than environment E_2 (60 kg N/ha) (Table 1). Heritability is in reality a measure of the efficiency of a selection system in separating genotypes Burton and Devane (7). Robinson (8) described heritability as useful measure for considering ratio of genetic variance to the total variance. Genetic advance from selection has been one of the most important application is concerned with the comparison of different selection methods. It is therefore, necessary to utilize heritability estimates in conjunction with selection differential which would indicate the expected genetic gain resulting through selection. Heritability in narrow sense for different characters in composite Mahidhawal varied from I to 96 per cent. A perusal of the heritability estimates

Table 1. Mean, estimates of heritability (narrow sense) and expected genetic gain (as per cent of mean) from one cycle of selection through full sib family and mass selection methods in composite Mahidhawal

Character	Environment	Mean	Heritability (narrow sense) (%)	Expected genetic gain	
				Full sib family	Mass selection
Days to 50% tasseling	E_1	51.23	37	2.51	1.40
	E_2	50.75	41	3.54	2.28
	Pooled	50.99	50	1.70	0.58
Days to 50% si lk ing	E_1	53.66	33	2.29	1.19
	E_2	53.03	40	3.45	2.13
	Pooled	53.35	50	1.70	0.59
Anthesis silking interval	E_1	2.43	6	0.82	0.28
	E_2	2.28	—	—	—
	Pooled	2.35	17	2.29	0.72
Ear length	E_1	15.29	27	3.01	1.11
	E_2	14.86	39	4.37	1.68
	Pooled	15.08	21	1.32	0.45
Ear girth	E_1	12.06	34	2.65	1.07
	E_2	11.77	87	2.80	0.93
	Pooled	11.91	42	1.59	0.54
Kernel rows per ear	E_1	12.75	96	7.45	3.21
	E_2	12.34	49	5.91	2.75
	Pooled	12.54	52	3.26	1.11
100-grain weight	E_1	25.28	10	3.16	2.01
	E_2	24.48	27	7.92	4.77
	Pooled	24.88	31	3.49	1.24
Grain yield per plant	E_1	92.43	18	7.96	4.50
	E_2	84.64	26	9.33	4.89
	Pooled	88.53	32	4.71	1.68
Stover yield per plant	E_1	113.39	9	3.40	1.99
	E_2	1 06.74	13	4.38	2.46
	Pooled	110.06	24	2.78	1.00
Harvest index	E_1	44.75	36	3.06	1.27
	E_2	44.09	1	0.07	0.03
	Pooled	44.42	27	0.90	0.31

revealed that most of the estimates exhibited low (15 to 40 per cent) to moderate values (41 to 65 per cent) except ear girth in E_2 (87 per cent) and kernel rows per ear in E_1 (96 per cent) which showed high heritability estimates. It is noted that many traits viz. grain yield per plant stover yield per plant, 100-grain weight, ear girth, ear length, days to 50 % silking and days to 50 % tasseling sho.wed higher estimates of heritability in environment E_1 than E_2 environment while kernel rows per ear showed higher estimates of heritability in environment E_1 than E_2 environment, which indicated that the expression of both additive genetic variance and total phenotypic variance varied under two environments. The estimate of heritability for grain yield per plant was lower in magnitude as compared to heritability estimates of yield components traits viz., ear length, ear girth and kernel rows per ear (Table 1). In the present experiment higher expected genetic gain have been reported in full sib family selection for ear length, 100-grain weight and grain yield per plant in environment E_2 (60 kg N/lta). The above findings are in agreement with the finding of Marker (9) who also reported higher expected genetic gain for grain yield per plant in N stressed environment (60 kg N/ha). The estimates of predicted genetic gains revealed that the components of grain yield *viz.*, ear length, ear girth, kernel rows per ear and 100-grain weight recorded lower estimates of genetic gains as compared to yield itself, thereby suggesting that in population Mahidhawal significant improvement in yield can be obtained by directing selection for yield *per se*. The predicted genetic gains for grain yield per plant through full sib family selection were 1.76 to 2.80 times greater than those of estimates from mass selection (Table 1). It thus, suggests continuation of intra-population improvement through full sib family selection.

References

1. **Vasal, S.V. and Gonzalez, C.** 1999. Non-conventional maize hybrids and their seed production. Advanced seed production course in maize. Maize Research Station. Amberpet, Hyderabad, 66-81.
2. **Comstock, R.E. and Robinson, H.F.** 1948. The components of genetic variance inpopulations of biparental progenies and their use in estimating the average degree of dominance. *Biometrics.* **4** : 254-266.
3. **Comstock, R.E. and Robinson, H.F.** 1952. Estimation of average degree of dominance of genes. In : Gowen, J.W.(ed), Heterosis, Iowa State College Press, Ames, Lowa, pp. 494-516.
4. **Robinson, H.F.; Comstock, R.E. and Harvey, P.H.** 1955. Genetic variances in open pollinated varieties of corn. *Genetics.* **40** : 45-60.
5. **Hallauer, A.R. and Miranda, J.B.** 1981. Quantitative genetics in maize breeding. Iowa State Univ. Press, Ames, Iowa, .75-80.
6. **Robinson, H.F.; Comstock, R.E. and Harvey, P.H.** 1949. Estimation of heritability and degree of dominance in corn. *Agron.J.* **41** : 353-359.
7. **Burton, G.W. and Devane, E.H.** 1953. Estimating heritability in Tall Fescue *(Festuca arundinacea)* from replicated clonal material. *Agron. J.* **45** : 478-481.
8. **Robinson, H.F.** 1966. Quantitative genetics in relation to breeding on the centennial of Mendilism. *Indian J. Genet.* **26** : 171-187
9. **Marker, S.** 2004. Genetic Studies in Heterozygous population of Maize *(Zea mays* L.) Ph.D Thesis. MPUAT. RCA, Udaipur.

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Contribution of relationship of various growth characters to oil and seed yield in Sesame (*Sesamum indicum* L.)

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Abstract

The seed yield per plant showed highly significant and positive correlation with days to maturity, number of branches per plant and capsules per plant. Path coefficient analysis showed high positive direct effect along with strong association of seed yield with days to maturity, number of branches per plant and capsules per plant.

Key words : Correlation coefficients, path analysis, sesame

Introduction

The seed yield is a complex and polygenic trait, dependent on number of component characters. Therefore, the study of relationship among seed yield and its components is of immense importance to provide information for exercising selection pressure in- relation to yield attributes for genetic improvement of seed yield.

Materials and methods

The experimental material consisting of 60 genotypes was grown at Main Castor and Mustard Research Station, S. D. Agricultural University, Sardarkrushinagar in randomized block design with three replications during *kharif* 2005. Each plot consisted of single row of 5 meter length with a spacing of 45 x 30 cm. Ten competitive plants from each plot were selected and observations were recorded on days to 50% flowering, days to maturity, plant height (cm), length of main branch (cm), number of branches/plant, capsule length (cm), capsules/plant, oil content (%), seeds/capsule, 1000-seed weight (g) and seed yield/ plant (g). The correlation coefficients were worked out utilizing variance and covariance components. The genotypic correlation coefficients of the yield were partitioned into direct and indirect effects (1).

Results and discussion

The estimated phenotypic and genotypic correlation coefficients are presented in Table 1. In general, the genotypic correlation coefficients were slightly higher than the phenotypic correlation coefficients indicating the masking effect of environment in the total expression of the genotypes. Such results are in concurrence with the results of Sankar *et al.*,(2) and Backiyarani *et al*, (3) in sesame. Seed yield per plant had significant and positive correlation with number of branches per plant and capsules per plant at genotypic and phenotypic levels. While, with days to maturity and plant height had significant association only at genotypic level and with oil content significant negative correlation. These results revealed that positive and significant genotypic and phenotypic association with above characters can be utilized in selection for improvement of seed yield. The results are in correspondence with Sankar *et al.* (2) and Chavan and Chopde (4) for plant height, number of branches per plant and capsules per plant, Backiyarani *et al.* (3), Bhele *et al.* (5) and Sharma and Chauhan (6) for plant height, capsules per plant and oil content, Vadhavani *et al.* (7) and Yadav *et al.* (8). for number of branches per plant and capsules per plant, Sharma and Chauhan (6) for days to maturity, Pathak and Dixit (9) for plant height and capsules per plant and Mishra *et al.* (10) for capsules per plant.

Table 1. *Genotypic(r_g) and phenotypic(r_p) correlation coefficients among eleven characters in sesame*

Characters		Days to maturity	Plant height	Length of main branch	Number of branches/ plant	Capsule length	Capsules/ plant	Oil content	Seeds/ capsule	1000-seed weight	Seed yield/ plant
Days to 50%	r_g	0.470**	0.798**	0.407**	0.184	0.073	0.308*	0.979**	0.226	-0.353**	0.098
flowering	r_p	0.315*	0.332**	0.106	0.044	0.079	0.073	-0.016	0.100	-0.166	-0.053
Days to maturity	r_g		0.545**	0.324*	0.290*	-0.063	0.298*	-0.909**	0.281*	0.008	0.363**
	r_p		0.322*	0.218	0.203	-0.105	0.157	-0.108	0.222	0.038	0.240
Plant height	r_g			0.823**	0.245	0.200	0.397**	-0.466**	0.077	-0.154.	0.272*
	r_p			0.771**	0.195	0.096	0.416**	0.049	0.015	-0.099	0.186
Length of main	r_g				0.055	0.204	0.242	-0.408**	-0.089	-0.027	0.235
branch	r_p				0.081	0.068	0.419**	0.049	-0.011	-0.003	0.094
Number of	r_g					-0.101	0.690**	-0.875**	-0.002	-0.165	0.376**
branches/plant	r_p					-0.139	0.534**	-0.035	-0.029	-0.900**	0.357**
Capsule length	r_g						0.060	0.388**	-0.034	-0.128	0.088
	r_p						0.065	0.019	-0.018	-0.075	-0.051
Capsules/plant	r_g							-1.000**	-0.055	-0.103	0.416**
	r_p							0.114	-0.006	-0.056	0.267*
Oil content	r_g								-0.170	-0.044	-0.652**
	r_p								-0.126	-0.089	0.014
Seeds/capsule	r_g									0.091	0.103
	r_p									0.051	0.058
1000-seed weight	r_g										0.205
	r_p										0.177

* and ** significant at 5% and 1% levels, respectively

Table 2. Path coefficient analysis showing direct (bold) and indirect effects of nine traits on seed yield in sesame

Characters	Days to 50 % flowering	Days to maturity	Plant height	Length of main branch	Number of branches/ plant	Capsule lenght	Capsule/ plant	Seeds/ capsule	1000-seed weight	Genotypic correlation with seed yield
Days to 50% flowering	**-0.043**	0.114	-0.102	0.081	0.044	0.010	0.066	0.015	-0.087	0.098
Days to maturity	-0.020	**0.243**	-0.070	0.064	0.070	-0.009	0.064	0.019	0.002	0.363**
Plant height	-0.035	0.132	**-0.128**	0.163	0.059	0.028	0.085	0.005	-0.038	0.272*
Length of main branch	-0.018	0.079	-0.105	**0.199**	0.013	0.028	0.052	-0.006	-0.007	0.235
Number of branches/plant	-0.008	0.070	-0.031	0.011	**0.242**	-0.014	0.147	0.000	-0.041	0.376**
Capsule length	-0.003	-0.015	-0.026	0.040	-0.024	**0.138**	0.013	-0.002	-0.032	0.088
Capsules/plant	-0.013	0.072	-0.051	0.048	0.167	0.008	**0.214**	-0.004	-0.025	0.416**
Seeds/capsule	-0.010	0.068	-0.010	-0.018	0.000	-0.005	-0.012	**0.067**	0.022	0.103
1000-seed weight	0.015	0.002	0.020	-0.005	-0.040	-0.018	-0.022	0.006	**0.247**	0.205

Residual effect = 0.6547

* and ** significant at 5% and 1% levels, respectively

The partitioning of correlation coefficients into direct and indirect effects revealed that the 1000-seed weight had the highest direct positive effect on seed yield but not significant association with seed yield per plant due to negative or negligible indirect effects (Table 2). These results were akin to the finding of Vadhvani *et al.* (7) and Pathak and Dixit (9). Next to this, the characters, days to maturity, number of branches per plant and capsules per plant was highly significant and positive association with seed yield per plant which indicates that increasing seed yield via improving these characters through selection. Similar findings were reported by Sankar *et al.* (2),Mishra *et al.* (10), Kavitha *et al.* (11), Pathak and Dixit (9) and Chavan and Chopde (4). Plant height had negative direct effect on seed yield but positive and significant association with seed yield due to positive indirect effect of other trait was observed via days to maturity, length of main branch, number of branches per plant, capsule length, capsules per plant and seeds per plant. Sankar *et al.* (2), Backiyarani *et al.* (3) and Godawat and Gupta (12) also observed same results.

Based on the present findings, it is inferred that while, selecting high yielding genotypes, selection pressure should be exercised simultaneously for days to maturity, plant height, number of branches per plant and capsules per plant

References

1. **Dewey, D.R. and Lu, K.H.** 1959. A correlationand path coefficient analysis of components of crested wheat grass seed production. *Agron. J.* **51** : 515-518.

2. **Sankar, D., Kumar, P., Ananda, C.R.** 2003. Genetic analysis of yield an related components in sesame *(Sesamum indicum* L.). *Crop Res.* **25** : 91-92.

3. **Backiyarani, S., Subramanian, M. and Shanthi, S.** 1999. Character association and path coefficient analysis in segregating generation of sesame. *Crop Res.* **18** : 251-255.

4. **Chavan, G.V. and Chopde, P.R.** 1981. Correlation and path analysis of seed yield and its components in sesame. *Indian J. Agric. Sci.*, **51** : 627-630.

5. **Bhele, D.S., Khorgade, P.W. and Narkhada, M.N.** 1987. Estimates of genetic parameters, correlation coefficients and path analysis in sesame *(Sesamum indicum L.). PKV Res. J.* **11** : 118-122.

6. **Sharma, R.L. and Chauhan, B.P.S.** 1984. Path analysis in sesame. *J. Maharashtra Agric. Univ.* **9** : 158-160.

7. **Vadhavani, H.K., Kukadia, M.U. and Parmar, V.L.** 1992. Correlation and path analysis in sesamum. *GAU Res. J.* **18** : 31-34.

8. **Yadav, T.P., Parkas Kumar and Yadav, A.K.** 1980. Association of yield and its components in sesame. *Indian J. of Agric. Sci.*. **50** : 317-319.

9. **Pathak, H.C. and Dixit, S.K.** 1986. Genetic variability, correlation and path coefficient analysis for components of seed yield in single stemmed sesame. *GAU Res. J.* **12** : 1-5.

10. **Mishra, A.K., Raghu, J.S., Ghurayya, R.S., Ali, S.A. and Raghuvanshi, R.S.** 1995. Genetic variability in multi capsule types of sesame. *Crop Res.* **9** : 317-323.

11. **Kavitha, M., Sethupathi, R. and Ramlingam** 1999. Path analysis in segregating population of sesame. *Madras Agric. J.* **86** : 158-159.

12. **Godawat, S.L. and Gupta, S.C.** 1986. Variability and association for agronomic traits in sesame *(Sesamum indicum* L.). *Indian J. of Agric. Res.* **20**:192-196.

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Changes in soil chemical properties under dillseed (*Anethum graveolenses L*) irrigated with sewage and well water along with N levels.

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Abstract

Field investigations were conducted at College farm, S.D. Agricultural University, Sardarkrushinagar during *rabi* 2004-05 and 2005-06 to assess the changes in soil chemical properties under dill seed crop irrigated with sewage(S) and tubewell water(T) in cyclic mode. Six schedules each of four irrigations in cyclic mode comprised main plot and three levels of N (0, 20 and 40 kg/ha) as sub plots were included in the study. The sewage water used in the study dominated with bicarbonates, chlorides, magnesium and sodium. Treatment I_2 (SSSS) raised soil EC as compared to rest of the treatments except that of I_5 (TSSS) after second crop. Cyclic mode of two and three irrigations of sewage and well water or vice versa did not differ from each other at the end of study. Similarly I_2 helped to increase available N and P_2O_5 status of soil remaining at par with I_5. After harvest of second crop, I_2 standing at par with I_5 registered highest values of DTPA extractable Fe, Mn, Zn and Cu in soil. Sewage water irrigations did not significantly influence the DTPA extractable cobalt, cadmium, lead and nickel content of soil at the end of the study. Nitrogen @ 40 kgha^{-1} helped to raise soil available N and Fe status over control. It did not influence the heavy metals content of soil after second crop.

Key Words: Dill seed, sewage water, tube well water irrigation, nitrogen

Introduction

The domestic waste water/sewage irrigation is an age old practice in India due to large volume of sewage produced in cities. The first farm for wastewater irrigation was started in Ahmedabad during 1895. As per survey report of WPCB (1), Ahmedabad city alone generates as much as 742 million liters per day of sewage. In general, sewage water generated in India contains more than 90 per cent water.

Sewage contains good amount of essential plant nutrients *viz.*, N, P, K and micronutrients like Zn, Cu, Fe and Mn (2). Sewage effluent had very good nutritive value besides having a suitable pH, soluble salt, NO_3-N, SO_4 etc., but also contained certain amount of heavy metals irrespective of population differences and districts (3).

The current aim of sustainable agriculture is to develop farming systems that are productive and profitable, conserve natural resources, protect the environment and maintain soil health and enhance crop production in long term perspective.

Water scarcity in North Gujarat is a serious concern in agriculture, withdrawal of more and more ground water, without recharging has not only declined water table but deteriorated the quality and also increased electricity charges. Recharging of ground water is restricted due to low and erratic rains in this region. Hence, one of the alternatives is to make use of sewage water for agriculture. At present, in the urban and peri urban areas, such water is left without systematic use. Here an attempt has been made to use the sewage/domestic wastewater released from the residential complex of the university campus for agricultural production in a cyclic mode with well irrigation water.

Fertilizer management has a vital role in light textured soils, which pose nitrogen deficiency. Considering the above facts the investigation was taken up to study the changes in soil chemical properties under dill seed

irrigated with sewage and well water along with levels of nitrogen on loamy sand soils of North Gujarat.

Materials and methods

Field experiments were conducted at Agronomy Instructional Farm, C.P. College of Agriculture, S. D. Agricultural University during 2004-05 and 2005-06 on loamy sand soils containing low available N and medium P_2O_5 and K_2O along with low S, Fe and medium Zn, high Mn and Cu. Soils were neither saline nor alkaline.

The irrigation water used (Sewage and Tube well water) was analyzed whenever applied and the average values worked out for different parameters are cited below.

Source	pH	EC dSm^{-1}	Carbonate me l^{-1}	Bicarbonate me l^{-1}	Chloride me l^{-1}	Sulphate me l^{-1}	Ca me l^{-1}	Mg me l^{-1}	Sodium me l^{-1}
S.W.	7.38	0.92	0.89	7.27	4.88	0.98	2.90	4.15	4.05
T.W.W.	7.65	0.68	0.67	4.55	3.50	0.81	1.75	4.70	1.50

Source	Potassium me l^{-1}	Fe ppm	Mn ppm	Zn ppm	Cu ppm	Pb ppm	Cad ppm	Ni ppm	Co ppm
S.W.	0.31	3.25	0.03	0.25	0.09	0.09	0.02	0.06	0.04
T.W.W.	0.11	2.08	0.01	0.11	0.08	0.08	0.02	0.06	0.03

Two common irrigations were applied initially to establish the crop, one after sowing and second at 8 DAS with tube well water. The treatments comprised of four irrigations with a schedule involving cyclic mode of sewage and tube well water viz., I_1 (TTTT), I_2 (SSSS), I_3 (TSTS), I_4 (TTSS), I_5 (TSSS) and I_6 (STTT), as per crop need after establishment of the crop. Three levels of N (0, 20, 40 kg ha^{-1}) were super imposed as sub plot treatments. The crop variety selected was dill seed G.A.-1 released by GAU for commercial cultivation. The experiment was laid out in split plot design. The soil samples were collected and analyzed for chemical properties of soil employing standard methods.

Results and discussion

Effect of irrigation water

The data pertaining to soil available N, P_2O_5 as well as DTPA extractable Fe, Mn, Zn, Cu content in soil after harvest of second crop as influenced by sewage and well water irrigation schedules as well as N levels are exhibited in Table - 1. Treatment I_2 noted higher available N content over I_1 and I_6, but it remained at par with rest of the treatments. Decrease in number of sewage water irrigations tended to decrease the available N content of the soil after harvest of the crop. Similar trend was observed for available P_2O_5 content of soil. Cyclic mode of two irrigations did not differ from each other, but three and four irrigations of sewage helped to bring significant improvement in available phosphorus content.

The buildup of soil N and P_2O_5 is attributed to the content of major essential plant nutrients in domestic waste water, which had been also noticed by Yadav *et al.* (4) and Tiwari *et al.* (5).

The analysis of soil after harvest of crop indicated that extractable Fe, Mn, Zn and Cu contents were significantly varied due to sewage and well water irrigation schedules. Treatment I_2 registering the highest value of Fe showed its superiority for building up of Fe with sewage water application. The magnitude of increase in Fe content by I_2 over I_1 and I_6 was to the tune of 35.33 and 24.74 per cent, respectively. Similarly, the status of Mn, Zn and Cu was also spectacularly improved with increase in number of sewage water irrigations. On an average I_2 ranked at top followed by I_5 with regard to build up of these micronutrients in the soil. The probable reason for improvement in status of micronutrients with increasing sewage water irrigations is due to higher concentration of these nutrients in the total solids of sewage waste water. These findings are in accordance with those reported by Tiwari *et al.* (5) and Khurana *et al.* (6).

Among the four heavy metals studied, the soil status of Co,Cd, Pb and Ni was not significantly influenced due to sewage and well water irrigation schedules (Table-2).This might be due to low concentration of heavy metals in sewage water and below permissible limits because of generation of sewage from

Table 1. Soil EC, N, P_2O_5 and Micronutrient status as influenced by different treatments after harvest of secon crop

Particulars / Treatments	EC dSm^{-1}	Available Nutrients kg ha^{-1}		DTPA extractable, ppm			
		N	P_2O_5	Fe	Mn	Zn	Cu
Irrigation Schedules							
I_1 : T T T T	0.17	144.95	47.59	3.71	9.65	0.71	0.64
I_2 : S S S S	0.21	176.72	58.53	5.90	14.84	1.01	1.08
I_3 : T S T S	0.19	159.40	52.74	4.77	13.26	0.87	0.83
I_4 : T T S S	0.19	161.15	52.23	4.85	12.85	0.84	0.81
I_5 : T S S S	0.20	171.43	56.45	5.26	14.13	0.92	1.04
I_6 : S T T T	0.19	154.95	50.71	4.44	10.76	0.77	0.73
S.Em ±	0.004	5.59	1.58	0.19	0.52	0.04	0.04
C.D. at 5 %	0.01	17.60	4.68	0.62	1.65	0.13	0.13
Nitrogen levels (kg ha^{-1})							
N_o : 00	0.19	154.32	51.96	4.66	12.48	0.82	0.83
N_1 : 20	0.19	162.49	53.29	4.86	12.62	0.85	0.87
N_2 : 40	0.20	167.48	53.89	4.95	12.65	0.89	0.87
S.Em ±	0.002	3.53	0.84	0.07	0.28	0.02	0.02
C.D. at 5 %	NS	10.30	NS	0.21	NS	NS	NS
Initial Status	0.18	159.85	52.54	3.96	10.51	0.75	0.69

T – Tube well water S – Sewage water

Table 2. Heavy Metals content of soil as influenced by different treatments after harvest of second crop

Particulars / Treatments	DTPA extractable, ppm			
	Co	Cd	Pb	Ni
Irrigation Schedules				
I_1 : T T T T	0.35	0.18	0.53	0.30
I_2 : S S S S	0.40	0.21	0.57	0.34
I_3 : T S T S	0.37	0.19	0.56	0.33
I_4 : T T S S	0.37	0.19	0.55	0.34
I_5 : T S S S	0.38	0.20	0.56	0.34
I_6 : S T T T	0.35	0.19	0.54	0.32
S.Em ±	0.012	0.009	0.02	0.011
C.D. at 5 %	NS	NS	NS	NS
Nitrogen levels (kg ha^{-1})				
N_o : 00	0.37	0.19	0.54	0.33
N_1 : 20	0.37	0.20	0.55	0.33
N_2 : 40	0.38	0.19	0.56	0.33
S.Em ±	0.006	0.005	0.009	0.05
C.D. at 5 %	NS	NS	NS	NS
Initial Status	0.37	0.19	0.55	0.32

T – Tube well water S – Sewage water

residential complex avoiding industrialization. These findings are in partial agreement with those obtained by Yadav *et al.* (4) and Khurana *et al.* (6).

Effect of N levels

Data presented in Table-1 indicated that treatment N_2 (40 kg ha^{-1}) recorded significantly higher available N content of soil over N_0, but seen statistically at par with N_1 (20 kg ha^{-1}). N levels did not produce significant effect on soil EC.

Successive increase in N levels, from N_0 to N_2 brought significant improvement in Fe content of soil.

Nitrogen application did not play significant role on available P_2O_5 as well as DTPA extractable Mn, Zn and Cu content of soil. Heavy metals viz., Cobalt, Cadmium, Lead and Nickel content of soil were also not altered due to application of nitrogen (Table 2).

Conclusion

On the basis of forgoing results, it can be inferred that in water scarce areas, sewage water can be used along with tube well water in a cyclic mode in the proportion of 3:1 irrigation schedule without affecting heavy metals contents of soil. It can improve the soil status of available N, P_2O_5 and DTPA extractable Mn, Cu, Zn and Fe. In water scarce area, nitrogen application also did not significantly influence the heavy metals content of soil, but helped to build up N and Fe status of soil.

References

1. **WPCB** 1995. Water prevention and control pollution Act., Act. No. 6, Water pollution control Board, Ministry of works and housing, New Delhi.
2. **Maiti S., Shad, K.D; Gupta, S.K. and Benerji, S.K.** 1992. Evaluation of sewage water as a source of irrigation and manual. *J. Indian Soc. Soil Sci.* **40** :168-172.
3. **Chitdeshwari, T., Duraisami, V.P, Poongothai, S. and Singh, M.V.** 2003. Chemical composition of sewage effluent of major cities of Tamilnadu. Proceedings of the International Conference on water and Environment (WE-2003) -Waste Water Treatment and Waste Management, Dec. 15-18, 2003, Bhopal, pp. 227-238.
4. **Yadav , R.K., Goyal, B., Sharma , R.K., Dubey, S.K. and Minhas, P.S.** 2002. *Environment International*, **28** :481-486
5. **Tiwari, R.C; Sarswat, P.K. and Agarwal, H.P.** 2003. Change in macronutriant status of soils irrigated with treated sewage water and tubewel water. *J. Indian Soc. Soil Sci.* **51**:150-155
6. **Khurana, M. P. S., Singh, M. and Nayyar V.K.** 2004. Assesment of heavy metal contamination in soils and plants irrigrated with sewage water contary industrial effluents in district Amritsar (Punjab). *Indian J. Environ. and Ecoplan.* **8**: 221-228

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Diversification of existing pearlmillet-wheat cropping system for sustainable productivity under irrigated condition

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Abstract

A field experiment with 10 crop sequences was conducted during 2001-02 to 2005-06 at Main CSR station, SDAU, Sardarkrushinagar (Gujarat). All cropping sequences were evaluated for their production potential, calorilic value, production efficiencies, land-use efficiency and economics. Pearlmillet equivalent yield, production efficiency and net realization was recorded maximum (13307 kg/ha, 168 5 Rs/ha/day and 49,719 Rs/ha, respectively) through cowpea - mustard-poailrnillet sequential cropping followed by greengram mustard - pearlmillet sequence (13205 kg/ha, 168.5 Hs/ha/ day and 48,827 Rs/ha, respectively). The highest BCR (2.79) was recorded with castor-fodder sorghum (summer) sequence. The crop sequence clusterbean - grain amaranth - groundnut recorded higher land use efficiency (92 %) over rest of the sequences.

Keywords: Diversification, cropping system, land use efficiency

Introduction

Pearlmillet wheat is the most popular crop sequence of North Gujarat. Though the system has sustained over the years. But over the years yield stagnation is observed in this sequence. This stagnation in productivity can attributed mainly to exhaustive nature of the cereal-cereal crop sequence. There are good numbers of more productive as well as more remunerative oil seeds, cash crops, pulses and todder crops which can successfully grown in this area. Therefore, cultivation of these crops in different sequences is the prime and urgent need to sustain the agriculture and cultivators of the area. Keeping in view the above facts, present investigation vas carried out under All India Co-ordinated Research Project on Cropping System to evaluate production potential and economically viable crop sequences.

Material and methods

A field experiment was conducted during *kharif*, *rabi* and summer seasons of 2001 -02 to 2005-06 at main CSR station, SDAU, Sardarkrushinagar (Gujarat).The soil was loamy sand having 0.28 % organic carbon and 191, 22.3 and 173 kg/ha available nitrogen, phosphorus and potassium, respectively.Ten cropping sequences of different crops viz. pearlmillet, clusterbean, greengram, castor, cotton and cowpea as *kharif*. wheat, mustard and grain amaranth as *rabi* and greengram, cowpea grain and fodder, fodder sorghum, groundnut and pearlmillet as summer were selected. The experiment was laid out in randomized block design with three replications in a permanent site. The crops were raised with recommended package of practices under irrigated conditions. Main products as well as by-product of economic importance of different crops of respective cropping sequences were converted to pearlmillet equivalent yield (PMEY) on the basis of prices prevailing during 2005-06. The data were pooled over five years. Production efficiency was calculated as per method given by Tomar and Tiwari (1990). Intensification in time was measured by calculating values of land-use efficiency by dividing total duration of a sequence with number of days in a year and expressed as percentage. Land-use efficiency was obtained by taking total duration of crops in individual crop rotation divided by 365 days. The production efficiency values in term of Rs/ha/day were calculated by net monetary returns of the rotation divided by total duration of the crops in the rotation. The calculation of calories was done on the basis of calories found in a particular crop on per gram basis.

Results and discussion

The data presented in Table 1 on PMEY for different sequences indicated that the differences in pearlmillet equivalent yields of different sequences were significant.The results indicated that the sequence cowpea - mustard - pearlmillet topped the list by recording significantly higher PMEY over rest of the treatments except greengram - mustard - pearlmillet sequence and clusterbean - grain amaranth - groundnut. Data further indicated that the sequences pearlmillet - wheat and clusterbean - wheat always gave significantly lower PMEY as compared to rest of the treatments.

L and use efficiency of all 10 crop sequences revealed that the highest land utilization efficiency was observed in clusterbean - grain amaranth - groundnut crop sequence while pearlmilet - wheat sequence recorded the lowest value. The highest production efficiency was obtained through cowpea - mustard - pearlmillet sequential cropping followed by greengram - mustard -pearlmillet sequence. Maximum calorific value was found in cowpea - mustard - pearlmillet sequential cropping followed by greengram - mustard - pearlmillet sequence. This indicates that these sequences have high value, high quality produce with highest biological efficient crop sequences.

The figures presented in Table 1 indicated that the net realization per ha was significantly influenced due to various sequences. The results indicated that the sequence cowpea - mustard - pearlmillet recorded higher net realization though it was at par with greengram -mustard pearlmillet, clusterbean - grain amaranth - groundnut and castor -fodder sorghum sequences.The BCR values worked out for different sequences revealed that the sequence castor - fodder sorghum recorded higher BCR over rest of the sequences but it was closely followed by cowpea - mustard - pearlmillet and greengram - mustard - pearlmillet sequences.

Table 1. Pearlmillet equivalent yield (PMEY), cost of cultivation, land-use efficiency (LEU), production efficiency (PE), total calories, net realization and BCR of different crop sequences (mean of 5 years from 2001 -02 to 2005-06)

Tr. No	Crops			PMEY (kg/ha)	Cost of cultivation (Rs/ha)	Net realiza-tion (Rs/ha)	Land use effition efficiency (%)	Produc-tion efficiency (Rs/ha/ day)	Total calories (K x 1000)	BCR
	Kharif	*Rabi*	Summer							
1	Pearl Imillet	Wheat	Fallow	7860	25152	22010	60	100.0	16561	1.88
2	Clusterbean	Wheat	Fallow	8522	23916	27216	64	115.8	12341	2.14
3	Pearlmillet	Wheat	Cowpea (F)	10703	35089	29128	77	104.0	16874	1.83
4	Greengram	Mustard	Pearlmillet	13205	30402	48827	79	168.4	21658	2.61
5	Cotton	Contd	Greengram	11868	32154	39054	82	130.2	-	2.21
6	Clusterbean	Wheat	Sorghum(F)	10503	34882	28135	82	93.8	12544	1.81
7	Clusterbean	grain amaranth	Groundnut	12704	31511	44714	92	133.5	14371	2.42
8	Castor	Contd	Sorghum(F)	11832	25438	45551	81	154.4	-	2.79
9	Cotton	Contd	Cowpea (g)	11031	32055	34133	82	113.8	-	2..06
10	Cowpea(g)	Mustard	Pearlmillet	13337	30303	49719	81	168.5	23476	2.64
	S.E.m±			439		2634				
	C.D. at 5 %			1261		8570				
	C.V (%)			7.6		13.8				

Conclusion

Amongst different cropping sequences, cowpea - mustard - pearlmillet sequence gave higher PMEY as well as net realization which were closely followed by greengram - mustard -pearlmillet, castor - fodder sorghum and clusterbean - grain amaranth - groundnut. The results clearly indicated that the existing predominant cropping sequences viz. pearlmillet - wheat and clusterbean - wheat are now found less remunerative as compared to cowpea/ greengram - mustard - pearlmillet, Castor- fodder sorghum, clusterbean - grain amaranth - groundnut sequences Therefore, to increase the income, the farmers of North Gujarat are advised to select more remunerative cropping sequence instead of existing less remunerative cropping sequences.

References

1. **Tomar, S. S. and Tiwari, A. S.** 1990. Production potential and economics of different crop sequences. *Indian J. of Agron.* **35** . 30-35.

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Effect of methods and dates of sowing on yield of green onion (*Allium cepa L.*) in *kharif* under North Gujarat conditions

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Abstract

The effect of different dates (18th August, 28th August, 7th September and 17th September) and two methods of sowing (Direct seeding and transplanting) on yield of green onion was investigated during kharif season. Sowing on 18th August gave maximum number of leaves plant-1. Early sowing up to 28th August helped to increase plant height and number of leaves plant-1. Days to maturity increased with delayed sowing from 18th August to 17th September. Neck thickness of plant and diameter of bulb were observed significantly higher with sowing on 18th August. Significantly higher green onion yield was recorded when crop sown on 18th August followed by 28th August. Transplanting method did not significantly affect the plant height and number of leaves per plant. Less days were required for maturity with transplanting method as compared to direct seeding method. The neck thickness of plant and diameter of bulb were significantly higher with transplanting method. Significantly higher green onion yield was obtained with transplanting method. The results indicated that to achieve maximum green onion yield and net realization with early sowing/ transplanting from second fortnight of August to September is worth adopting for North Gujarat region.

Key Words: Green onion, sowing methods, transplanting

Introduction

To catch the off-season market for green leaves onion its sporadic cultivation is initiated in *kharif* by the farmers in the vicinity of urban area in North Gujarat. Production technology to raise onion during *kharif* season needs to be generated to recommend to the farmers. The time of sowing exerts a distinct effect on growth and eventually on yield of onion. The optimum time of sowing is decided by several factors, the most important which is the temperature during the growing season. Furhter, transplanting of seedlings or planting of small bulbs is labour intensive and involve either nursery raising or need small bulbs for planting purpose. Direct seeding is also one of the methods to raise onion crop. The technology related to appropriate time of sowing as well as economically viable method of sowing for *kharif* season, to meet the supply of green onion during off-season is the need for the farmers. Keeping this in view an experiment was planned to find out the appropriate time and method of sowing *kharif* onion.

Materials and methods

The field experiment was conducted during 2003-04 at the Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. Eight treatments comprised of four dates of sowing (18th August, 28th August, 7th September and 17th September) and two methods of sowing (Direct seeding and transplanting) were tried in factorial randomized block design with four replications. The seeds of onion variety Agrifound Dark Red were sown directly on 18th August, 28th August, 7th September and 17th September 2003 in respective beds, keeping the seed rate 10 kg ha^{-1}. For transplanting method, the seed were sown in the nursery on the same respective dates as in the direct seeding. After 40 days, when the seedlings become ready, those were used for transplanting on 27th September, 7th October, 17th October and 27th October 2003. The entire quantity of phosphorus and potash was applied as basal dose at the time of sowing in form Diamonium phosphate and Muriate of potash, respectively. Whereas, nitrogen was

top dressed in two equal splits at 25 and 45 days after sowing/transplanting.

Results and discussion

Effect of dates of sowing

The perusal of data presented in Table 1 indicated that different sowing dates significantly influenced the plant height at 45 DAS/DATP and 60 DAS/DATP. Higher plant height was obtained with treatment D_1 (18th August) and D_2 (28th August) at 45 DAS/DATP (25.46 and 25.38 cm) and 60 DAS/DATP (32.35 and 32.26 cm) over later dates of sowing. The plant height recorded at harvest stage was not significantly influenced due to dates of sowing. Treatments D_1 (18th August) remaining at par with D_2 (28th August) produced significantly higher number of leaves (4.73, 5.55 and 6.48) at 45DAS/DATP, 60 DAS/ DATP and at harvest as compared to later dates of sowing i. e. D_3(7th September) and D_4(17th September). Thus early sowing favoured to increase plant height and number of leaves per plant might be due to availability of favourable weather during sowing time and growth period. These findings land support to the observations of Singh *et al.* (1). The result presented in Table 2 indicated that treatment D_1 (18th August) recorded maximum neck thickness of plant followed by D_2 (28th August). Grater neck thickness of plant might be due to high humidity and lesser sunshine hours at the time of sowing and during initial growth period in case of early sown crop. Similar results were also obtained by Singh *et al.* (1).

Maximum diameter of bulb was observed under first date of sowing D_1 (18th August). The magnitude of increase in diameter of bulb under D_1 (18th August) was to the tune of 2.01, 16 and 17.35 per cent over D_2 (28th August), D3 (7th September) and D_4 (17th September) respectively. Similar findings have been reported by Kumar *et al.* (2). Early sowing D_1 (18th August) and D_2 (28th August) required significantly shorter period for maturity as compared to delayed sowing on D_3 (7th September) and D_4(17th September). Sowing date D_1 (18th August) produced the highest yield of green onion 28,342 kg ha^{-1} followed by D_2 (28th August). The magnitude of increase in green onion yield with sowing date D_1 (18th August) was 23.44 percent over sowing date D_4 (17th September). Prevalence of favourable weather conditions at sowing time and during growth period might have helped to increase in growth and yield attributes in early sown crop and ultimately higher green onion yield. These results are accordance with the findings reported by Singh *et al.* (1). The maximum net realization of Rs. 2, 57,912 ha^{-1} realized when crop was sown on 18th August.

Effect of methods of sowing

An appraisal of data presented in Table 1 indicated that transplanting favoured for increase in plant height at 45 DAS/DATP (31.23 cm) and 60 DAS/DATP

Table 1. Effect of dates and methods of sowing on growth attributes

Treatments	Plant height (cm)			Number of leaves $plant^{-1}$		
	45 DAS/DATP	60 DAS/DATP	At harvest	45 DAS/DATP	60 DAS/DATP	At harvest
Dates of sowing (D)						
D_1 : 18th August	25.46	32.35	40.78	4.73	5.55	6.48
D_2 : 28th August	25.38	32.26	40.08	4.45	5.48	6.38
D_3 : 7th September	22.36	28.66	38.76	4.13	5.03	6.30
D_4 : 17th September	21.69	27.97	38.49	3.68	4.60	5.93
S. Em ±	0.98	0.78	0.79	0.12	0.14	0.10
C. D. at 5%	2.88	2.29	NS	0.34	0.40	0.28
Methods of sowing (S)						
S_1 : Direct seeding	16.21	22.71	39.12	3.61	4.56	6.26
S_2 : transplanting	31.23	37.91	39.94	4.87	5.76	6.28
S. Em ±	0.69	0.55	0.56	0.08	0.10	0.07
C. D. at 5%	2.04	1.62	NS	0.24	0.28	NS
C. V.%	11.68	7.26	5.69	7.83	7.42	4.37

Table 2. Effect of dates and methods of sowing on yield attributes and yield and net realization

Treatments	Neck thickness of plant (cm)	Diameter of plant (cm)	Days to maturity	Green onion yield (kg ha^{-1})	Net realization (Rs. ha^{-1})
Dates of sowing (D)					
D_1 : 18th August	1.13	2.03	83.25	28,342	2,57,912
D_2 : 28th August	1.13	1.99	84.75	25,043	1,74,836
D_3 : 7th September	1.02	1.75	90.37	24,175	1,19,242
D_4 : 17th September	1.02	1.73	93.25	22,960	1,11,912
S. Em ±	0.03	0.07	0.64	1221	
C. D. at 5%	0.08	0.21	1.88	3593	
Methods of sowing (S)					
S_1 : Direct seeding	1.04	1.74	105.18	23,828	1,59,650
S_2 : transplanting	1.11	2.01	70.62	26,432	1,65,983
S. Em ±	0.02	0.05	0.45	863	
C. D. at 5%	0.06	0.14	1.33	2540	
C. V.%	7.29	10.73	2.05	13.75	

(37.91 cm) over direct seeding method. Similarly transplanting helped to increase number of leaves per plant at 45 DAS/ DATP and 60 DAS/ DATP.These results are conformity with those reported by Movalia (3). The data presented in Table 2 indicated that transplanting method recorded significantly higher neck thickness as well as diameter of bulb over direct seeding. This might be due to maintenance of optimum plant stand and spacing under transplanting method. Similar results were also obtained by Movalia (3) and Sukhadia *et al.* (4) reported that maintenance of optimum plant stand and spacing under transplanting helped for more vegetative growth and bulb development and ultimately an increase in diameter of bulb. In direct seeding method green onion matured late, took 105.18 days where as transplanted crop took 70.62 days. The reason for late maturity of green onion in direct seeding can be attributed to time take from germination to seedling stage. These results are in agreement with the findings of Khokhar *et al.* (5) for dry onion bulb. Transplanting registered higher yield of green onion (26,432 kg ha^{-1}) over direct seeding in accounted 10.92 percent. The availability of optimum plant geometry might have helped to improve growth and yield attributes under transplanting method and also the increase in green onion yield. These findings akin the report of Sukhadia *et al.* (4) for dry onion bulb. Maximum net realization of Rs. 1, 65,983 ha^{-1} was accrued from transplanting method as compared to direct seeding method (Rs. 1, 59,650 ha^{-1}).

References

1. **Singh, A. K., Singh, V. and Singh, V.** 2002. Effcet of agronomical package of practices on production and economics of green onion (*Allium cepa* L.). *New Botanist.* **29** : 75-81.
2. **Kumar, R., Khurana, S. C., Bhutani, A. K., Bhatia and Dudi, B. S.** 2003. Effect of sowing time on the kharif onion (*Allium cepa* L.) sets production. *Haryana J. Horti. Sci.* **32** :134-137.
3. **Movalia, A. G.** 1996. Comparative performance of direct seeded and transplanted onion (*Allium cepa* L.) under varying dates of sowing and nitrogen levels. M. Sc. (Agri.) Thesis. GAU, Sardarkrushinagar.
4. **Sukhadia, N. M., Ramani, B. B. and Dudhatra, M. G.** 2002. Rsponse of rainy season onion (*Allium cepa* L.) to sowing methods and weed management practices. *Indian J. Agron.* **47** : 278-283.
5. **Khokhar, K. M., Mahmood, T., Hussin, S. I. and Qureshi, K. M.** 1990. Effect of different sowing dates, direct seeding and transplanting of seedling on maturation, bulb weight and yield of onion cultivation. *Indian J. of Agric. Sci.* **60** : 668-671.

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Response of N, P and S on yield and quality of mustard and their residual effect on moong

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Abstract

Field experiment was laid out during two consecutive (mustard – moong sequence) crop years for 1995 – 96 and 1996- 97 on a loamy sand soil to study the response of mustard (*Brassica juncea* L.) crop to applied N, P and S. Doses of N were 50, 75 and 100 kg ha^{-1}. The doses of P and S were 0, 25 and 50 kg P_2O_5 ha^{-1} and 0, 20 and 40 kg S ha^{-1}, respectively. The seed yield and protein content in seed of mustard significantly increased with increasing levels of applied N, P and S. N application increased seed yield by 26.23 and 29.42 per cent, while decreased the oil content by 2.83 and 1.55 per cent in the year 1995-96 and 1996-97, respectively over control. Similarly, P application increased the seed yield and oil content by 11.24, 19.28 and 0.75 and 1.56 per cent and sulphur application by 49.07, 35.63 and 2.00 and 4.26 per cent in both the years, respectively over control. Significant responses of mustard to applied nutrients were found 100 kg N, 50 kg P_2O_5 and 40 kg S ha^{-1}. Application of N, P and S the previous crop of mustard significantly elevated the grain yield of moong during second year.

Key Words: Moong, mustrad, residual effects

Introduction

Mustard and rapeseed are the major oilseed crops of India. Oilseeds belonging to *Brassica* family have higher sulphur requirement as their oil storage organs are rich in protein of which sulphur is a constituent (1). Nitrogen is the nutrient which most often increased mustard yield by increasing the growth attributes. Application of adequate phosphorus results in increased yield and proportion of oil in seed. The higher oil content with high phosphorous fertilization may be possibly due to increased rate of glycosis resulting in production of acetyl Co A which leads to formation of more oil and protein in oil crops (2). Sulphur catalyses the metabolic of carbohydrates. Sufficient application of sulphur causes formation of more oil by reducing accumulation of carbohydrates in plants (3) and improved the nodulation of legumes.

There are quite a few reports on the effect of N, P and S on the yield, oil and protein content of mustard and their residual effect of moong. Thus, the present investigation was taken upto throw more light on this aspect. The present study was undertaken to elicit such information.

Materials and methods

Field experiment was conducted for two consecutive years in *rabi* and summer seasons of 1995 – 96 and 1996 – 97 with mustard (Cv. GM -1) and moong crop (K 851) in a sequence at Agronomy Farm, Anand in a R.B.D with 27 treatments in 3 replications. The soil (*Alluvial ustocrept*) of the site had the characteristics as follows well drained loamy sand texture sand- 84.5 %, silt – 5.50 %, clay – 7.0 %, pH (1:2.5) -8.2, EC–0.09 dS m^{-1}, CEC – 12.85 C mol (p$^+$) kg^{-1}, organic carbon -2.6 g kg^{-1}, available N 168.56 kg ha^{-1}, available P_2O_5 – 16.44 kg ha^{-1} and available S – 13 ppm. The soils were tested for available N (4), available P_2O_5 (5), available S (6). The oil content in seed samples was determined by NMR method (7) and protein content was calculated (N x 6.25). Nitrogen was determined in seed by micro – Kjeldahl's method (8).

Nitrogen was applied @ 50, 75 and 100 kg N ha^{-1}, phosphorus @ 0, 25 and 50 kg P_2O_5 ha^{-1} and sulphur @ 0, 20 and 40 kg S ha^{-1} through urea, DAP and gypsum, respectively. As per treatment full dose of P, S and half dose of N was applied as basal before

sowing and remaining half dose of N was applied as top dressing after one month. Fertilizer was not applied to the subsequent moong crop.

Results and discussion

Seed yield

The results show that seed yield of mustard increased significantly by N, P and S application in both the years and being highest at N_{100}, P_{50} and S_{40} levels (Table 1). The highest dose of N (100 kg ha^{-1}) gave 26.23 and 29.42 per cent increase in seed yield over control during 1995-96 and 1996-97, respectively. Similar, results were reported by Tiwari *et al.* (9) and Tomer *et al.* (10).

Oil Content

Higher level of nitrogen application decreased significantly the oil content. The decrease in oil content was 2.83 and 1.55 per cent in both the years, respectively. Phosphorus and sulphur increased significantly the oil content of mustard, highest oil content being recorded at higher doses of P and S (50 kg and 40 kg ha^{-1}), respectively. Phosphorus increased by 0.75 and 1.56 per cent while S increased oil content significantly by 2.00 and 4.26 per cent in both the years, respectively.

The results are in agreement with those obtained by Singh *et al.* (11) and Tomer *et al.* (10). Beneficial effect of P and S on oil content is due to the increase in linolenic acid content and probably due to the increase in glycosides, which on hydrolysis produced higher amount of oil.

Protein content

N, P and S application enhanced positively and significantly the protein content in mustard in both the years (Table 1). However, the results were more pronounced in case of N treatment. Results show increasing trend with an increase in levels of these nutrients being highest at N_{100}, P_{50} and S_{40} levels. At P_{50} level, there was increase in protein content. Addition of S has been found to be beneficial for enhancing protein content in mustard and S containing amino acids increased with S application which ultimately leads to high protein (12).

Residual effect on grain yield of moong

The results show that grain yield of moong increased significantly by N, P and S application in the second year only and being highest at N_{100}, P_{50} and S_{40} levels (Table 2). The percentage increase over control in grain yield of moong in the second year under N_{100}, P_{50} and S_{40} levels over N_{50}, P_0 and S_0 were 18.0, 24.54 and

Table 1. Effect of N, P and S on seed yield (q/ha), oil and protein content (%) of mustard

Levels	Seed yield		Oil content		Protein content	
	1995-96	1996-97	1995-96	1996-97	1995-96	1996-97
N levels						
N_1	13.65	15.43	38.74	35.29	17.75	17.41
N_2	14.53	17.72	38.36	34.82	18.56	18.38
N_3	17.23	19.97	38.15	34.32	20.29	19.77
CD at 5 %	0.26	0.43	0.16	0.35	0.28	0.35
P levels						
P_0	14.32	16.08	38.27	34.54	18.81	18.33
P_1	15.16	17.86	38.43	34.81	18.84	18.48
P_2	15.93	19.18	38.56	35.08	18.95	18.75
CD at 5 %	0.26	0.43	0.16	0.35	NS	NS
S levels						
S_0	12.33	15.10	38.03	34.07	18.66	18.30
S_1	14.70	17.63	38.42	34.84	18.85	18.50
S_2	18.38	20.38	38.79	35.52	19.08	18.76
CD at 5 %	0.26	0.43	0.16	0.35	0.28	0.35

Table 2 Residual effect of N, P and S on grain yield (kg/ha) of moong

Levels	Seed yield	
	1996-97	1997-98
N levels		
N_1	544	549
N_2	535	607
N_3	579	871
CD at 5 %	NS	23.1
P levels		
P_0	550	599
P_1	558	683
P_2	571	746
CD at 5 %	NS	23.1
S levels		
S_0	551	606
S_1	561	683
S_2	566	739
CD at 5 %	NS	23.1

21.95, respectively. Similar results were obtained by Sreemanarayana and Raju (13).

References

1. **Subbiah, B. V. and Singh, M.** 1970. Efficiency of gypsum as a source of sulphur to oilseeds crops studied with radioactive sulphur and radioactive calcium. *Indian J. Agric. Sci.* **40** : 227–234.
2. **Misra, S. H. and Anand, P. Singh** 1987. Changes in carbohydrates fraction and ascorbic acid content of groundnut under the influence of sulphur and phosphorus fertilizers. *Indian J. Pl. Physiol.* **30**: 134 – 138.
3. **Omkar Singh and Nandal, T. K.** 1987. Effect of sulphur deficiency on lead area ratio and dry matter production in sunflower related with their nitrate reductase activity in leaves. *Indian J. Pl. Physiol.* **30**: 368 – 371.
4. **Subbiah, B. B. and Asija, G. K.** 1956. A rapid procedure for the estimation of available nitrogen in soils. *Curr. Sci.* **25** : 259.
5. **Olsen, S. R., Cole, C. V., Watanable, P. S. and Dean, L. A.** 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Cir. U. S. Dep. Agric., : 939.
6. **William, D.H. and Steinberg, A.** 1959. Sulphur fraction as chemical index of available sulphur in some Australian soils. *Aust. J. Agric. Res.* **10** : 340-352.
7. **Tiwari, P. N.** 1974. Pulsed NMR for rapid and non-destructive determination of oil in oilseeds. *J. Oil Chem. Sci.* **51** : 1049.
8. **Jackson, M. L.** 1973. Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi.
9. **Tiwari, K. P., Dixit, J. P and Saran, R. N.** 1988. Effect of nitrogen and irrigation on linseed. *Indian J. Agron.* **33** : 44.
10. **Tomar, T. S., Singh, S., Kumar, S. and Tomar, S.** 1977. Response of Indian mustard (*Brassica juncea)* to nitrogen, phosphorus and sulphur fertilization. *Indian J. Agron.* **42** : 148 – 151.
11. **Singh, V., Mehta, V. S. and Singh, B.** 1986. Individual and interaction effect of sulphur, phosphorus and molybdenum in mustard. *J. Indian Soc. Soil Sci.* **34** : 535 – 538.
12. **Singh, R. A. and Singh, H. R.** 1978. Effect of nitrogen and phosphorus on yield, quality and moisture use pattern of linseed grown on rainfed lands. *Indian J. Agric. Sci.* **48**: 583.
13. **Sreemannarayana, B., and Raju, A. S.** 1993. Direct and residual effect of applied sulphur in sunflower based cropping systems. *Fert. News.* **38** : 39.42.

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Bionomics and behaviour of *Helicoverpa armigera* (Hubner) Hardwick on okra

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Abstract

The bionomics and behavior of *Helicoverpa armigera* was studied in laboratory during *kharif* 2004 at Anand. The eggs were round shaped and shining yellowish white in color. The length and breadth of eggs were 0.45 ± 0.01 and 0.48 ± 0.02 mm, respectively. The incubation period was 2.9 ± 0.78 days. Larva passes through five instars. First instar larva was translucent and yellowish white in color. Second instar larva was yellowish brown color with black thoracic legs and white hairy structure on its body surface. Third and fourth instars larva has yellowish orange longitudinal lines and many short hairs scattered all over the body. Full grown larva brownish or pall green with brown lateral stripes and distinct dorsal strips. The length of fulfed larva was 28.72 ± 1.14 mm, whereas it was 3.56 ± 0.14 mm in case of breadth. Larval duration was 22.49 ± 4.42 days. Larvae feed on inner material by making the hole on okra fruit. The length of male and female pupa was 20.32 ± 1.31 and 21.76 ± 1.41 mm, whereas breadth was 5.68 ± 0.57 and 5.90 ± 0.51 mm, respectively. The duration of male and female pupa was 16.94 ± 0.81 and 17.00 ± 1.05 days, respectively. The moth was brownish gray color and forewings were pale brown with a marginal series of black dots. Hind wings were white in color. The length of male and female moth was 17.70 ± 1.03 and 20.10 ± 1.74 mm, whereas breadth with expanded wing was 34.20 ± 1.92 and 40.20 ± 1.92 mm, respectively. The fecundity of female was 240.2 ± 62.06 eggs. The sex ratio (male : female) was 1 : 12. Total lifespan of male and female was 48.68 ± 6.49 and 52.08 ± 5.58 days, respectively.

Keywords : Okra, bionomics, facundity

Introduction

Okra is grown in *kharif* and summer seasons. Being hardy and short duration crop, it is profitably cultivated in summer when other vegetables are not available in the market and in Gujarat, it is grown almost throughout the year. In Gujarat, it is mainly grown in Vadodara, Surat, Junagadh, Banaskantha, Bhavnagar, Valsad, Gandhinagar and Anand districts (1). Incidence of insect pests is one of the prime factors in production of okra. The okra crop is attacked by many species of insect pests right from germination to harvest. Earlier, *Helicoverpa armigera* (Hubner) Hardwick was considered as one of the minor pest of okra but in recent past become a serious limiting factor in the state. Its infestation affects the quality and quantity of fruit production, which ultimately reduce the market price. Though, the *H. armigera* appears regularly in okra and causes considerable damage but available literature showed that very little work had been carried out on this insect pest especially in Gujarat condition. Considering the importance of the pest and lacunae in the informations regarding its bionomics, nature of damage and behavior, the present study was made to fulfil the same.

Materials and methods

Initially, *H. armigera* larvae were collected from the unsprayed okra field of Agronomy and Vegetable farm of Anand Agricultural University, Anand during *kharif* 2004 and mass reared in the laboratory on fingers of okra variety Parbhani kranti. The larvae were reared in round plastic tube (4.0 cm diameter x 5 cm height) providing fresh and tender finger of okra. The plastic tube closed individually with lid having small aeration holes on a lid. Okra fingers and plastic tubes were changed daily to maintain sanitation. After pupation of larvae, the pupae were kept in Petri dish. The sex of

adult moths could be differentiated in the pupal stage by examining the location of genital slit in relation to anal slit with the help of binocular microscope. The male and female pupae were kept in separate acrylic rearing cage (30 x 30 x 30 cm) for emergence of adults. Male and female adults emerging out from pupae were collected with the help of plastic tube and released in separate acrylic rearing cage for mating and egg laying. A small terminal okra shoot with four to five okra leaves, flower and tender okra fruit was provided inside the cage for egg laying purpose. Absorbent cotton dipped in 5 % honey solution was served as food for the adults. The twigs with freshly laid eggs were used for the studies of different stages of bionomics, behaviour and damage symptoms caused by the pest. During the study period, average temperature and relative humidity were recorded as 27.31 ± 1.04 °C and 73 ± 9.53 %, respectively.

Results and discussion

The female moths laid the eggs singly usually on okra fruits, some times on newly emerged okra fruits, flower buds and leaves (Plate I). Similar egg laying pattern of *H. armigera* was observed by Naganagoud and Thontadarya (2) and Jallow *et al.* (3). The eggs were nearly hemispherical round shaped with flattened base, giving a somewhat dome-shape appearance and shining yellowish white in colour (Plate I) which ultimately becomes darker prior to hatching. This is in accordance with the report of Bhatt and Patel (4). The length and breadth of eggs were 0.45 ± 0.01 and 0.48 ± 0.02 mm, respectively (Table 1). Slightly higher length (0.49 ± 0.01 mm) and breadth (0.51 ± 0.02 mm) of eggs was noted by Bhatt and Patel (4) on gram. The incubation period was 2.9 ± 0.78 days (Table 2). Similar (2 to 4 days) observation was also noted by Change and Chu (5). The hatching percentage of *H. armigera* eggs was 73.6 ± 12.36 %. Almost, the nearest egg hatching percentage (55 to 91 %) have been reported by Saoud *et al.* (6) on chickpea.

The newly hatched larvae feed on okra fruits by scrapping finger surface. The second instar larvae made small damage on finger. The third, fourth and fifth instar larva feed by boring the finger and feeds on inner material. The larvae mainly feed on finger but when finger was not available for food then due to starvation larvae first prefer floral bud followed by leaf and flower. In field, initial stage larvae feed on pollen of flower and on terminal fruit. Latter stage larvae feed on okra fruit by scrapping and feeds inner material by making the hole. As per the findings of Dhawan and Sidhu (7), the larvae of *H. armigera* bore the floral buds and fruits of okra. These investigations are in accordance with the damage symptoms caused by *H. armigera* in okra crop. As regards the behavior of larvae, during feeding kept it's half portion inside and remaining half portion of body outside the okra fruits. The cannibalism met with the larvae of *H. armigera* of the same species. Similar larval behavior of *H. armigera* has been reported by Atwal and Dhaliwal (8).

The larvae were found to passing through five instars on okra food. Similar larval instars were noted on cotton (9). The newly hatched larvae were translucent and yellowish white in colour with black head. The larvae in second instar slightly increased in size with yellowish brown colour with black thoracic legs and minute hairy structure on its body surface. More or less similar observations on morphological characters of first and second instar larva have been reported by Bhatt and Patel (4). Third instar larvae were similar to second instar but it has yellowish orange longitudinal lines with brownish head. Many short hairs were scattered all over the body. The larva in fourth instar increased in size only but showed no remarkable change to third larval instar. The full-grown fifth instar larvae were brownish or pale green with brown lateral stripes and distinct dorsal stripe (Plate I). According to Atwal and Dhaliwal (8), full grown larva was greenish with dark grey lines along the sides of the body. Bhatt and Patel (4) reported that the full-grown larva was brownish or pale green with brown lateral stripes and distinct dorsal stripe. These reports are in agreement with the present morphological characters of the last instar larva. The length of first, second, third, fourth and fifth instar larva was 1.74 ± 0.12, 4.85 ± 0.42, 8.58 ± 0.53, 17.42 ± 0.75 and 28.72 ± 1.14 mm, whereas it was 0.30 ± 0.01, 0.57 ± 0.02, 1.05 ± 0.16, 2.21 ± 0.10 and 3.56 ± 0.14 mm in case of breadth, respectively. The respective instar width of head capsule was 0.27 ± 0.01, 0.49 ± 0.02, 0.72 ± 0.03, 1.27 ± 0.03 and 2.59 ± 0.02 mm, respectively (Table 1). The length and breadth of first, second, third, fourth and fifth instar was measured 1.94 and 0.29, 5.23 ± 0.04 and 0.55 ± 0.01, 8.07 ± 0.07 and 0.83 ± 0.01, 17.40 ± 0.13 and 2.09 ± 0.02 and 28.27 ± 0.09 and 3.41 ± 0.02 mm by Koshiya (9) on cotton, respectively. The slight difference in length and breadth in present findings might be due to effect of food.

The duration of first, second, third, fourth and fifth instar larvae were 2.46 ± 0.50, 3.38 ± 0.90, 4.48 ± 1.90, 4.38 ± 1.14 and 5.00 ± 1.42 days, respectively (Table 2). The larval duration of 2.83, 2.23,

2.46, 2.40 and 3.11 days for the respective instars has been noted by Reed (10) on cotton. The higher duration showed in present investigations might be due to difference in food and climatic condition. The total larval period of pest was 22.49 ± 4.42 days. The larval duration was 20 days on cotton (5) and 19.20 days on pigeon pea (11) was reported by earlier researchers. These reports are strongly support the present larval duration. The larval growth index value was exhibited as 2.62. More or less similar (2.80) growth index value was worked out by Mehta (12) on chickpea.

Pre-pupal stage was marked when the larva completed development, become darker and wrinkled, contracted their body, become sluggish and suspended feeding and movement (Plate I). More or less similar morphological character of pre-pupa was observed by Bhatt and Patel (4). The length of this stage was 24.76 ± 1.72 mm, while the breadth was 3.76 ± 0.56 mm. Almost similar length (25.41 ± 1.60 mm) and slightly higher (4.56 ± 0.43 mm) breadth were measured by Bhatt and Patel (4). The width of head capsule was 2.67 ± 0.02 mm. The duration of pre-pupal stage was 2.54 ± 1.04 days. The pre-pupal period lasted for 2.47 ± 0.70 days was mentioned by Bhatt and Patel (4). These reports are in accordance with the present findings.

The larvae of *H. armigera* was pupated in soil in field and in rearing tube in laboratory. Similar site of pupation was observed by Mehta (12). The newly formed pupa of *H. armigera* was soft and green or pale brown in colour. Latter on this pupa was dark brown in colour, broadly rounded anteriorly and tapered posteriorly and have a sharp spine at the posterior end. Reed (10), Atwal and Dhaliwal (8) and Bhatt and Patel (4) have been described more or less similar colour and structure of pupae. The average length, breadth and distance between genital and anal pore of female pupa was 21.76 ± 1.41, 5.90 ± 0.51 and 1.72 ± 0.02 mm, while it was 20.32 ± 1.31, 5.68 ± 0.57 and 0.63 ± 0.02 mm in case of male pupae, respectively (Table 1). Bhatt and Patel (4) observed that the average length and breadth of pupa was 20.19 ± 1.18 mm and 5.54 ± 0.27 mm in case of male, while in case of female it was 21.66 ± 1.38 mm and 6.06 ± 0.17 mm, respectively. This report tallies with the present findings. The duration of male pupae was 16.94 ± 0.81 days, while duration of female pupae was 17.00 ± 1.05 days (Table 2). The pupal stage to be completed in 18.65 days for male and 18.67 days for female in Gujarat (12). These reports tally with the present investigations.

The moth was stoutly built and of brownish grey colour. Fore wings were pale brown with a marginal series of black dots. There was a black kidney shaped mark on the under side of each fore wing. The hind wings were white in colour with a black band on apical margin of the wings (Plate I). Atwal and Dhaliwal (8) and Bhatt and Patel (4) have observed the more or less similar colour pattern of the adult of *H. armigera*. The length of male and female moth was 17.70 ± 1.03 mm and 20.10 ± 1.74 mm, whereas breadth with expanded wing was 34.20 ± 1.92 mm and 40.20 ± 1.92 mm, respectively. Bhatt and Patel (4) reported that the average length and breadth of male was 17.65 ± 0.72 mm and 34.73 ± 1.76 mm, whereas it was 20.17 ± 1.21 mm and 40.94 ± 1.46 mm in case of female moth, respectively, which was almost similar to present findings. The pre-oviposition period was observed to be 2.80 ± 0.83 days. The pre-oviposition period was 2.5 days reported by Chaudhary and Sharma (13) in Haryana. The oviposition period was 7.40 ± 1.41 days. The oviposition period was 7.5 ± 0.86 days reported by Bhatt and Patel (4) in Gujarat. The post-oviposition period was 1.20 ± 0.83 days. The post oviposition period was 1.13 ± 0.25 days (14) and 1.10 ± 0.54 days (4) reported by earlier workers. Present results are in agreement with these reports. The egg laying capacity of female was 240.2 ± 62.06 eggs. The female moth laid on an average of 198 ± 44.7 eggs during June-July in Tanganyika (10), 297.8 eggs in Egypt (15) and 270 to 420 eggs during October-November in Himachal Pradesh (11). These reports showed more or less similar number of eggs as calculated in present findings. The longevity of male moths was 8.08 ± 0.81 days, while it was 11.40 ± 1.95 days in case of female moths. The longevity of male adult was 5 to 9 days and 10 to 14 days of female moths in Madhya Pradesh (16). These duration of male and female moths reported by above workers are more or less in agreement with the present findings.

The male to female sex ratio of *H. armigera* was 1 : 1.15 under field and 1 : 1.12 under laboratory (Table 2). The sex ratio of male to female was 1 : 09.1 (10), which was more or less similar to present findings.

The average life cycle was completed in 48.68 ± 6.49 days in case of male and 52.08 ± 5.58 days in case of female (Table 2). The pest completed its life cycle in 50.9 ± 4.89 days for male and 53.9 ± 4.89 days for female in Gujarat (4). These reports tally with the present findings.

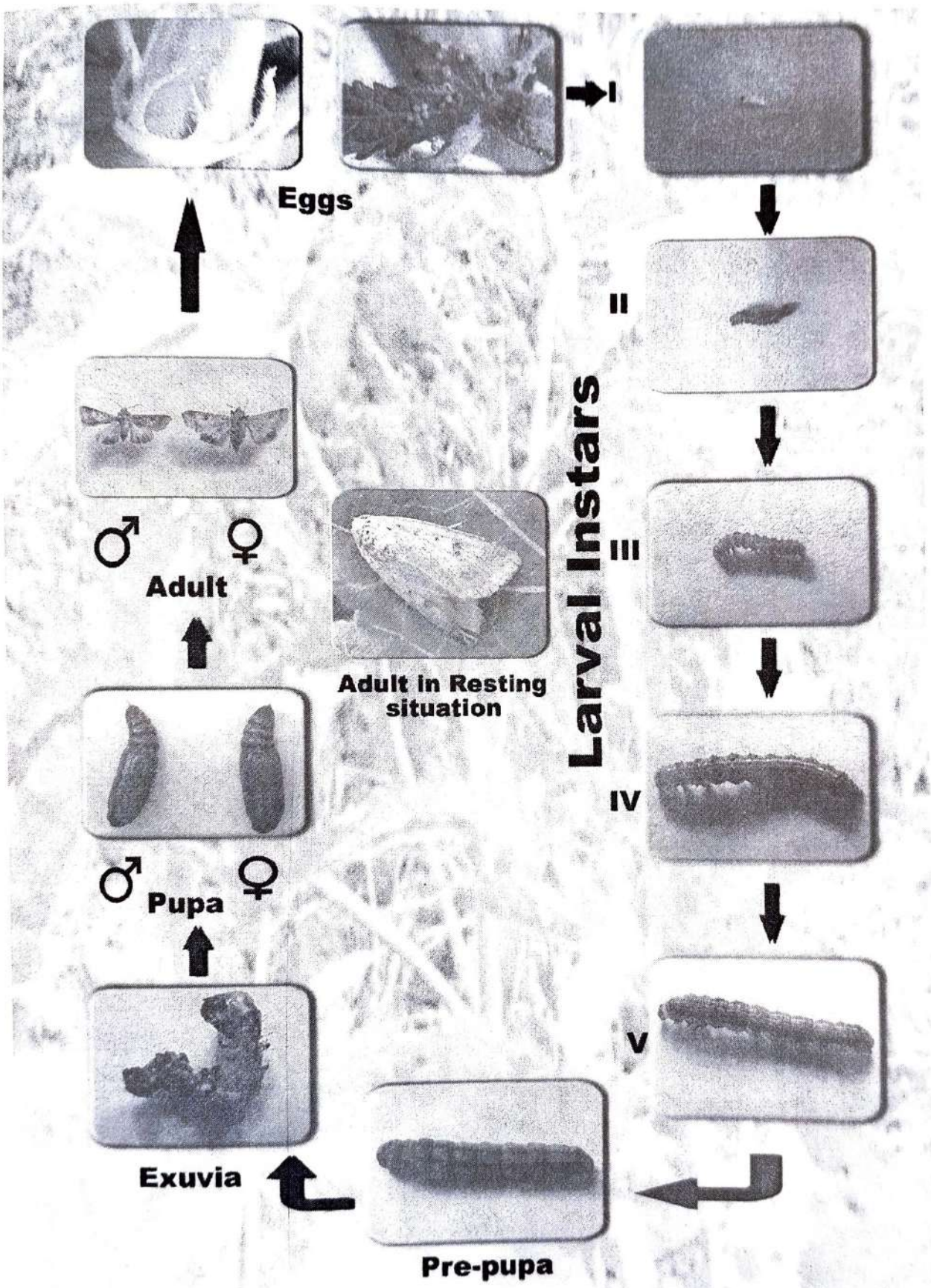

Plate I : Different Stages of *H. armigera*

Table 1 : Measurement of different stages of *H. armigera*

Sr. No.	Stage	Particulars	Measurement (mm)		
			Min.	Max.	Mean ± S.D.
1	Egg	Length	0.43	0.49	0.45 ± 0.01
		Breadth	0.45	0.53	0.48 ± 0.02
2	Larva				
	I instar	Length	1.52	1.91	1.74 ± 0.12
		Breadth	0.28	0.33	0.30 ± 0.01
		Head capsule	0.26	0.29	0.27 ± 0.01
	II instar	Length	4.20	5.50	4.85 ± 0.42
		Breadth	0.53	0.62	0.57 ± 0.02
		Head capsule	0.46	0.53	0.49 ± 0.02
	III instar	Length	8.00	9.50	8.58 ± 0.53
		Breadth	0.80	1.30	1.05 ± 0.16
		Head capsule	0.68	0.77	0.72 ± 0.03
	IV instar	Length	16.50	18.50	17.42 ± 0.75
		Breadth	2.05	2.40	2.21 ± 0.10
		Head capsule	1.20	1.32	1.27 ± 0.03
	V instar	Length	27.00	30.50	28.72 ± 1.14
		Breadth	3.40	3.80	3.56 ± 0.14
		Head capsule	2.57	2.63	2.59 ± 0.02
3	Pre-pupa	Length	22.00	27.00	24.76 ± 1.72
		Breadth	3.00	4.50	3.76 ± 0.56
		Head capsule	2.63	2.72	2.67 ± 0.02
4	Pupa				
	Male	Length	18.50	22.50	20.32 ± 1.31
		Breadth	5.00	6.50	5.68 ± 0.57
		Distance between genital and anal pore	0.59	0.67	0.63 ± 0.02
	Female	Length	19.50	24.00	21.76 ± 1.41
		Breadth	5.50	7.00	5.90 ± 0.51
		Distance between genital and anal pore	1.69	1.76	1.72 ± 0.02
5	Adult				
	Male	Length	16.50	19.00	17.70 ± 1.03
		Breadth (wing expanded)	32.00	37.00	34.20 ± 1.92
	Female	Length	18.00	22.50	20.10 ± 1.74
		Breadth (wing expanded)	38.00	43.00	40.20 ± 1.92

Table 2. Duration of different stages of *H. armigera*.

Sr. No.	Life stage	Periods (days) Min.	Max.	Mean ± S.D.
1	Egg	2	4	2.9 ± 0.78
	Hatching (%)	57	89	73.6 ± 12.36
2	Larva			
	I instar	2	3	2.46 ± 0.50
	II instar	2	5	3.38 ± 0.90
	III instar	3	6	4.48 ± 1.09
	IV instar	3	6	4.38 ± 1.14
	V instar	3	7	5.00 ± 1.42
	Total	15	27	22.49 ± 4.42
	Growth index	-	-	2.62
3	Pre-pupa	1	4	2.54 ± 1.04
4	Pupa			
	Male	16	18	16.94 ± 0.81
	Female	16	19	17.00 ± 1.05
5	Adult			
	Pre-oviposition	2	4	2.80 ± 0.83
	Oviposition	6	9	7.40 ± 1.41
	Post-oviposition	0	2	1.20 ± 0.83
	Longevity			
	Male	7	9	8.08 ± 0.81
	Female	8	13	11.40 ± 1.95
6	Total life span : Egg to adult death			
	Male	41	61	48.68 ± 6.49
	Female	44	65	52.08 ± 5.58
7	Fecundity	167	317	240.2 ±62.06
8	Sex ratio (Male : Female)			
	Field	1 : 1.111 : 1.20		1 : 1.15
	Laboratory	1 : 1.081 : 1.17		1 : 1.12

Reference

1. **Anonymous** 2004. District-wise area and production of Gujarat State, Directorate of Horticulture, Gujarat State, Gandhinagar, pp. 13-29.

2. **Naganagoud, A. and Thontadarya, T. S.** 1986. Distribution of eggs of *Earias* spp. and *Helicoverpa armigera* Hb. on okra. *Curr. Res.* **15** : 8-10.

3. **Jallow, M. F. A., Matsumura, M. and Suzuki, Y.** 2001. Oviposition preference and reproductive performance of Japanese *Helicoverpa armigera* Hb. *Applied Ent. and Zool.* **36** : 419-426.

4. **Bhatt, N. J. and Patel, R. K.** 2001. Biology of chickpea pod borer, *Helicoverpa armigera* Hb. *Indian J. Ent.*, **63** : 255-259.

5. **Chang, HSU and Chu** 1958. A study on the cotton bollworm, *Helicoverpa armigera* Hb. *Acta Coan. Ent. Sin-1*, **1** : 18-30.

6. **Saoud, A. H., Ftayeh, M. A., Samara, F. and Hamidi, M.** 1989. Biological study on *Helicoverpa armigera* (Hb.) on chickpea in southern Syria. *Arab J. Plant Prot.* **7** : 133-137.

7. **Dhawan, A. K. and Sidhu, A. S.** 1984. Incidence and relative abundance of different species of spotted bollworm on okra at Ludhiana. *J. Res. PAU*, **2** : 533-542.

8. **Atwal, A. S. and Dhaliwal, G. S.** 1976. "*Agricultural Pests of South Asia and their Management*". Publ. by Govt. of India, p.200.

9. **Koshiya, D. J.** 1984. Studies of biometrical analysis, growth and life table of *Helicoverpa armigera* (Hb.) (Lepidoptera : Noctudae) on different hosts, Ph. D. Thesis. GAU, Sardar krushinagar.

10. **Reed, W.** 1965. *Heliothis armigera* Hb. in western Tanganyika-1. Biology with special reference to the pupal stage. *Bull. Ent. Res.* **56** : 117-125.

11. **Kashyap, N. P. and Dhindsa, S. S.** 1990. Biology and bionomics of gram pod borer (*Heliothis armigera*) on pigeon pea (*Cajanus cajan*). *Indian J. Agril. Sci.* **60** : 157-158.

12. **Mehta, D. M.** 1993. Biology, population dynamics and control of *Heliothis armigera* Hb. on important host crops in middle Gujarat, Ph. D. Thesis. GAU, Sardarkrushinagar. pp. 65-68.

13. **Chaudhary, J. P. and Sharma, S. K.** 1983. Biology of gram pod borer *Helicoverpa armigera* Hb. in the Haryana State. *Bull. Ent.*, **22** : 101-112.

14. **Singh, H. and Singh, G.** 1975. Biological studies on *Heliothis armigera* Hb. in Punjab. *Indian J. Ent.* **37** : 154-164.

15. **Ismail, I. I. and Swailem, S. M.** 1976. On the biology of the bollworm *Helicoverpa armigera* (Hb.). *Bull. De. La. Societe Entomologique d' Egypt.* **59** : 207-216.

16. **Goyal, S. P. and Rathore, V. S.** 1988. Patterns of insect-plant relationship determining susceptibility of different hosts to *Heliothis armigera* Hb. *Indian J. Ent.* **50** : 193-201.

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Chemical control of powdery mildew, fruitfly and fruit borer in *ber*

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Abstract

Results of the field experiment on chemical control of powdery mildew, fruitfly and fruit borer in her conducted at Sardarkrushinagar during 1996-97 to 2003-04 revealed that minimum powdery mildew severity (15.47 %) was recorded in monocrotophos (0.04 %) + wettable sulphur (0.2 %) followed by endosulphan (0.07 %) + wettable sulphur (0.2 %) (15.91 %) and wettable sulphur (0.2 %) (16.36 %). All the treatments were significantly superior to control except endosulphan and wettable sulphur alone in reducing the fruitfly damage. Fruit borer damage was minimum in monocrotophos alone as well as in combination with other treatments. Highest fruit yield (58.2 kg tree^{-1}) was recorded in monocrotophos (0.04 %) + wettable sulphur (0.2 %) and thus clearly indicated its superiority in checking the powdery mildew, fruit fly and fruit borer damage as well as increasing the fruit yield appreciably in ber.

Keywords : *Ber,* powedry mildew, fruit fly, fruit borer

Introduction

Ber (Zizyphus mauritiana Lamk.) is one of the ancient fruit trees and known for high vitamin C content (1). It is a peculiar tree with an ability to tolerate drought and to bear heavy crop regularly and to give attractive returns even under constraints of irrigation, fertilizers and other inputs. However, *her* crop is reported to be attacked by several biotic and abiotic stresses. Shedding of young developing fruits due to powdery mildew caused by *Oidium erysiphoides* f. sp. *zizyphi* Yen and Wang is of very serious concern (2). The disease appears from October to February on young developing fruits and is more conspicuous on fruits during October-November (3). The affected fruits either drop or become corky, misshaped and remain under-developed (4, 5). Fruit fly *(Carpomyia vesuviana* Costa) is a specific pest of ber and up to 77 % damage to fruits was reported (6). The female fruit fly punctures the ripening fruits and lays their eggs inside. The infested fruits turn dark brown, rot and smell offensively. Fruit borer *(Meridarchis scyrodes* Meyrick) bore in to the fruits, feed on pulp and fill the cavities with faecial matter (7).

Several efforts were made in the past to control either the disease or the pest of *ber* fruits separately. However, information on combined efforts to manage the pests and disease of *ber* fruit is meager. Therefore, an attempt was made to investigate an effective combined plant protection schedule for the control of fruit fly, fruit borer and powdery mildew disease of *ber.*

Materials and methods

A field experiment was conducted at AICRP on Arid Zone Fruits, Dry Farming Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during 1996-97 to 2003-04. The experiment was vitiated during 1998-99 to 2001-02 due to non-appearance of powdery mildew disease. The experiment was laid out in randomized block design replicated three times on *ber* cv. Umran with twelve different treatments (Table 1). The first spray of respective treatment was given when the first symptom of powdery mildew appearance on fruit was noticed (last week of September to first week of October) and subsequently sprayed twice at 15 days interval. One tree was designated as treatment per replication and 50 fruits representing all the four sides of the tree were randomly selected and tagged for observation on powdery mildew severity. The disease severity was recorded 10 days after last spray using 0-5 scale and per cent disease intensity (PDI) was calculated (8). Similarly, per cent damage by fruit fly

and fruit borer was recorded by randomly collecting 100 fruits from each tree and examined by cutting open to confirm the fruit fly and fruit borer damage. The matured *ber* fruits harvested at each picking were weighed and fruit yield (kg tree^{-1}) was calculated. The data were summarized and subjected to statistical analysis.

Results and discussion

Powdery mildew

The data (Table 1) revealed that disease severity differ significantly due to different treatments. Minimum powdery mildew severity of 15.47 % was recorded in T_6 i.e. monocrotophos (0.04 %) + wettable sulphur (0.2 %) which was at par with T_6 i.e. endosulphan (0.07 %) + wettable sulphur (0.2 %) and T_3 i.e. wettable sulphur (0.2 %) with respective powdery mildew severity of 15.91 and 16.36 %. The data further revealed that the effect of neern seed kernel extract (5 %) and neem oil (3 %) in reducing powdery mildew severity though inferior to wettable sulphur, was also comparatively superior to control. The powdery mildew severity in the control was 57.02 %.

Fruit fly and fruit borer damage

A perusal of data (Table 1) clearly indicated that all the treatments were significantly superior to control except endosulphan and wettable sulphur alone in reducing the fruit fly damage. Significantly lowest damage (2.23 %) due to fruit fly was recorded in T_8 i.e. monocrotophos (0.04 %) + neem oil (3 %) followed by T_7 (2.46 %), T_1 (3.00 %), T_6 (3.15 %), T_{10} (4.73 %), T_{11} (4.90 %), T_9 (3.00 %), T_4 (5.16 %) and T_5 (5.32 %). Per cent fruit fly damage in the control was recorded as 13.99 %. With regard to fruit borer damage, monocrotophos alone or in combination with other treatments was found significantly superior in reducing fruit borer damage. The minimum fruit borer damage (2.09 %) was observed in T_1 i.e. monocrotophos (0.04 %) followed by T_7 (2.17 %), T_6 (2.41 %) and T_8 (2.42 %). Among the other treatments, T_2 i.e. endosulphan (0.07 %), T_4 i.e. neem seed kernel extract (5 %) and T_5 i.e. neem oil (3 %) alone and in combination were also significantly superior to control in reducing percent damage by fruit borer. The fruit borer damage in the control was recorded as 12.11 %.

Table. 1. Powdery mildew, Fruit fly and fruit borer damage in *ber*

	Treatment	Conc. (%)	Powdery mildew on fruit* (%)	Per cent Damage*		Fruit yield (kg tree^{-1})
				Fruit fly	Fruitborer	
T_1	Monocrotophos	0.04	49.40	3.00	2.09	51.8
T_2	Endosulphan	0.07	49.22	7.98	4.71	49.0
T_3	Wettable Sulphur	0.20	16.36	11.89	8.09	53.4
T_4	Neem seed kernel extract	5.00	44.98	5.16	5.21	45.2
T_5	Neem product	3.00	46.76	5.32	5.83	46.8
T_6	$T_1 + T_3$	–	15.47	3.15	2.41	58.2
T_7	$T_1 + T_4$	–	46.74	2.46	2.17	44.5
T_8	$T_1 + T_5$	–	47.16	2.23	2.42	45.2
T_9	$T_2 + T_3$	–	15.91	7.54	5.63	51.7
T_{10}	$T_2 + T_4$	–	46.58	4.73	5.08	42.9
T_{11}	$T_2 + T_5$	–	43.96	4.90	4.35	41.0
T_{12}	Control	–	57.02	13.99	12.11	32.7
	CD (P = 0.05)		6.31	4.94	2.59	7.62
	C.V.%		5.22	6.92	9.10	13.64

* Figures were arc-sin transformed before analysis

Fruit yield

The data revealed significant differences in fruit yield due to different treatments. Significantly highest fruit yield of 58.2 Kg tree^{-1} was recorded in T_6 which was at par with T_3 (53.4 Kg tree^{-1}) Fruit yield in the control was 32.7 Kg tree^{-1}.

The present study clearly indicated the efficacy of monocrotophos (0.07 %) + wettable sulphur (0.2 %) in checking the powdery mildew, fruit fly and fruit borer damage as well as increasing the fruit yield appreciably in *ber*. The information on combined efforts to manage the pests arid disease of *ber* fruit is meager. One prophylactic spray of 0.2 % wettablc sulphur at 50 % flowering stage followed by four subsequent sprays at an interval of 20 days starting from initiation of powdery mildew disease was reported (9). An alternate spray schedule of triadimefon 0.1 % and wettable sulphur 0.3 % was also effective for economical control of powdery mildew disease in *ber* (10). Application of two sprays of either fenthion (0.1 %) or endosulfan (0.07 %) or quinalphos (0.05 %) was reported effective insecticides for the control of fruitfly in *ber* (11). Thus, the results obtained in the present study more or less in conformity with the findings of earlier reports.

References

1. **Jawanda, J. S. and Bal, J. S.** 1978. The Ber, Highly paying arid rich in food value. *Indian Horti.* **23** : 19-21.
2. **Mehta, P.R.** 1950. Some new diseases of plants of economic importance in Uttar Pradesh. *Plant Protection Bulletin,* New Delhi, India. **2** : 50-51.
3. **Kapur, S.P., Cheema, S. S. and Singh, M.P.** 1975. Occurrence and control of powdery mildew of her *(Zizyphus mauritiana* Lamk.) in Punjab. *J. of Res., PAU,* **12** : 26-29.
4. **Pareek, O. P.** 1983. The Ber, ICAR, New Delhi, India.
5. **Chandra, Atul, Chandra, Anju and Gupta, I.C.** 1994. Arid Fruit Research, Scientific Publishers, Jodhpur, pp. 40-41.
6. **Nair, M.R.G.K.** 1975. *Insects and Mites of Crops in India,* Indian Council of Agricultural Research, New Delhi. pp.404
7. **Butani, D.K.** 1979. *Insects and* Fruits. International Book Distributors, Dehradun. pp 173-186.
8. **Wheeler, B.E.J.** 1969. An Introduction to plant diseases. John Wiley and Sons Ltd. London, pp.374.
9. **Anonymous.** 1996. Biennial Report of Eighth Group Workers Meeting of All India Co-ordinated research Project on Arid *Zone* Fruits held at Rajasthan Agricultural University, Bikaner during January 4-6, 1996. pp. 321.
10. **Jamadar, M.M. and Desai, S.A.** 1998. Chemical control of powdery mildew of ber. *Karnataka J. of Agric. Sci.* **11** : 415-418.
11. **Saravaiya, S.N., Patel, M.B., Patel, C. B., Desai, H.R. and Patel, J.R.**1998. Bio-efficacy of different insecticides against, fruitfly *Carpomyia vesuviana* Costa *(Tephritidae : Diptera). GAU Res. J.* **24** : 101 -103.

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Study on the compatibility of the fungus *Verticillium lecanii* (Zimm.) Viegas with commercial formulations of insecticides used in mustard crop

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Abstract

Laboratory tests were made to determine the effect of various types of insecticides on the entomopathogenic fungus, *Verticillium lecanii*. Acephate 75 WP and quinalphos 25 EC inhibited the mycelial growth of *V. lecanii* by 100 per cent at recommended dose, while azadirachitin 0.000375 per cent, imidacloprid 0.005 per cent and monocrotophos 0.04 per cent had less effect. Dimethoate 0.03 per cent, methyl-o-demeton 0.025 per cent, chlorpyriphos 0.05 per cent and methyl parathion 0.05 per cent showed more than 50 per cent growth inhibition.

Keywords : *Verticillium lecanii*, insecticides, growth inhibition, mustard

Introduction

Integrated management of insect pests is an important way in reducing the severe impact of chemical pesticides on ecosystem. Biocontrol agents have been studied inadequately as component of integrated pest management system. *V. lecanii* (Zimm.) a potential biocontrol agent occurred naturally and it readily attacks a large number insect pests. It is an effective biocontrol agent of mustard aphid, *Lypaphis erysimi* (Kalt.). Insecticides may have antagonistic or synergistic effect on the potentiality of *V. lecanii*, and may disrupt natural epizootics. Under such epizootic condition, it is expected to enhance effectiveness through joint action of pathogen and compatible insecticides, which would reduce not only the cost of protection but also reduce the contamination of the environment. Growth inhibition of entomopathogenic fungi is a useful criterion for initial testing of its compatibility. The present study aims at to know the influence of some selected insecticides on the growth of *V. lecanii* in *vitro*.

Materials and methods

The *Verticillium lecanii* preparation, a wet dispersible powder (VERTICEL) supplied by Excel Industries, Mumbai was used for the present study and cultured on PDA medium at Department of Plant Pathology, Junagadh Agricultural University, Junagadh during the period of 2006-07. Commercial formulations of nine common insecticides used against insect pests of mustard *viz*; monocrotophos 0.04 per cent, acephate 0.05 per cent, quinalphos 0.05 per cent, dimethoate 0.03 per cent, chlorpyriphos 0.05 per cent, imidacloprid 0.005 per cent, azadirachtin 0.000375 per cent, methyl Parathion 0.05 per cent and methyl-o-demeton 0.025 per cent were selected. These were tested for their growth inhibition of *V. lecanii* by poison food technique on PDA medium with three replications. Each 100 ml portion of the medium was dispersed into a 250 ml Erlenmeyer conical flask and autoclaved at 121° C for 30 minutes, it was then cooled to about 45°C, stock solutions of the insecticides prepared in sterilized distilled water were incorporated into each flask under aseptic condition. Each flask was shaken well and poured into sterilized Petri dishes (90 mm). Medium without insecticides served as a control. Each plate was inoculated with a 5 mm inoculum disc cut out with the help of sterile cork borer from 14 days old culture of *V. lecanii* and transferred to center of Petri dishes containing the desired media. The inoculated dishes were incubated at 25±1° C. Observations on radial growth of colony (mm) of *V. lecanii* in the Petri dishes treated with different insecticides at recommended doses were recorded when full growth obtained in control (7th day of inoculation). Per cent inhibition of growth over control was calculated using the formula given by Vincet (1).

Results and discussion

Data on radial growth of *V. lecanii* presented in Table 1 showed that the highest growth was obtained in azadirachtin 0.000375 per cent which recorded 89.00 mm radial growth and it was at par with control (89.67 mm). The insecticides imidacloprid 0.005 per cent and monocrotophos 0.04 per cent remained next in order, which registered 72.00 and 63.00 mm radial growth, respectively. The treatments of dimethoate 0.03 per cent, methyl-o-demeton 0.025 per cent, chlorpyriphos 0.05 per cent and methyl parathion 0.05 per cent gave lower fungal growth with 38.00, 32.67, 15.33 and 12.66 mm radial growth, respectively. The insecticides acephate 0.05 per cent and quinalphos 0.05 per cent resulted in no growth.

The percentage of inhibition of radial growth (Table 1) indicated that azadirachtin 0.000375 per cent showed lowest growth inhibition (0.75 %) of *V. lecanii*. Imidacloprid 0.005 per cent and monocrotophos 0.04 per cent could be tolerated well and as they registered 19.71 and 29.74 per cent growth inhibition, respectively. The insecticides, dimethoate 0.03 per cent, methyl-o-demeton 0.025 per cent, chlorpyriphos 0.05 per cent and methyl parathion 0.05 per cent having 57.62, 63.57, 82.90 and 85.87 per cent growth inhibition, respectively. There is complete inhibition of mycelial growth (100 %) with acephate 0.05 per cent and quinalphos 0.05 per cent.

From the results of this study, azadirachtin 0.000375 per cent was found the most compatible with *V. lecanii*, followed by imidacloprid 0.005 per cent and monocrotophos 0.04 per cent as they inhibited less than 30 per cent fungal growth. While, methyl parathion 0.025 per cent, chlorpyriphos 0.05 per cent, methyl-o-demeton 0.025 per cent and dimethoate 0.03 per cent were found to be strong inhibitor for *V. lecanii* growth. Acephate 0.005 per cent and quinalphos 0.05 per cent inhibited the mycelial growth of *V. lecanii* by 100 per cent.

The poor inhibition of mycelial growth of *V. lecanni* (19.71 %) was observed with imidacloprid in the present study is in concurrence with Sterk (2) who reported 10 per cent growth inhibition at recommended dose. The present studies open an area of using entomopathogenic together with compatible insecticides as multiple mortality factors against target pests and also help in delay and expression of resistance to new insecticides.

Table 1 Effect of different pesticides on radial growth of *V. lecanni*

Sr. No.	Treatment	Dose (%)	Average diameter of colony growth (mm)	Growth Inhibition over control (%)
1	Monocrotophos 36 SL	0.04	52.54 (63.00)	29.74
2	Acephate 75 WP	0.05	5.74 (0.00)	00.00
3	Quinalphos 25 EC	0.05	5.74 (0.00)	00.00
4	Dimethoate 30 EC	0.03	38.05 (38.00)	57.62
5	Chlorpyriphos 20 EC	0.05	23.04 (15.33)	82.90
6	Imidacloprid 17.8 SL	0.0005	58.07 (72.00)	19.71
7	Azadirachtin 0.15 W/W	0.000375	70.64 (89.00)	00.75
8	Methyl Parathion 50 EC	0.05	20.85 (12.67)	85.87
9	Methyl-o-demeton 25 EC	0.025	34.85 (32.67)	63.57
10	Control	-	71.25 (89.67)	-
	S.Em.±	0.54	-	
	C.D. at 5%	1.60	-	
	C.V. %	2.50	-	

* Angular transformation Figures in parentheses are original value

Reference

1. **Vincet, J. M.** 1927. Distribution of fungal hyphae in the present study of certain inhibitors. *Nature*. **159** : 850

2. **Sterk, G.** 2003. Toxicity of fungicides to entomopathogenic fungi. *Protection integree agriculture biologique* . pp 119-121

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Share of main indicators in entrepreneurial behaviour of potato growers

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Abstract

A study was conducted to identify the indicators of entrepreneurial behaviour of potato growers. For measuring the entrepreneurial behavior, an objective scale was developed using Normalized Rank Approach method. Banaskantha and Gandhinagar districts from the zone were purposively selected. A total of six talukas and 18 villages were covered and the size of sample was kept as 270 based on variability in overall modernization in the universe A field survey by personal contact method for data collection was used. All 270 respondents were interviewed personally and data were collected with the help of interview schedule. Based on the findings of the study, the major indicators of the entrepreneurial behaviour as found relevant by the panel of Judges were (i) decision making ability, (ii) economic motivation (iii) market orientation (iv) knowledge of improved potato production technology (v) ability to co-ordinate available resources (vi) Risk taking ability (vii) ability to solve problems (viii) credit orientation (ix) self confidence (x) scientific orientation (xi) communication skill (xii) experience of potato cultivation (xiii) production management (xiv) achievement motivation and (xv) perceiving opportunities. It was also observed that majority of the respondents were in medium to high level categories with respect to all the main indicators which indicate the importance and contribution of the indicators in entrepreneurial behaviour.

Key Words : Main indicators, enterpreneurial behaviour, potato growers

Introduction

Entrepreneur is a highly respected word in the developed world. It conjures up vision of active, purposeful men and women accomplishing a wide variety of significant deeds.The entrepreneur is an important change agent in every society. Yet, he is one of the most enigmatic characters particularly in the less developed world. Although, it is his purposive activity that bridges the gap between plan and reality, the precise way that this change agent - entrepreneur acts is, often unclear (1). However, on the basis of some reviewed thoughts, it may be stated that the entrepreneur is perceived as an individual with certain characteristics helpful in conceiving, initiating, establishing, running and finally managing an enterprise. An enterprise can vary from starting a small shop to establishing an advanced technology based industry. An entrepreneur therefore, may be differentiated not only in terms of the kind of activities he pursues but in the context of his life style, attitudes, values and behaviour which together go to make the entrepreneurial personality. Entrepreneurs have been considered instrumental in initiating and sustaining socio-economic development. Entrepreneurs discover new sources of supply of materials and markets and they establish new and more effective forms of organisations. Entrepreneurs perceive new opportunities and seiz them with super normal will power and energy, essential to overcome the resistance that social environment offers.

These all reviewed thoughts lead to identify certain factors determining entrepreneurship behaviour. The present study was conducted to identify the indicators of entrepreneurial behaviour of potato growers of North

Gujarat Agro-climatic zone of Gujarat State with following specific objectives.

1. To identify the indicators of entrepreneurial behaviour of potato growers.
2. To assess the share of the main indicators in entrepreneurial behaviour.

Methodology

The study was divided into two parts, the first part consists of scale construction for measuring the entrepreneurial behaviour of potato growers and the second part deals with the execution of the scale among the potato growers.

For measuring the entrepreneurial behaviour of potato growers, an objective scale was developed using Normalized Rank Approach method as suggested by Guilford (2). Total 17 possible indicators of entrepreneurial behaviour were selected for the scale and circulated to a group of 150 experts, judges and Professors from State Agricultural Universities (SAUs) and various related institutions. Out of 150 judges, 90 had responded. Their opinion was utilized for item analysis. Out of the 17 indicators, 15 indicators were selected as they were found relevant by 80 per cent of the judges, while two indicators were deleted. In order to determine the scale value of each item ranked by judges, the centile position "P" was worked out. Those indicators which received more than one positive scale value were considered. All 15 relevant indicators were finally selected for the scale. The second part of the investigation was the execution of the scale among the potato growers. For this purpose, North Gujarat Agro-climatic Zone of Gujarat State was considered as it is an intensive potato cultivation area and contributes 80 per cent of potato production of the state. Banaskantha and Gandhinagar districts from the zone were purposively selected. A total of six talukas and 18 villages were covered and the size of sample was kept as 270 based on variability in overall modernization in the universe. Fifteen potato growers from each village were randomly selected to make a sample size of 270 potato farmers. Primary and raw data were collected with the help of well structured and pre-tested interview schedule incorporating all the items on which information were required for the study. A field survey by personal contact method for data collection was used. All 270 respondents were interviewed personally.

Results and discussion

Identification of the indicators of entrepreneurial behaviour

It is clear from the data presented in Table 1 that the responses received from the ninety judges supported the relevancy of the 15 main indicators. Those items which received more than 80 per cent responses were considered as relevant items for inclusion in the scale. It was observed that the indicators viz., leadership ability (58.70%) and the perceiving management services (78.90%) were found less relevant and hence both items were removed form the scale items and conclusive 15 main indicators were included in the entrepreneurial behaviour scale of potato growers.

Table 1. Relevancy of the indicators of entrepreneurial behaviour of potato growers as judged by the judges (n=90).

Sr. No.	Item	Relevance	
		Number	Percentage
1	Self confidence	90	100.00
2.	Risk taking ability	90	100.00
3	Scientific orientation	80	88.90
4.	Decision making ability	90	100.00
5.	Leadership ability	53	58.70
6.	Communication skill	75	83.30
7.	Knowledge of improved potato technology	87	96.70
8.	Experience of potato cultivation	78	86.70
9.	Ability to coordinate available resources	83	92.20
10.	Market orientation	88	97.80
11.	Achievement motivation	75	83.30
12.	Economic motivation	90	100.00
13.	Perceiving management services	71	78.90
14.	Credit orientation	80	88.90
15.	Production management	78	86.70
16.	Perceiving opportunities	75	83.30
17.	Ability to solve problems	86	95.55

Share of main indicators in entrepreneurial behaviour

In order to determine the share of each main indicator of the scale constructed on the entrepreneurial behaviour of potato growers, the scale developed by the investigator was applied to the 270 respondents.

Table 2. Share of main indicators in entrepreneurial behaviour and distribution of the respondents according to their category in each main indicator. (n=270).

Sr. No	Main indicator	Category	Distribution		Share of indicator mean of E.B.I, of each indicator	Rank
			Frequency	Percentage		
1	Risk taking ability	Low (Upto 3.66 E.B.I.	29	10.74	4.32	VI
		Medium (3.67 to 4 98 E.B.I.)	223	82.59		
		High (Above 4.98 b.B.I)	18	6.67		
		x = 4.32, S.D. = 0.66, C.V.% = 15.28				
2.	Self confidence	Low (Upto 1.55 E.B.I.)	73	27.04	1.84	IX
		Medium (1.56 to 2.13 E.B.I.)	197	72.96		
		High (Above 2.13 E.B.I.)	0.00	00.00		
		x =1.84, S.D.=0.29, C.V.% = 15.76				
3	Decision making ability	Low (up to 16.19 index)			18.74	I
		Medium(16.20 to 21.29 index)				
		High (above 21.29 index)				
		x =18.74, S.D.=2.59, C.V.% = 13.61				
4.	Knowledge of improved potato technology	Low (upto 5.34 index)	19	7.04	6.77	IV
		Medium (5.35 to 8.2 index)	215	79.63		
		High (above 8.2 index)	36	13.3		
		x = 6.77, S.D.=1.43, C.V.% = 21.12				
5.	Economic motivation	Low (up to 9.37 index)	51	18.89	10.80	II
		Medium (9.38 to 12.23 index)	182	67.41		
		High (above 12.23 index)	37	13.70		
		x = 10.80, S.D.=1.43, C.V.% =13.24				
6	Scientific orientation	Low (up to 0.99 index)	79	29.26	1.35	X
		Medium (1.0 to 1.71 index)	121	44.81		
		High (above 1.71 index)	70	25.93		
		x = 1.35, S.D.= 0.36, C.V. % = 26.67				
7	Expenence of potato cultivation	up to 5 years of experience	65	24.07	0.76	XIV
		6 to 10 years of experience	101	37.41		
		11 to 15 years of experience	27	10.00		
		More than 15 years of experience	77	28.52		
8	Market orientation	Low (up to 7.00 index)	52	19.26	8.38	III
		Medium (7.01 to 9.76 index)	181	67.04		
		High (above 9.76 index)	37	13.70		
		x = 8.38, S.D.=1.38, C.V.% = 16.47				
9.	Ability to coordinate available resources	Low (up to 5.02 index)	24	8.89	5.64	V
		Medium (5.03 to 6.26 index)	218	80.74		
		High (above 6.26 index)	28	10.37		
		x = 5.64, S.D.=0.62, C.V.% = 14.77				
10	Achievement motivation	Low (up to 0.75 index)	19	7.04	0.88	XI
		Medium (0.76 to 1.00 index)	140	51.85		
		High (above 1.01 index)	111	41.11		
		x = 0.88, S.D. = 0.13, C.V. % = 14.77				

Table 2. Conti...

Sr. No	Main indicator	Category	Distribution		Share of indicator mean of E.B.I, of each indicator	Rank
			Frequency	Percentage		
11.	Production management	Low (up to 0.55 index)	75	2778	0.79	XIII
		Medium (0.56 to 1.03 index)	166	61.48		
		High (above 1.03 index)	29	10.74		
		x = 0.79, S.D.=0.24, C.V.% = 30.38				
12	Credit orientation	Low (up to 2.07 index)	65	24.07	2.61	VIII
		Medium (2.08 to 3.15 index)	121	44.82		
		High (above 3.48 index)	44	16.30		
		x = 2.61, S.D. = 0.54, C.V.% = 20.69				
13	Ability to solve problems	Low (up to 2 52 index)	37	13.70	3.00	VIII
		Medium (2.53 to 3.48 index)	189	70.00		
		High (above 3.48 index)	44	16.30		
		x = 3.00, S.D. = 0.48, C.V.% = 16.00				
14	Communication skill	Low (up to 0.75 index)	27	10.00	0.80	XII
		Medium (0.76 to 0.96 index)	212	78.52		
		High (above 0.96 index)	31	11.48		
		x = 0.80, S.D. = 0.16, C.V. % = 20.00				
15.	Perceiving opportunities	Low (up to 0.25 index)	30	11.11	0.30	XV
		Medium (0.26 to 0.35 index)	144	53.33		
		High (above 0.35 index)	96	35.56		
		x =0.30, S.D. = 0.05, C.V.% = 16.67				

The classification of the respondents was made on the basis of their score obtained for each main indicator of the scale. The data regarding this aspects are presented in Table 2.

It is clear from the data presented in Table 2 that majority of the potato growers (82.59%) had medium level of risk taking ability followed by low and high risk taking ability, with regards to self confidence, 72.96 per cent of potato growers had medium self confidence, followed by low (27.04%) self confidence. The probable reason for such findings for both indicators might be that agricultural enterprise is totally dependent on natural environment, further there is no control of the producer on market prices of their agricultural produce. In connection of decision making ability 65.56 per cent of potato growers had medium decision making ability. The probable reason might be that the potato growers were good in examining the pros and cons and were selecting most efficient means for achieving maximum economic returns from agricultural enterprise especially from potato farming. As regards to knowledge of improved potato technology, 79.63 per cent of the potato growers had medium level of knowledge of improved potato technology followed by high (13.33%) and low (7.04%) level of knowledge of improved potato technology. The majority (67.81%) of potato growers had medium level of economic motivation. The results could be focussed that after green revolution the peasant community are conscious about their economic development and for this they may be motivated economically. It is obvious that economically motivated farmers are oriented towards maximization of profit from farming, because farming is mostly a source of livelihood for them. The results in Table 2, further indicate that about 45.00 per cent of the potato growers had medium level of scientific orientation followed by low (29.26%) and high (25.93%) level of scientific orientation. It could be interred that majority (70.74%) of the potato growers had medium to high level of scientific orientation. This might be due to mass media exposure and high literacy rate. It is also true that scientifically oriented farmers always incline to use scientific methods in farming and have a favourable perception towards innovations, which leads potato growers to develop their entrepreneurial behaviour.

Considering the experiences of potato farming it was observed that majority (61.48%) of the potato growers had introduced potato crop from last ten years. With regards to market orientation, it could be inferred that majority (80.74%) of the potato growers were market oriented. The probable reason might be that potato is a perishable commodity, which is produced in plenty in crop season and due to non-availability of store and processing facilities, there is great fluctuation in the market, due to which the middle men are making unbelievable profits.

Considering the ability to coordinate available resources, 80.74 per cent of the respondents had medium level ability to coordinate available resources. The probable reason might be that the potato farming is very expensive in comparison to other winter crops. The farmers are making maximum use of available resources for more production and profits. The results could be impressed strongly that the great majority (92.96%) of the respondents had medium to high level of achievement motivation. It could be indicated that all human beings always try to gain something more and more in life.

As regards to production management, the majority (72.22%) of the potato growers had medium to high level of production management ability. The probable reason might be that the potato is a perishable commodity, so the farmers are very much alert in production management.

Finance is the life blood of any enterprise. For agricultural development in general and adoption of agricultural innovation in particular, substantial amount of capital is required. Potato farming also is a very expensive enterprise, which requires higher initial investment for purchasing seeds, fertilizers etc. considering this fact credit orientation of potato growers was studied. The data presented in Table 2 indicate that majority (75.93%) of the respondents had medium to high level of credit orientation. In connection with the ability to solve problems, 70.00 percent respondents had medium ability to solve problems. Nearly more than three-fourths (78.52%) of potato growers had medium communication skill. The majority of the potato growers (88.89%) had medium to high extent of perceiving opportunities. With a cursory observation of the data presented in Table 2, it can be concluded that majority of the potato growers were found in medium to high level categories with respect to all the main indicators, which indicate the importance of the indicators. An attempt was also made to know the share of various indicators in entrepreneurial behaviour. Table 2 shows that the indicator "Decision making ability" was the important indicator with highest average share value of 18.74 and was ranked first, followed by economic morivation (10.80 average share) and market orientation (8.38 average share).The fourth and fifth ranked indicators were knowledge of improved potato technology and ability to coordinate available resources. The other indicators according to their average share in entrepreneurial behaviour in the descending order were risk taking ability, ability to solve problems, credit orientation, self confidence, scientific orientation, achievement motivation, communication skill, produc-tion management, experience of potato cultivation and perceiving opportunities.

It can thus be concluded that all the main indicators were having contribution in entrepreneurial behaviour. This study also provided evidence about the overwhelmingly important role of all fifteen main indicators in achieving entrepreneurship.

Conclusion

Based on the findings of the study, it can be concluded that the major indicators of the entrepreneurial behaviour as found relevant by the panel of judges were; (i) Decision making ability, (ii) economic motivation, (iii) Market orientation, (iv) Knowledge of improved potato production technology (v) Ability to coordinate available resources, (vi) Risk taking ability, (vn) ability to solve problems, (viii) Credit orientation (ix) Self confidence, (x) Scientific orientation (xi) Communication skill, (xii) Production Management (xiii)) Experience of potato cultivation, (xiv) Achievement motivation and (xv) Perceiving opportunities. It is also observed that majority of the respondents were found in medium to high level categories with respect to all the main indicators which indicate the importance and contribution of the indicators in entrepreneurial behaviour. This study also provided evidence about the overwhelmingly important role of all fifteen main indicators in achieving en-trepreneurship.

References

1. **Cunningham, J.Barton and Lischeron, Joe.** 1991. Defining Entrepreneurship. *The J. Small Business Management.* **29** : 45.

2. **Guilford, J.P.** 1954. Psychometric methods, Tata McGraw Hill Book Publication Co., New Delhi, pp. 178-183.

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Evaluation of front line demonstrations on groundnut

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Abstract

The present study was undertaken with a view to know the extent of adoption of groundnut production technologies as a result of Front line Demonstrations (FLDs). After conducting FLDs on groundnut, majority of the growers adopted the recommended package of practices for groundnut crop cultivation on method of fertilizer application (Basal), interculturing, weeding, seed treatment for white grub control, time of sowing, insecticides, top dressing of fertilizers (urea) and improved varieties. Very few farmers had adopted seed treatment use of FYM, application of plant protection measures before conducting FLD. Adoption rate of the above practices was significantly increased after conduct of FLDs.

Keywords : Front line demonstrations, adoption, groundnut

Introduction

India has been self sufficient in food grains, but production of oil seed crops remain static during last 30 to 40 years. There is urgent need to increase the production of oil seeds. To accelerate the production of oil seeds, ICAR has started FLD programme through KVKs. FLD on groundnut has been started by KVK, GAU, Deesa since 1994. Latest recommended package of practices of groundnut crop were demonstrated on the farmers field. To evaluate the FLD on groundnut, the study was under taken with the following specific objectives.

1. To study the socio - economic attributes of the groundnut growers.
2. To evaluate the FLDs in terms of adoption of recommended groundnut production technologies.
3. To study the yield of groundnut on farmers field before FLD and after FLD.
4. To study the increase in profitability through FLDs on groundnut.

Methodology

Three talukas namely Deesa, Dantiwada and Vadgam of Banaskantha district were selected for the present study. Godh village of Dantiwada and Rampura, Khardosan, Vadaval of Deesa Taluka and Kabirpura of Vadgam Taluka were selected for conducting FLDs during years 1994 to 2004.10 groundnut growing farmers from each village were randomly selected. Thus total fifty farmers / respondents were selected for the present study. Before conducting the FLDs, eighteen production technologies of groundnut crop were identified and responses were recorded to know the prevailing production technologies of groundnut crop in these villages and yield of groundnut per hectare was also recorded from these villages.

In both the cases before FLD and after FLD the respondents remained same for the present study. Data were collected in light of the objectives of the present study tabulated, analyzed and interpreted.

The data in the table 1 revealed that majority (56%) of the farmers were in the age group of 35 to 50 years while 24 % of the respondents were in the young age. Most of the respondents (60 %) had primary education, while 24 % of the respondents were illiterate. Only 5 % and 3 % of the respondents were having the secondary education and higher secondary education respectively. Majority of the respondents (30 %) of the respondents belonged to other backward class; while 20 % of the respondents

Table 1. Socio-economic attributes of the groundnut growers No=50

Sr. No.	Category	Number	Percent
A	Age Group		
I	Young Age (Up to 35 Years)	12	24
II	Middle Age (36 to 50 Years)	28	56
III	Old Age (Above 50 Years)	10	20
B	Education level		
I	Illiterate (Cannot read & write)	12	24
II	Primary education (1 to 7 std)	30	60
III	Secondary education (8 to 11 std)	5	10
IV	Higher education (12 std. & above)	3	6
C	Caste		
I	SC (Schedule Caste)	—	—
II	OBC (Other Backward Class)	32	60
III	Other	20	40
D	Land Holding		
I	Up to 1 .0 ha.	9	18
II	1.01 to 2.0 ha.	9	18
III	2.01 ha. and Above	32	64
E	Irrigation Source		
I	Well Irrigation	—	—
II	Canal Irrigation	—	—
III	Tube-Well Irrigation	50	100

belonged to general caste. In case of land holding, 64 % of the respondents were found to have land holding above 2.01 hectare, where as 18 % respondents had up to 1 to 2.0 ha. land 18 % of the respondents had up to 1.0 ha. of the land respectively. All the respondents irrigated their farm through tube well.

In order to find out the extent of adoption of improved agricultural practices of groundnut before conducting FLDs on groundnut, a survey of production technologies of groundnut was made. On the basis of the survey, 18 production technologies were identified.

In order to find out the extent of adoption of improved agricultural practices of groundnut after FLDs the same 18 improved practices were identified for the study. The respondents were asked to give their responses towards these practices.

In both the cases before FLD and after FLD, the respondents were same for the present study. The response was calculated and converted into mean percent (Table 2).

Table 2. Extent of adoption of recommended package groundnut crop before FLD and after FLD. of practices of N=50

Sr. No.	Practices	Adoption of recommended practices (Before FLD)		Adoption of recommended practices (After FLD)	
		No.	Percent	No.	Percent
1	Type of Groundnut	22	44	34	68
2	Improved varieties	23	46	35	70
3	Seed rate	17	34	30	60
4	Seed treatment	6	12	20	40
5	Time of sowing	31	62	48	96
6	Sowing distance	20	40	35	70
7	FYM	9	18	16	32
8	Fertilizers	20	40	36	72
9	Method of fertilizers application (Basal)	25	50	50	100
10	Top dressing (Urea)	18	36	39	78
11	Use of Sulphur	14	28	33	66
12	Weeding	32	34	50	100
13	Interculturing	30	60	50	100
14	Irrigation	19	38	32	64
15	Seed treatment (for white grub)	30	60	50	100
16	Dose of insecticides	17	34	46	92
17	Disease control	11	22	24	48
18	Pest control	26	52	42	84

The data in the Table 2 indicated that vary few respondents adopted the seed treatment (12%), FYM (18%), use of sulphur as fertilizer (28%), diseases control (22%) and doses of insecticides (34 %) before conducting FLDs.

Mathod of fertilizers application (Basal), weeding, Interculturing and seed treatment for white grub were cent per cent adopted by the farmers after FLDs.

Majority of farmers adopted, recommended type of groundnut (68%) recommended /improved varieties (70%), seed rate (60 %), time of sowing (96 %), Sowing distance (70 %), fertilizers (72 %), top dressing (Urea) ((78 %) use of sulphur (64 %) pest control (84%), and dose of insecticide (92%) after FLDs.

Very few farmers adopted FYM (32 %) and disease control (48 %) after FLDs. The probable reason might be that the FYM was available in limited quantity. Disease control required precautionary measures. These findings are in accordence to the results of Lakhara (1) and Singh *et al.* (2).

Yield of Groundnut

The yield of groundnut obtained by the respondents before and after FLD was compared.

Table 3. Yield of groundnut before and after FLD.

Sr. No.	Yield of groundnut kg / ha.		Percent increase
	Before FLD	After FLD	
1.	1850	2295	24.05 %

t = 10.15 (Calculated t)
t = 1.96 (Table t at 0.05 percent)

The data in the Table 3 revealed that the yield of groundnut per hectare increased by 24.05 percent after FLDs. The 't' test was also indicated the significant difference between two groups. Patel (3) also reported similar results.

Profitability of FLDs on groundnut

As per market price, the economics of groundnut cultivation before and after conduct of the FLDs was calculated.

Table 4. Profitabillity of groundnut before and after FLD.

S. No.	Items	Before FLD	After FLD
1	Cost of inputs (Rs.)	5561	6991
2	Yield of Groundnut (Qt./ ha.)	18.50	22.95
3	Market price (Rs./Qt.)	1700	1700
4	Gross income (Rs./ha.)	31450	39015
5	Net profit (Rs./ha.)	25889	32024

The data in the Table -4 revealed that before FLD the yield of groundnut was 18.50 q/ ha. while after FLD the yield of groundnut was 22.95 Q/ ha. The prevaling market price was rupees 1700 / - per Qt. and on that base the profitability was calculated which showed that net profit from Groundnut crop before FLD was Rs. 25,889 / ha. while the net profit from groundnut crop after FLDs was Rs. 32024 / ha. An appreciable increase in net profit to the tune of Rs. 6135/ha. was attended after FLDs. This findings are supported by Patel (3) and Singh (4).

Impact of FLD groundnut on the near by village :

Table 5. The groundnut variety GG -20 was covered the area in different villages after conducting the FLD programme.

Year	Area ha. under groundnut variety GG-20					
	Ram-pura	Vasada	Dhar-pada	Akhol	Vadaval	Manek-pura
1998	112	70	25	50	15	112
1999	83	70	40	50	25	83
2000	61	100	40	50	75	61

Conclusion

In light of the findings following conclusions may be drawn :

1. Majority of the respondents were from middle age group.
2. Majority (60 percent) of the respondents had education up to primary level only.
3. Majority (60 percent) of the respondents belonged to other backward classes (OBC)
4. 64 percent of the respondents possess more than 2 ha. of land.
5. All the respondents had irrigation facility through tube well.

6. on the set of technologies of Groundnut crop, before FLD the adoption of the crop were not known by respondents but after conducting the FLD programme on the farmers field, most of the respondents became aware about the production technologies of groundnut. Majority of the respon-dents adopted most of the production technologies of Groundnut after FLD. The yield of Groundnut increased by 24.05 percent after FLDs as compared to before FLDs. It shows positive impact of FLDs on the adoption.

References

1. **Lakhera, J.P.** 2000. Impact of front line demonstration on adoption of improved mustard production technology. Ph.D, Thesis. R.A.U., Bikaner (Rajasthan).

2. **Singh, N., Prasad, N. and Ram, D.** 2005. Front line demonstration on rice in Manipur. *Agril. Ext. Review.* May-June : 06-07.

3. **Patel, B.M.** 1995. Impact of front line demonstration on groundnut growers knowledge adoption and yield with respect to groundnut production technology. Ph.D, Thesis, G.A.U., Sardarkrushinagar.

4. **Singh, B.** 2002. Production technology adopted in Rajasthan for mung and moth. *Agril. Ext. Review.*, May-June : 09-11.

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Adoption of watershed crop production technology by farmers

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Abstract

This study was conducted in Banaskantha district of Gujarat State. Using purposive random sampling three talukas where National Watershed Development Project in Rainfed Areas (NWDPRA) was operating were selected. There were 21 villages where the project was in operation during 9th Five Year Plan. All these villages were selected purposively to make the present study reliable. Using proportionate random sampling, 200 beneficiaries were selected. The findings revealed that majority of the beneficiaries of the project had medium level of knowledge and adoption of Watershed Crop Production Technologies (WCPT). Majority of them adopted no cost or low cost technologies such as summer ploughing, sowing across the slope, growing short duration varieties, hand weeding and use of organic manures. Very less number of beneficiaries had adopted costly/complex technologies such as mulching, use of herbicides, recharging of well and terracing.

Keywords : Watershed, production technology, organic manure, correlation coefficient

Introduction

The farmers in rainfed area are mostly following subsistence farming and have low resources and their income is subject to large fluctuations. High risk of crop failure further dissuades the individual farmer from using costly inputs for increasing production, although, this area has high potential to increase the production. In view of the above, development of rainfed areas assumes a major thrust in attaining national food security and narrowing down regional socio-economic imbalance. This could be attained by following conservative production oriented programmes through integrated watershed approach.

Keeping in view the problem and potential of rainfed farming, the National Watershed Development Project in Rainfed Areas (NWDPRA) was started during 1987-88 in Gujarat state. The present study was undertaken to examine the pattern of adoption of watershed crop production technology by the farmers with following specific objectives :

(1) To assess the level of knowledge of beneficiary farmers about watershed crop production technology
(2) To study the extent of adoption of watershed crop production technology by the beneficiary farmers
(3) To ascertain the relationship between selected characteristics of the beneficiary farmers and their extent of adoption of watershed crop production technology

Methodology

The present study was undertaken in Banaskantha district of Gujarat state. Using purposive random sampling, three talukas *viz.*, Palanpur, Vadgam and Danta were selected, as these talukas are having similar agro-climatic condition, soil type and cropping pattern.

A list of villages covered under NWDPRA during 9th Five Year Plan in selected three talukas was obtained from the office of Gujarat State Land Development Corporation, Palanpur the implementing agency of the project. There were 21 villages where the project was in operation during 9th Five Year Plan. All these villages were selected purposively to make the present study reliable. Using proportionate random sampling, 7.00 per cent beneficiaries were selected from each village making a sample of 200 respondents. The interview schedule was developed and the data were collected, tabulated, analysed and interpreted in light of objectives. This study was conducted during 2004 to 2006.

Results and discussion

Knowledge level of beneficiary farmers

The result of the study reported in Table 1 show that 77.00 per cent of the respondents had medium level of knowledge about watershed crop production technology. While, 12.50 per cent and 10.50 per cent of the respondents had low and high level of knowledge about watershed crop production technology, respectively.

Table 1. Distribution of the respondents according to their knowledge level about watershed crop production technology

Sr. No.	Level of knowledge	Frequency	Per cent
1.	Low (up to 17 score)	25	12.50
2.	Medium (18 to 28 score)	154	77.00
3.	High (above 28 score)	21	10.50
	Total	**200**	**100.00**

Mean (X) = 22.700 ; S.D. = 5.3959.

Extent of adoption by the beneficiary farmers

It is observed from the data presented in Table 2 that 63.50 per cent of the respondents had medium level of extent of adoption followed by 20.00 per cent with high level and 16.50 per cent with low level of extent of adoption of Watershed Crop Production Technology.

Practice-wise adoption of Watershed Crop Production Technology

The Watershed Crop Production Technologies are two fold *viz.,* (1) Soil and Water Conservation Technology and (2) Crop Production technology. The practice-wise adoption under both the heads of Watershed Crop Production Technology (WCPT) was ascertained and the data obtained have been reported in table 3. A critical perusal of the data in Table 3 discloses that significant numbers of respondents had adopted Watershed Crop Production Technologies *viz.,* improved/short duration varieties of crops (95.50 %), use of organic manure (92.00 %), hand weeding (91.00 %), interculturing (82.00 %) and summer ploughing (81.00 %). The results indicated that higher adoption was observed for simple and no cost/low cost technologies. Contrary to this, costly/complex technologies like mulching, recharging of wells, use of herbicides, terracing and drip/sprinkler irrigation system were adopted by less number of respondents.

Table 2. Distribution of the respondents according to their extent of adoption of WCPT

Sr. No.	Extent of adoption	Frequency	Per cent
1.	Low (Up to 43 score)	33	16.50
2.	Medium (44 to 67 score)	127	63.50
3.	High (Above 67 score)	40	20.00
	Total	**200**	**100.00**

Mean ($\bar{X}$) = 55.0300; S.D. = 11.7798

Relational analysis

It could be observed from Table 4 that the characteristics *viz.,* education, social participation, occupation, land holding, irrigation potentiality, sources of information, extension participation, scientific orientation, economic motivation, risk preference, knowledge about WCPT and attitude towards WCPT had positive and significant association with the extent of adoption of WCPT by the beneficiary farmers. Whereas, the relationship between age of the beneficiary farmers and their extent of adoption was negatively significant.

Table 4. Zero order correlation coefficient between characteristics of the beneficiary farmers and their extent of adoption of WCPT

Sr. No.	Characteristics	Correlation coefficient ('r' value)
[I]	**Socio-personal**	
1.	X_1 Age	-0.2527**
2.	X_2 Education	0.4620**
3.	X_3 Social participation	0.6073**
[II]	**Economic**	
4.	X_4 Occupation	0.2201**
5.	X_5 Land holding	0.1600*
6.	X_6 Herd size (Animal possession)	0.0923^{NS}
7.	X_7 Irrigation potentiality	0.5306**
[III]	**Communication**	
8.	X_8 Sources of information	0.5015**
9.	X_9 Extension participation	0.5462**
[IV]	**Psychological**	
10.	X_{10} Scientific orientation	0.7277**
11.	X_{11} Economic motivation	0.7017**
12.	X_{12} Risk preference	0.6358**
13.	X_{13} Knowledge	0.5940**
14.	X_{14} Attitude	0.8122**

NS = Non significant,
* Significant at 0.05 level of significance,
** Significant at 0.01 level of significance.

Table 3. Practice-wise adoption of watershed crop production technology

Sr. No.	Technology	Frequency	Per cent	Rank
[I]	**Soil and water conservation technology**			
1.	Land leveling	70	35.00	IV
2.	Summer ploughing	162	81.00	I
3.	Tillage across the slope	102	51.00	III
4.	Sowing across the slope	106	53.00	II
5.	Contour bunding	62	31.00	V
6.	Terracing	4	2.00	XII
7.	Nala plugging (use of stone/sand begs)	20	10.00	VI
8.	Plantation on bunding for soil erosion	19	9.50	VII
9.	Construction of farm pond	14	7.00	IX
10.	Recharging of wells	17	8.50	VIII
11.	Drip/sprinkler irrigation system	8	4.00	XI
12.	Small check dam	13	6.50	X
13.	Mulching	0	0.00	XIII
[II]	**Crop production technology**			
1.	Use of improved/hybrid/short duration varieties	191	95.50	I
2.	Timely sowing	130	65.00	VII
3.	Inter cropping	140	70.00	VI
4.	Mid season correction	60	30.00	X
5.	Use of organic manure	184	92.00	II
6.	Use of chemical fertilizers	164	82.00	V
7.	Interculturing	180	90.00	IV
8.	Weed management			
	i Hand weeding	182	91.00	III
	ii Use of herbicides	6	3.00	XIV
9.	Plant protection measures			
	i Seed treatment	12	6.00	XIII
	ii Pest control	104	52.00	VIII
	iii. Disease control	22	11.00	XII
10.	Supplementary irrigation	68	34.00	IX
11.	Planting of trees (Fellow land field/boundary)	24	12.00	XI

Conclusion

It can be concluded that majority of the beneficiaries of National Watershed Development Project in Rainfed Areas (NWDPRA) had medium level of knowledge and adoption of Watershed Crop Production Technology (WCPT). Majority of them had adopted simple and no cost/low cost technologies such as summer ploughing, sowing across the slope, short duration varieties, hand weeding and use of organic manure. It was interesting to note that very less number of beneficiaries had adopted costly/complex technology such as mulching, use of herbicides, recharging of wells and terracing.

Reference

1. **Prajapati, V.V.** 2006. Impact of National Watershed Development Project in Rainfed Areas of Banaskantha District of Gujarat State. Ph.D. Thesis., S. D. Agricultural University, Sardarkrushinagar.

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Evaluation of suitability and effectiveness of preservatives in lactose hydrolyzed UF-permeate whey beverage

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Abstract

Investigation was planned to evaluate the suitability and effectiveness of preservatives in extending the shelf life of UF-permeate whey beverage. Beverage was prepared from UF-permeate of whey (hydrolyzed with p-galactosidase) added with two types of flavours (mango and pineapple), two sugar levels (5% and 7%), and two levels of stabilizer, guar gum (@ 0.1 and 0.2 %). The pasteurized (72°C/15 sec) product containing either sorbic acid or sodium benzoate at 0.06% and 0.03% (w/v) as a preservatives and control samples were packed in sanitized pouches and stored at refrigerated temperature (7±1°C) to study shelf life of the beverage. The beverages were subjected to sensory evaluation by trained panel of judges. The richness as well as other sensory characteristics of mango pulp-containing beverages was highly accepted with 5 % sugars and 0.1% level of guar gum. The required tartness in beverage was obtained with the addition of citric acid. During storage, the pH of beverages decreased, acidity increased and total bacterial counts and yeast and mould counts also increased. These changes were greater in case of control sample compared to beverages containing either sodium benzoate or sorbic acid. It was observed that the control sample had a shelf life of 14 days and beverages containing sodium benzoate and sorbic acid had a shelf life of 35 days, however, sodium benzoate was more effective as preservative than sorbic acid.

Keywoerds : Preservatives, lactose, beverage

Intodruction

Whey permeate is a residual by-product obtained during ultrafiltration of whey in the production of whey protein concentrates (WPC). It accounts for nearly 90% of original whey in volume. It is crystal clear, greenish fluid consisting mainly lactose in the same concentration as in the original fluid (1). Among different ways of whey utilization, conversion of fluid whey as such or as permeates after UF into whey beverage is one of the promising ways to utilize whey. Various kinds of whey beverages with or without fermentation are thought in commercial operation in developed countries like the United States and New Zealand (2). Beverages made from either whey or whey permeate are clear, transparent liquids, closed to traditional soft drinks. India has not only made great progress in milk production but has also emerged as a major fruit producer in the world. Citriculture is third largest fruit industry in India after mango and banana and collectively citrus fruits contribute to 11.53 % of total area under fruits with an annual production of 3.0 million tones (3).

An extensive survey of the published literature indicates that ready-to-drink whey based fruit flavoured drink have been studied in different parts of world. Utilization of whey as well as UF whey permeates for beverage production has importance in our country to solve the problems of whey disposal and improve the techno-economic conditions. Microbial activity in juices and beverages is usually controlled by adjusting the pH value lower than 4.0 which is almost 100 % effective against pathogens (4).

Sugar content in excess of 65 % will provide protection against yeast by lowering the water activity (5). According to Fruit Products Order (6), chemical preservatives permitted to be used in fruit products are: Sulphur dioxide (including potassium metabisulphite) and benzoic acid (including benzoates). Potassium metabisulphite has good preservative action against moulds and pathogens and it inhibits enzymes also, whereas, benzoic acid has a low taste threshold, low volatility and wide anti-microbial spectrum (3). These two chemical preservatives are widely used throughout the world in

the preservation of juice, pulp, nectar, squash, crush, cordial, and other fruit products (7). FPO (6) allows the addition of sulphur dioxide up to a maximum level of 700 ppm in fruit juice, 350 ppm in squash, and 100 ppm in RTS beverages. The permitted level of benzoic acid is 100 ppm and 600 ppm in RTS beverages and squash, respectively. Amongst the addition of sodium propionate (0.05 %) along with potassium metabisulphite (0.01 %) and sorbic acid (0.06 %) in beverage, sorbic acid was found more effective and product had storage life of 35 days at room temperature (8). Sodium benzoate @ 300 ppm was used as preservative by Singh et al. (9). Present investigation was planned to evaluate suitability of various preservatives in extension of the shelf life of hydrolyzed whey permeate beverage.

Materials and methods

Whey: The sweet whey (0.1% fat, 0.72% protein, 4.90% lactose, 0.52% ash and 6.31% total solids) was obtained from Student Training Dairy (STD) of the SMC College of Dairy Science, Anand. The whey, after filtration through muslin cloth was pasteurized at 72°C for 16 sec. and immediately cooled and stored at 4°C until used. Whey was heated to 55°C before ultrafiltration.

Permeate: Permeate (0.28 % protein, 4.93 % lactose, 0.54 % ash and 5.80 % total solids) was obtained by processing the whey (at 55°C) with UF unit (Make: Paterson Candy International Ltd., England) installed at STD. The UF module is of tubular type, and having polysulphone membrane providing an effective area of 0.9 m^2.

p-D-galactosidase: Maxilact L 2000 (p-D-galactosidase) from Kluyveromyces marxianus var. lactis, (DSM Food Specialties, Denmark) was supplied by Duke Thomson Food Specialties International, Indore and used for lactose hydrolysis of whey and permeate.

Mango Pulp: Canned kesar sweetened mango pulp (Madhu brand, Foods and Inns Ltd., Valsad (Gujarat) was used at required level.

Pineapple Juice: Pineapple fruits were procured from local market of Anand and the juice was prepared in mixer and filtered through muslin cloth to obtain clear juice. Pineapple juice was used at required level.

Sugar: Fine crystalline sugar of commercial grade was obtained from the local market.

Stabilizer : Stabilizers, namely guar gum (Indian gum Industries, Bombay) and carboxy methyl cellulose (CMC) (LOBA Chemie, Bombay) at different levels were tried in whey beverages.

Preservatives: Sorbic acid (LR grade, SD-fine Chem Ltd., Mumbai) and sodium benzoate (LR grade SD-fine Chem Ltd., Mumbai) were used as preservatives in beverage.

Packaging material: The beverage samples during study were packaged in a clean and sanitized (soaking in 100 ppm chlorine solution for 15 min) LDPE pouches (capacity 200 ml) and stored at refrigerated temperature (7±1°C).

Citric acid: Citric acid solution (LR grade SD-fine Chem Ltd., Mumbai) was used for adjusting the pH of beverage to 4.0.

Preparation of beverage: The preparation of beverages involved different processing steps including filtration, pasteurization (72°C/15 sec), cooling (55°C) and UF of whey. UF permeate was pasteurized and cooled to 37°C. For hydrolysis of whey/permeate, pH was adjusted to 6.6 using 1N KOH. Then hydrolysis was carried out by adding lactase @ 0.04 % (w/v) and incubated at 37°C for 4 hr with intermediate stirring at an interval of 30 min. After incubation, heating it at 80°C/5 min carried out inactivation of enzyme. The different media were added with the required amount of mango pulp, stabilizer along with sugar with continuous stirring. After addition of above ingredients, pH of beverage was adjusted to 4.00±0.01 using 20% citric acid solution. The preservatives were added at the rate of 0.03% sodium benzoate and 0.06 % sorbic acid. The beverages were then pasteurized at 72°C/15 sec. followed by immediate cooling to refrigerated temperature (7±1°C) and stored at the same temperature till it was served to judges for sensory evaluation and also for storage studies. The fresh as well as stored beverage samples were analyzed for different physico-chemical, sensory and bacteriological quality.

Standard Plate Count: Lactose hydrolyzed whey permeate beverage samples were analyzed throughout the storage period at an interval of 7 days

by standard plate count (SPC) procedure as described for milk in IS: 1479 (10).

Yeast and Mould Count: The yeast and mould count was analyzed according to the method described in IS I Handbook (11).

Sensory evaluation: All beverages were subjected to sensory evaluation by a panel of five trained judges for flavour, body, colour and appearance and overall acceptability. The experimental samples were served to the judges at 7±1°C. The panelists were instructed to rate each sample on nine-point Hedonic Scale. Consumer preference survey was done for the finally selected beverage.

Statistical analyses: The data obtained during investigation were subjected to appropriate statistical analyses, as per the procedures mentioned by Steel and Torrie (12).

Rresults and discussion

Influence of preservatives on storage related changes in lactose hydrolyzed whey beverage: The behavior of beverage similar to other dairy/food product during storage is of vital importance and crucial for commercial success. Shelf life of any dairy/food product is most important from manufacturing as well as consumer point of view. Among various methods for improving the shelf life of a dairy/food product, heat treatment and addition of preservatives are common. To make the beverage a commercially viable product, it has to have sufficient shelf life. Generally, the growth of microorganisms brings about various changes in the food product and spoils the taste of product during storage. Thermal processing as well as addition of preservatives has been found to control the growth of microorganisms during storage. The lactose hydrolyzed whey beverages in the present study were added with sorbic acid @ 0.06 % (w/v) and sodium benzoate @ 0.03% (w/v) followed by pasteurization at 72°C/15 sec. The level of addition of preservatives was selected on the basis of earlier research works of Mandal *et al.* (8) and Singh *et al.* (13).

The lactose hydrolyzed ultrafiltred deproteinized whey beverages processed as above were stored at refrigeration temperature (7±1°C). The pH, acidity and microbial status (SPC and Yeast & Mould counts) of fresh and stored samples of beverages were monitored at predetermined time interval (after every 7thday) until the product was rejected on sensory basis. The results of three replications on storage related changes in whey beverages are presented here under:

Changes in acidity

The changes in acidity during storage of lactose hydrolyzed ultrafiltred deproteinized whey beverage are

Table 1 Changes in acidity (% LA) during storage of lactose hydrolyzed UF deproteinized whey beverage stored at 7±1°C*

Treatment (T)	Storage Period (in days) (P)							
	0	7	14	Avg. (T)	21	28	35	Avg. (T)
Control (C)	0.46	0.48	0.52	0.48	**	**	**	**
Sodium benzoate (SB)	0.47	0.47	0.48	0.47	0.49	0.51	0.52	0.51
Sorbic acid (SA)	0.48	0.48	0.50	0.49	0.52	0.55	0.59	0.55
Average (P)	0.47	0.48	0.50		0.51	0.53	0.55	

Source of variation	SE_m		C.D. (0.05)		C.V. (%)	
	S_1	S_2	S_1	S_2	S_1	S_2
Treatment (T)	0.002	0.003	0.01	0.01	1.44	1.67
Period (P)	0.002	0.003	0.01	0.01		
TxP	0.004	0.005	0.01	0.02		

* Average of three replications

** Samples were rejected by the judging panel, hence not subjected to further sensory evaluation

S_1 : Storage study up to 0 -14 days S_2 : Storage study up to 21-35 days

represented in Table 1. The acidity of beverage without preservative (C) was 0.46 (% L.A.) when fresh but increased at faster rate and reached a value of 0.52 (% L.A.) at the end of 14 days of storage compared to the samples containing either SB or SA. The acidity of beverage containing SB preservatives remained unchanged upto 14 days of storage, while that of SA samples did not change for first 7 days and then significantly increases at 14 days. The control sample was rejected at 14 days of storage. The sample added with preservatives was further analyzed upto 35 days. During this period, the acidity was significantly ($P<0.05$) increased to 0.52 (% L.A.) in SB and 0.59 (% L.A.) in SA. The increase was significantly higher in beverage containing SA than SB as preservative. The interaction of treatment and period was significant upto 35 days. Thus, the addition of preservatives prevents the increase in acidity and use of SB was found more effective than SA throughout the storage period.

Changes in Standard Plate Count (SPC)

The changes in microbial population of beverages expressed as SPC (Log cfu/ml) of lactose hydrolyzed whey beverage during storage is presented in Table 2. The SPC was almost similar in all fresh samples (control as well as those added with preservatives). In general, as the storage period advanced, the SPC increased significantly at each stage during 7 days. The control sample had significantly higher SPC (6.06) compared to SB (5.17) and SA (5.51) on 14th day of storage, which was reflected in the sample, by significant increase in acidity. The SB containing samples initially for first 7 days did not show any significant increase in SPC, but from 7 to 35 day the increase was statistically significant at each stage. In sample SA the SPC increased significantly at each stage of 35 days storage. The increasing trend was significantly higher in beverage containing SA than SB. Thus, growth of bacteria can be controlled by the addition of preservatives and SB was found more effective compared to SA.

Changes in Yeast and Mould Count

The yeast and mould count (Log cfu/ml) during the storage of lactose hydrolyzed whey beverage is presented in Table 3. On the production day all the whey beverages (control as well as added with preservatives) had almost same yeast and mould count (1.53) and it increased rapidly in control sample (3.06 log cfu/ml) than in sample containing either SB or SA as preservatives up to 14 days. The increase was significantly higher in control samples than those added with preservatives. At the end of 14 days the control sample became unacceptable. The samples added with preservatives were further studied up to 35 days.

Table 2 Changes in SPC (log cfu/ml) during storage of lactose hydrolyzed ultrafiltered deproteinized whey beverage stored at 7±1°C*

Treatment (T)	Storage Period (in days) (P)							
	0	7	14	Avg. (T)	21	28	35	Avg. (T)
Control (C)	4.77	5.28	6.06	5.37	**	**	**	**
Sodium benzoate (SB)	4.76	4.89	5.17	4.94	5.40	5.51	5.82	5.58
Sorbic acid (SA)	4.76	4.91	'5.51	5.06	5.64	5.82	5.89	5.78
Average (P)	4.76	5.03	5.58		5.52	5.66	5.86	

ANOVA

Source of variation	SE_m		C.D. (0.05)		C.V. (%)	
	S_1	S_2	S_1	S_2	S_1	S_2
Treatment (T)	0.049	0.037	0.15	0.11	2.86	1.95
Period (P)	0.049	0.037	0.15	0.11		
TxP	0.085	0.064	0.25	NS		

*Average of three replications

**Samples were rejected by the judging panel, hence not subjected to further sensory evaluation

S_1 : Storage study up to 0 -14 days S_2 : Storage study up to 21-35 days

Table 3. Changes in yeast and mould counts (log cfu/ml) during storage of lactose hydrolyzed UF deproteinized whey beverage stored at 7±1°C*

Treatment (T)	Storage Period (in days) (P)							
	0	7	14	Avg. (T)	21	28	35	Avg. (T)
Control (C)	1.54	2.01	3.06	2.20	**	**	**	**
Sodium benzoate (SB)	1.52	1.66	1.85	1.68	2.23	2.31	2.45	2.33
Sorbic acid (SA)	1.53	1.72	1.99	1.75	2.40	2.54	2.98	2.64
Average (P)	1.53	1.80	2.30		2.32	2.43	2.72	

ANOVA

Source of variation	SE_m		C.D. (0.05)		C.V. (%)	
	S_1	S_2	S_1	S_2	S_1	S_2
Treatment (T)	0.040	0.026	0.12	0.08	6.80	3.09
Period (P)	0.040	0.026	0.12	0.08		
TxP	0.070	0.044	NS	0.14		

*Average of three replications
**Samples were rejected by the judging panel, hence not subjected to further sensory evaluation
S_1 : Storage study up to 0 -14 days S_2 : Storage study up to 21-35 days

Table 4. Changes in flavour score during storage of lactose hydrolyzed UF, deproteinized whey beverage stored at 7±1°C*

Treatment (T)	Storage Period (in days) (P)							
	0	7	14	Avg. (T)	21	28	35	Avg. (T)
Control (C)	7.47	7.07	5.00	6.51		**	**	**
Sodium benzoate (SB)	7.53	7.37	7.20	7.37	7.18	7.07	6.10	6.78
Sorbic acid (SA)	7.60	7.20	7.07	7.29	7.00	6.83	5.77	6.53
Average (P)	7.53	7.21	6.42		7.09	6.95	5.93	

ANOVA

Source of variation	SE_m		C.D. (0.05)		C.V. (%)	
	S_1	S_2	S_1	S_2	S_1	S_2
Treatment (T)	0.076	0.059	0.23	0.18	3.23	2.64
Period (P)	0.076	0.059	0.23	0.18		
TxP	0.131	0.102	0.39	NS		

*Average of three replications
**Samples were rejected by the judging panel, hence not subjected to further sensory evaluation
S_1 : Storage study up to 0 -14 days S_2 : Storage study up to 21-35 days

During this period of storage the yeast and mould count increased significantly ($P<0.05$) and were higher in SA beverage (2.98) compared to SB beverage (2.45). The interaction of treatment and period was non-significant up to 14 days of storage. Thus it is concluded that addition of preservatives is very much effective in retarding the growth of yeast and mould and SB again proved better than SA as preservative in beverages in this study.

Changes in flavour score

The changes in flavour score of whey beverages are presented in Table 4. It is evident from the table that the flavour score was apparently more (7.60) in sample added with SA as preservative followed by SB (7.53) and control (7.47), however all the samples were statistically alike. On production day, addition of preservative had no affect on flavour score of beverage. The flavour score showed declining trend during storage period but it was slower in sample containing preservatives. The flavour score was significantly ($P<0.05$) lower (5.00) in control sample at the end of 14 days of storage than sample added with SB and SA as preservatives, so it was rejected at this stage. The flavour score in remaining two samples declined significantly ($P<0.05$) when they were further stored up to 35 days. The declining trend was significantly higher in SA compared to SB as preservative, proving effectiveness of SB in controlling the flavour changes compared to SA.

Changes in body score

The mean body score of lactose hydrolyzed ultrafiltred deproteinized whey beverages during storage are presented in Table 5.

The body score of whey beverages were almost similar when they were fresh. It decreased rapidly in control (5.57) but remained almost constant in SB and SA up to 14 days. Further storage up to 35 days also showed declining trend in flavour score of SB and SA samples but the decline was higher in SA than SB. Both SA and SB samples were statistically at par up to 21 days of storage but subsequently the changes became more rapid in SA samples compared to SB samples.

Changes in colour and appearance score

The changes in colour and appearance score during storage of beverages are presented in Table 6. All the samples had identical colour and appearance score on production day. It deteriorated relatively faster in control compared to experimental samples up to 14 days of storage. Preservatives added beverages did not show any change in colour and appearance score. The judging panel rejected the control sample on 14

Table 5. Changes in body score during storage of lactose hydrolyzed ultrafiltered deproteinized whey beverage stored at 7±1°C'

Treatment (T)	Storage Period (in days) (P)							
	0	7	14	Avg. (T)	21	28	35	Avg. (T)
Control (C)	7.82	7.23	5.57	7.74	AA	Aft	AA	Aft
Sodium benzoate (SB)	7.82	7.80	7.77	7.79	7.73	7.60	6.37	7.23
Sorbic acid (SA)	7.81	7.72	7.70	6.87	7.63	7.57	5.97	7.06
Average (P)	7.82	7.58	7.01		7.68	7.58	6.17	

ANOVA

Source of variation	SE_m		C.D. (0.05)		C.V. (%)	
	S_1	S_2	S_1	S_2	S_1	S_2
Treatment (T)	0.065	0.057	0.19	0.18	2.60	2.40
Period (P)	0.065	0.057	0.19	0.18		
TxP	0.132	0.099	0.33	NS		

*Average of three replications

"Samples were rejected by the judging panel, hence not subjected to further sensory evaluation

S_1 : Storage study up to 0 -14 days S_2 : Storage study up to 21-35 days

Table 6. Changes in colour and appearance during storage of lactose hydrolyzed ultrafiltered deproteinized whey beverage stored at 7±1°C*

Treatment (T)	Storage Period (in days) (P)							
	0	7	14	Avg. (T)	21	28	35	Avg. (T)
Control (C)	8.00	7.83	5.00	6.94	**	**	**	Aft
Sodium benzoate (SB)	8.03	7.90	7.87	7.93	7.80	7.70	6.50	7.33
Sorbic acid (SA)	8.07	7.80	7.73	7.87	7.73	7.63	6.20	7.19
Average (P)	8.03	7.84	6.87		7.77	7.67	6.35	

ANOVA

Source of variation	SE_m		C.D. (0.05)		C.V. (%)	
	S_1	S_2	S_1	S_2	S_1	S_2
Treatment (T)	0.041	0.056	0.12	NS	1.63	2.30
Period (P)	0.041	0.056	0.12	0.17		
TxP	0.071	0.096	0.21	NS		

*Average of three replications
**Samples were rejected by the judging panel, hence not subjected to further sensory evaluation
S_1 : Storage study up to 0 -14 days S_2 : Storage study up to 21-35 days

Table 7. Changes in overall acceptability during storage of lactose hydrolyzed ultrafiltered deproteinized whey beverage stored at 7±1°C*

Treatment (T)	Storage Period (in days) (P)							
	0	7	14	Avg. (T)	21	28	35	Avg. (T)
Control (C)	7.67	6.97	4.80	6.48	**	**	**	**
Sodium-benzeate (SB)	7.88	7.62	7.57	7.69	7.37	7.23	6.10	6.90
Sorbic acid (SA)	7.73	7.33	6.87	7.31	6.80	6.53	5.67	6.33
Average (P)	7.76	7.31	6.41		7.08	6.88	5.88	

Source of variation	SE_m		C.D. (0.05)		C.V. (%)	
	S_1	S_2	S_1	S_2	S_1	S_2
Treatment (T)	0.057	0.070	0.17	0.22	2.40	3.17
Period (P)	0.057	0.070	0.17	0.22		
TxP	0.099	0.121	0.30	NS		

days. During further storage of experimental samples, there was a marginal decrease in colour and appearance score of beverages added with preservatives. However, the SB samples had better colour and appearance scores compared to SA samples.

Changes in overall acceptability score

The changes in overall acceptability of beverages during storage of the product are presented in Table 7. The overall acceptability is the cumulative affect of flavour, body and colour and appearance of the product. The score was almost same, when the samples were fresh, but it decreased as storage period progressed. The decline was significantly higher in control and SA ($P<0.05$) up to 14 days of storage. The control sample had the least acceptability at 14 days and hence the samples containing preservatives were stored further up to 35 days. During this period, there was a non-significant difference in flavour was observed in experimental sampler Throughout the storage period, beverage containing SB were preferrec Tover SA and control by the judging panel.The organoleptic quality bevrages under refrigerated

conditions with added preservatios was reported upto 35 days of storage by Krishnaih *et al.* (14)

Thus, from the above discussion, it is clear that storage life of lactose hydrolyzed UF deproteinized whey beverage can be enhanced with the use of preservatives up to 35 days at 7±1°C. However the use of sodium benzoate is found more effective in controlling the changes in pH, acidity, sensory properties as well as microbiological quality.

Conslusion

The lactose hydrolyzed whey beverage was subjected to storage studies with the addition of two preservatives viz., sorbic acid (SA) (@ 0.06 %) and sodium benzoate (SB) (@ 0.03 %) under refrigeration conditions (7±1°C) along with control (without preservative). The samples were monitored after every 7th day for changes in pH, acidity, microbial load (SPC and yeast and mould count) and for sensory attributes. During storage, the pH was decreased and acidity was increased as storage period proceeded and this rate was faster in control compared to beverages containing either SB or SA as preservatives. The panel of judges rejected control samples after 14 days of storage. However, in case of beverages containing preservatives, the rate of decrease in pH and increase in acidity was higher in beverage containing SA than SB.

The SPC and yeast and mould counts were studied during the storage and it was observed that SPC increased as storage advanced. The control had stgntficantly higher SPC compared to beverage containing either SB or SA on 14th day of storage. During 35 days of storage, the increase in count was faster in beverage containing SA than SB as preservatives. The yeast and mould count also showed similar trend, with high counts were found in control up to 14 days of storage. During further study up to 35 days, the count was increased significantly in beverage containing SA than SB. Hence, SB was found more effective as preservative compared to SA.

The changes in sensory attributes also showed that control samples became unacceptable after 14 days and obtained lower flavour, body, colour and appearance and overall acceptability scores compared to experimental samples. Between, samples containing SA and SB, SB samples showed their superiority over SA throughout the storage period.

References

1. **Renner.E. and Abd-El-Salem, M.H.** 1991. Application of Ultrafiltration in the Dairy Industry. Elsevier Applied Science, London, New York. pp. 80-129.

2. **Zadow. J.G.** 1986. Utilization of milk components. In: Modern Dairy Technology, Vol.1, Robinson.R.K. (Ed.), London, UK, 273.

3. **Ghorai.K. and Khurdiya. D.S.** 1998. Storage of heat processed Kinnow mandarin juice. *J. Food Sci. Technol.* **35** : 422-424.

4. **Batchelor.V.J.** 1993. Soft Drinks: Dietary Importance. In: Encyclopaedia of Food Science, Technology and Nutrition, Vol.I. Macrae, R, Robinson, R.K. and Sadler, M.J. (Eds.). Academic Press, London, pp: 4189- 4200.

5. **Khamrui.K. and Rajorhia.G.S.** 1998. Making profits from whey. *Indian Dairyman.* **50**: 13-18.

6. **FPO** 1955. Fruit Products Order. Ministry of Health, Govt. of India. New Delhi.

7. **Jay, J.M.** 1996. Modern Food Microbiology. CBS Publishers & Distributors, New Delhi, pp. 259

8. **Mandal, R.L, Ghatak, P.K. and Bandopadhyay, A.K.** 1997. Studies on the shelf life of whey beverage. *Indian J. Dairy Sci.* **50** : 193-198.

9. **Singh.W., Kapoor,C.M. and Srivastava,D.W.** 1999. Standardization of technology for the manufacture of Guava-whey beverage. *Indian J. Dairy Sci.* **52** : 268 - 271.

10. **IS:** 1479. 1962. Method of test for Dairy Industry. Part III. Bacteriological examination of milk. Indian Standards Institution, New Delhi, pp. 45, 53.

11. **ISI Handbook of Food Analysis**.1981. Dairy Products. SP: 18 (Part XI). Indian Standards Institution, New Delhi, pp 64.

12. **Steel, R. D. and Torrie, J.H.** 1960. Principles and Procedures of Statistics. McGraw Hill Publ. New York, N.Y.

13. **Singh.S., Ladkani.B.G., Kumar. A and Mathur.B.N.** 1994. Development of whey based beverages. *Indian J. Dairy Sci.* **47**: 586 - 590.

14. **Krishnaiah.N, Reddy. C.R, Sastry, P.M. and Ramarao, M.** 1989. Studies on keeping quality of whey beverage. *Asian J. Dairy Res.* **8** : 8-14.

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Dystocia due to Monocephalus thoracopagus tetrapus tetrabrachius conjoined twin in a primiparous buffalo heifer – A case report

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Abstract

Dystocia due to monocephalus thoracopagus tetrapus tetrabrachius conjoined twin in a primiparous Mehsani buffalo heifer is placed on record.

Key Words: Mehsani buffalo heifer, dystocia, monocephalus thoracopagus tetrapus tetrabrachius, caesarean section

Introduction

Conjoined twin monsters arise from a single ovum and are monozygotic and they have considerable importance both from obstetrical and embryological point of view. They are relatively more common in cow, sow, bitch and cat while rare in other animals and often lead to a severe dystocia (1).

History and Clinical Diagnosis

A Buffalo aged 4 years in its first parity with the history of labour pain since last 24 hrs and unsuccessful attempts of relieving the dystocia at field was presented to Veterinary College clinics of Sardarkrushinagar. The animal was straining in recumbency and had already passed away the fluid after rupturing of the water bags during local manipulation at field level. Pervaginal examination revealed the fetus to be in anterior longitudinal presentation with only two forelimbs without the head but at the same time deeper palpation revealed the accessibility of two hind limbs and two other forelimbs with left lateral deviation of the head. The case was diagnosed as dystocia due to a large fetal monster.

Discussion

Since the birth passage was constricted and there was no room for the fetotomy, therefore the case was opted for the caesarean section. A monocephalus thoracopagus tetrapus tetrabrachius conjoined twin was observed having single head and neck, four fore limbs and four hind limbs which were fused at the thorax and both these male fetuses had complete

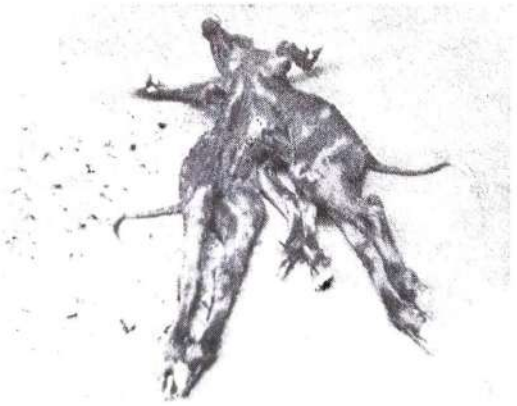

Plate-1 : Monocephalic thoracopagus tetrapus tetrabrachius Monster

Plate-2 : Closeup view of incised hydrocephalic head

posterior duplication. (Plate -1) The associated anomaly in the present case was hydrocephalus, which yielded 2 liters of fluid on an incision over it (Plate-2). Hydrocephalus is formed due to accumulation of liquid in the ventricular system or in the arachnoid space (2). It is caused by stenosis of the cerebral aqueduct associated with malformation of other normal structures (3) Hydrocephalus is seen mostly in cattle (4, 5) and rarely in buffaloes (6, 7).

There are reports on conjoined twins with varying degree of duplication and anomalies in their integuments. Similar to present record Monocephalus tetrapus tetrabrachius in a pluriparous buffalo has been reported by Chede et al. (8). Dicephalic conjoined twins have been reported by various authors viz., Dicephalus dibrachius monster (9), Dicephalus dipus hexabrachius (10), Dicephalus monster (11), Dicephalus dipus dibrachius (12), Diplopagus sternopagus(13), Dicephalus dipus tetrabrachius ischiopagus in different buffaloes and Dicephalus ischiopagus dipus tetrabrachius monster, Dicephalus dipus tetrabrachius (14) in cows.

The conjoined twins are always identical twins of the same sex as observed in the present case. The embryonic period, when cell growth and differentiation are at their maximum is the period of great susceptibility to teratogens. Severe cases of limb or vertebral column contracture represent a faulty posture of the fetus and finally cause a dystocia, one or more complete or incompletely formed parasitic limb, occasionally develop on an otherwise normal fetus or conjoined twins (15)

References

1. **Robert, S.J.** 1971.Veterinary Obstetrics and Genital Diseases (Theriogenology), 2nd Edn.C.B.S.Publishers, India.

2. **Jubb, K.V.F. and Kennedy, P.C.** 1970. Pathology of domestic animals, 2nd edn Vols 1 and 2 Academic press Newyork.

3. **Woodard, J.C. and Newberne, P.M.** 1967. *J. Embryol.Exp.Morphol.* **17**:177.

4. **Balasubramanian, S., Ashokan, S.A.Seshagiri, V.N. and Pattabiraman, S.R.** 1997. Congenital internal hydrocephalus in a calf. *Indian Vet.J.* **74** : 446-447.

5. **Nandkumar, S.Ramchandra, K.M., Mohan, S. and Anilkumar, T.V.** 1999. Pathology of bovine congenital external hydrocephalus. *Indian Vet.J.* **76** : 847-849.

6. **Salunke, S.P., Amle, M.B. and Zambre, P.C.** 2001. Dystocia due to hydrocephalus in Pandharpuri buffalo. *Indian J. Anim. Reprod.* **22**: 96.

7. **Kumaresan, A., Garg, A., Mahapatra, U.S., Shankar, U.M.A., and Agarwal, S.K.** 2003. Dystocia due to hydrocephalus calf in a buffalo cow. *Indian J. Anim. Reprod.* **24** : 82.

8. **Chede, G.S., Bedi, M.K., Mishra, Y. and Dadarwal, D.** 2005. Dystocia due to Monocephalus tetrapus tetrabrachius fetus in a pleuriparous buffalo. *Indian J. Anim. Reprod.*, **26** :71

9. **Thirumalesh, T. and Azeemulla, H.R.** 2001. Dicephalus dibrachius monster in a buffalo. *Indian Vet. J.* **78** : 355-356.

10. **Urankar, R.M., Chhonker, S.V. and Gangaprai, P.M.** 1994. Conjoined twin monstrosity in a buffalo. *Indian J. Anim. Reprod.* **15** : 165.

11. **Kasiraj, R. Mutharo, M., Ranga Reddy, N.S. and Misra, A.K.** 2001.Dicephalus buffalo neonate –A Case report. *Indian J. Anim. Reprod.* **22** :191.

12. **Sharma, A.Singh, M. and Sood, P.** 1996. Dystocia due to a fetal monster in a buffalo – A Case report. *Indian J. Anim. Reprod.* **17** : 74.

13. **Makkena, S., Srinivas, M. and Naidu, S.** 2004. Dystocia due to Diplopagus sternopagus conjoined twins in a buffalo. *Indian J. Anim. Reprod.*, **25** :160.

14. **Harendra kumar, Purbey, L.N. and Gupta, S.K.** 2000. Conjoined twin monstrosity in a cow. *Indian J. Anim. Reprod.* **21**:83.

15. **Sloss, V. and Dufty, J.H.** 1980. In Handbook of bovine obstetrics. Williums and Wilkins, Baltimore/London.

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Short communication

Effect of Zn-enriched organic manures in INM for biomass of dry roots, nutrient uptake and CEC of fodder maize roots

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The cation concentration in the external solution surrounding the root surface affects the cations adsorbed by the surface exchange sites of the plant roots. The higher levels of nitrogen increased root CEC significantly. The addition of dung in long term fertilizer trials significantly increased the root CEC of maize, wheat and rice crops. Singh and Ram (1) have shown that effect of fertilizer and manure on the root

Table. 1. Effect of zinc enriched manures and other manurial treatments on biomass of dry roots, nutrient uptake organic CEC of roots by and fodder *maize*

Sr. No.	Treatment Details	Biomass of dry root (gm)	Nutrient uptake by roots (mg pot^{-1})				CEC (meq l^{-1})
			N	P	K	Zn	
T_1	RDF	2.01	98.16	36.93	101.60	0.53	12.10
T_2	RDF+ Zn 25	1.75	121.92	35.54	125.41	0.89	13.20
T_3	RDF+SO_4 equivalent to Treat. No.2	1.89	110.22	42.83	116.96	0.62	12.30
T_4	½ N- IF + ½ N FYM E-with Zn 25	2.56	140.64	40.79	156.47	1.07	14.50
T_5	½ N- IF + ½ N CC E-with Zn 25	1.97	127.33	37.85	141.49	0.87	14.80
T_6	½ N- IF + ½ N PM E-with Zn 25	2.62	182.26	53.27	197.58	1.68	14.90
T_7	½ N- IF + ½ N BGS E-with Zn 25	2.08	141.68	41.95	155.22	0.98	14.60
T_8	½ N- IF + ½ N FYM E-with Zn 12.5	2.41	129.63	39.70	137.61	0.90	13.90
T_9	½ N- IF + ½ N CC E-with Zn 12.5	1.72	127.47	40.31	138.46	0.87	14.20
T	½ N- IF + ½ N PM E-with Zn 12.5	2.50	144.75	46.01	159.53	1.17	14.40
T_{11}	½ N- IF + ½ N BGS E-with Zn 12.5	2.15	135.72	41.35	147.73	1.02	14.10
T_{12}	½ N- IF + ½ N FYM + Zn 25	1.94	130.39	37.11	146.88	0.92	13.30
T_{13}	½ N-IF + ½ N CC + Zn25	1.97	147.45	40.99	164.22	0.97	13.50
T_{14}	½ N- IF + ½ N PM + Zn 25	2.33	148.73	43.90	162.74	1.25	13.50
T_{15}	½ N- IF + ½ N BGS + Zn 25	2.03	144.93	43.06	156.06	1.28	13.40
T_{16}	½ N-IF + ½ N FYM	1.89	129.86	43.92	136.28	0.89	12.90
T_{17}	½ N-IF + ½ N CC	1.80	133.83	46.92	143.19	0.70	13.10
T_{18}	½ N- IF + ½ N PM	2.02	136.14	47.68	147.75	0.95	13.10
T_{19}	½ N- IF + ½ N BGS	1.81	121.40	43.88	128.52	0.71	13.00
SEm±		0.09	8.57	3.71	11.25	0.07	0.62
CD at 5%		0.26	24.56	NS	32.24	0.19	NS
C.V.%		7.50	11.05	15.20	13.39	12.10	7.90

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

significantly increased cation exchange capacity of some rice and wheat varieties.

A pot experiment was conducted at the Department of Agricultural Chemistry and Soil Science, B. A. College of Agriculture, Anand during the summer 2002. The soil was alluvial in nature, light brown in colour. The texture is loamy sand (Typic Ustochrept) in Inceptisols. All the fertilizer and manurial treatments were given to pots as per the treatments. After giving the treatments, 6-8 seeds per pot 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 often 60 days. Plant root sample were pulverized in a mechanical grinder having stainless steel blades and preserved in a plastic bag for further chemical analysis.

The maximum dry weight of fodder maize roots was produced with the treatment T_6, which was 52.33 per cent higher than the T_9 treatment, the lowest one. Results are in line with those reported by Jayamani and Devarajan (2).

The uptake of N, P, K and Zn by fodder maize roots are shown in Table 1 which revealed that the N, P, K and Zn uptake were significantly influenced by various levels of zinc enriched organic manures and other manurial treatments and it varied from 98.16 to 182.86 mg pot^{-1} for N, 35.54 to 53.27 mg pot^{-1} for P, 101.60 to 197.58 mg pot^{-1} for K and 0.53 to 1.68 mg pot^{-1} for Zn. Maximum N, P, K and Zn removed by fodder maize under T_6 treatment, which was significantly highest over the rest of the treatment except for P. Similar results were reported for N and P by Itanal and Palled (3), Madhavi *et al.* (4) and for Zn Singh *et at.* (5).

The CEC of fodder maize roots ranged from 12.10 to 14.90 meq l^{-1} and highest under the T_6 treatment.

The application of manure has shown increasing in trends in CEC of maize roots. Similar effect was observed by Morita (6), Donstov (7) and Singh and Ram (1).

Reference :

1. **Singh, S. and Ram, L.C.** 1976. Effect of fertilizers and manure on the root CEC of some rice and wheat varieties. *J. Indian Soc. Soil Sci.*, **24** : 427-431.
2. **Jayamani, R. S. and Devarajan, R.** 1995. Effect of organic amendments and zinc on availability and uptake of P, Ca and Na by sugarcane.*Madras Agric. J.* **82** : 36-39.
3. **Itnal, P. K. and Palled, Y. B.** 2001. Studies on intercropping of sunnhemp green manuring in hybrid maize. *Karnataka J. Agric. Sci.* **14** : 586-592.
4. **Madhavi, B. L, Reddy, M. S. and Rao, P. C.** 1995. Integrated nutrient management using poultry manure and fertilizers for maize. *J. of Res. APAU.* **23** : 1-4.
5. **Singh, A. P., Sakal, R. and Singh, B. P.** 1983. Relative effectiveness of various types and methods of zinc application on rice and maize crop grown in calcareous soil. *Plant and Soil,* **73** : 315-322.
6. **Morita, S. C.** 1972. CEC of roots nutrient uptake by plants. *Scientific-Reports-of-the-Kyoto-Prefectural-Uni.-Agriculture.* **24** : 142-158.
7. **Dontsov, M. B.** 1974. A study of the cation and an ion exchange capacity in some crops. *Fiziologiya-i-Biokhimiya-Kul'turnykh-Rastenii.* **6** : 86-87.