The different P fractions viz., Al-P, Fe-P, Ca-P and occluded P constituted 2.54-25.08, 10.83-12.37,5.01-7.45 and 18.21-19.91 per cent of total P at harvest stage respectively. The available P (Olsen's) formed 3.34 to 6.21 per cent of total P. The content of different P fractions as per cent of total P followed the order: occluded P > Fe-P > Ca-P > Al-P.

Results have revealed that occluded P and Fe-P are the important P fractions contributing to supply of P in these paddy soils.

REFERENCES

BISWAS, C.R., SEKHON G.S. and SINGH. R (1977). Accumulation and decline of available phosphorus and potassium in a soil under multiple cropping. **J. Indian Soil. Sci. 25**: 23-27 .

DAS, MADHUMITA, SINGH. B.P., RAM MUNNA, DWIVEDI, B.S. and PRASAD. R.N. (1991). Influence of organic manures on native plant nutrient availability in an acid alfisol. **J. Indian Soc. Soil Sci. 39**: 286.

DHILLON, N.S. and DEV. G. (1990). Grain yield and P uptake by crops in relation to P availability in a sandy loam soil. **J. Indian Soc. Soil Sci. 39**: 286.

GILL, H.S. and MEELU, O.P. (1980). Studies on the substitution of in organic fertilizers with FYM and their effect on soil fertility in a rice-wheat nation. In Proc. Recycling of Residues of Agriculture and Industry, PAU, Ludhiana PP 297-310.

GUPTA, J.P. and SHARMA P.K. (1987) Phosphorus efficiency in wheat (Rs. 308) as influenced lime and FYM in an acid soil of Himachal Pradesh. **Fert. News 32** (2): 37-40.

JACKSON, M.L.(1957). Soil chemical Analysis. Prentice, Inc. Englewood Cliffs. New Jersey. U.S.A.

JASHPAL. VIG. A.C. and CHAND. MILAP (1993). Available soil phosphorus in relation to Sesbania green manure incorporation in calcerious soils. **J. Indian Soc. Soil Sci. 41**: 47.

NAD. B.K. and GOSWAMY, N.N. (1984). Effect on long term application of phosphate on soil phosphorus status in rice-wheat-rotation. **J. Indian Soc. Soil Sci. 32**: 288.

SHARMA, P.K. BHUMBLA. D.R. and VERMA. S.P.(1980). Transformation of added P in acid soils of Himachal Pradesh. **J. Indian Soc. Soil Sci. 28**: 450.

SHARMA. P.K. and TRIPATHI. B.R.(1984). Phosphorus availability indices in relation to phosphorus fractions in some himalayan acid soils of North West India. **J. Indian Soc. Soil Sci. 32**: 292.

SUBRAMANIAN'S and GOPALSWAMY. A.(1991). Effect of moisture, organic matter, phosphate and silicate in availability of silicon. **J. Indian Soc. Soil Sci. 39**: 99.

VYAS. K.K.(1964). Availability and uptake of phosphorus by wheat under different moisture and organic matter levels.**Curr. Sci. 33**: 756.

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HETEROSIS AND INBREEDING DEPRESSION FOR SEED OIL AND PROTEIN CONTENTS IN UPLAND COTTON (*GOSSYPIUM HIRSUTUM* L.)

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ABSTRACT

Inbreeding depression estimated from F_2 data for seed oil and seed protein exhibited significant loss of vigour for these two traits. It is suggested that for achieving lines with high seed oil and seed protein content, recurrent selection may be resorted to.

KEY WORDS: Plant Breeding & Genetics, Inbreeding depression, F_2

Cotton besides providing fibre for manufacture of textiles, is also contributing edible oil and cakes. Cotton seed is the second largest source of edible seed oil in India (Pandey, 1976). Kohel (1978) reported a considerable range in variability for seed oil and protein. The success of commercial cotton hybrids in the seventies and eighties offers fresh properties in their exploitation for oil. However, very little information is available on breeding procedures based on the estimates of the nature

Table 1. Heterosis, F_2 mean and inbreeding depression for seed oil and seed protein percent

Hybrids	Seed oil				Seed protein			
	Relative heterosis	Hetero-beltiosis	F_2 mean	Inbreeding depression	Relative heterosis	Hetero-beltiosis	F_2 mean	Inbreeding depression
1	2	3	4	5	6	7	8	9
MCU 9 x Acala Q 6-1	24.02**	19.95**	22.20	23.70**	50.23**	36.21**	2.11	40.10**
MCU 9 x ISC 78	9.67**	6.92*	24.60	3.91**	61.50**	50.77**	20.34	44.47**
MCU 9 x Deltapine	3.75	-0.86	20.50	13.65**	71.10**	70.65**	19.17	46.90**
MCU 9 x Saudi Arabia	5.80*	5.76*	23.04	9.11**	35.32**	20.66**	18.03	47.62**
MCU 9 x Alagodenlas Brenas	-1.47	-3.61	22.22	3.73**	48.85*	26.05**	16.90	55.83**
MCU 9 x Okra leaf Acala	14.98**	5.11	22.18	11.88	21.73**	2.86	19.87	36.66**
MCU 9 x Mc Namara wine sap	12.82**	7.42*	21.62	15.94**	19.14**	0.54	17.47	43.22**
MCU 9 x ELS 470	-1.54	-5.07	21.72	11.31**	59.09**	43.97**	20.19	35.75**
MCU 9 x ELS 481	-3.06	-6.68*	20.84	6.76**	31.28**	13.21**	17.12	47.93**
MCU 9 x Glandless Acala	5.63*	2.64	21.26	13.51**	47.79**	35.08**	18.04	47.62**
MCU 7 x Acala Q 6-1	9.53**	9.36**	18.15	25.75**	25.69**	22.27**	18.73	44.02**
MCU 7 x ISC 78	13.25*	12.10**	22.28	12.63**	43.02**	34.99**	16.70	54.73**
MCU 7 x Deltapine	12.22**	11.07**	20.12	18.67**	29.73**	14.99**	19.77	37.18**
MCU 7 x Saudi Arabia	9.94**	6.06*	22.55	11.29**	22.80**	21.68**	18.88	43.30**
MCU 7 x Alagodenals Brenas	11.35**	9.82**	18.22	27.58**	32.31**	25.83**	18.43	51.74**
MCU 7 x Okra leaf Acala	21.68**	15.01**	19.38	24.36**	26.61**	20.11**	21.10	42.40**
MCU 7 x Mc Namara wine sap	9.69**	8.16*	21.64	10.17**	18.07**	11.83**	18.44	46.11**
MCU 7 x ELS 470	-0.70	-7.47**	21.25	10.98**	22.69**	19.60**	17.51	46.50**
MCU 7 x ELS 481	13.17**	12.87**	19.05	24.22**	22.13**	18.60**	17.69	48.65**
MCU 7 x Glandless Acala	10.41**	9.63**	21.38	10.17**	35.38**	30.56**	19.84	44.47**
MCU 5 x Acala Q 6-1	25.81**	24.78**	23.82	10.98**	12.34**	3.40**	20.98	33.63**
MCU 5 x ISC 78	18.22**	16.30**	24.20	24.22**	28.10**	14.63**	18.44	47.72**
MCU 5 x Deltapine	12.50**	12.03**	22.09	13.67**	28.95**	8.80**	20.98	37.22**

Table 1. Contd

Hybrids	Seed oil				Seed protein			
	Relative heterosis	Hetero-beltiosis	F_2 mean	Inbreeding depression	Relative heterosis	Hetero-beltiosis	F_2 mean	Inbreeding depression
1	2	3	4	5	6	7	8	9
MCU 5 x Saudi Arabia	-10.38**	-14.05**	19.57	14.68**	19.84**	12.25**	18.44	46.61**
MCU 5 x Alagodenlas Brenas	17.99**	15.67**	19.84	8.51**	21.64**	20.81**	20.70	44.31**
MCU 5 x Okra leaf Acala	20.73**	14.77**	20.19	10.39**	20.27**	19.75**	19.47	47.15**
MCU 5 x Mc Namara wine sap	33.78**	32.70**	24.51	5.00**	28.60**	28.26**	17.69	55.17**
MCU 5 x ELS 470	0.92	-7.49*	20.01	25.13**	14.23**	5.35**	17.51	45.97**
MCU 5 x ELS 481	39.33**	38.86**	21.50	20.07**	14.61**	11.40**	22.72	33.70**
MCU 5 x Glandless Acala	9.24**	7.85*	22.00	16.06**	34.40**	22.72**	21.99	41.74**
LRA 5166 x Acala Q 6-1	15.65**	13.01**	20.83	17.04**	25.62**	19.91**	17.84	47.71**
LRA 5166 x ISC 78	18.86**	15.21**	22.14	30.13**	22.57**	13.60**	20.99	35.08**
LRA 5166 x Deltapine	10.56**	9.36**	20.04	9.70**	48.69**	29.60**	20.10	45.50**
LRA 5166 x Saudi Arabia	11.60**	5.51	23.14	17.60**	24.24**	20.78**	22.88	45.43**
LRA 5166 x Alagodenlas Brenas	11.83**	8.03**	19.94	15.52**	19.52**	15.79**	21.41	9.50**
LRA 5166 x Okra leaf Acala	25.58**	21.12**	21.25	16.01	15.98**	12.10**	20.98	38.63**
LRA 5166 x Mc Namara wine sap	10.55**	9.78**	20.05	15.65**	23.51**	19.18**	21.30	41.60**
LRA 5166 x ELS 470	2.43	-7.40*	21.74	10.02**	37.93**	32.00**	17.94	52.24**
LRA 5166 x ELS 481	11.81**	9.78**	20.02	17.68**	12.43**	11.29**	19.17	40.69**
LRA 5166 x Glandless Acala	15.48	12.30**	21.74	14.31**	28.74**	21.87**	18.26	47.35**
Mean	-	-	21.32	15.03	-	-		43.55
SE	-	-	0.25	0.19	-	-		0.20

and magnitude of gene action in seed oil and seed protein content in cotton. Hence an experiment was conducted with 40 crosses to find out the magnitude of inbreeding depression in seed oil and seed protein.

MATERIALS AND METHODS

The experiment was conducted during the year 1996. Material for this study consisted of 40 cross combinations. Forty F_1 crosses made during summer 1995 were evaluated along with parents in a randomized block design with three replications during kharif 1996. Each entry was sown in a single row of 20 dibbles at a spacing of 75 x 30 cm. Three mature and fully opened bolls from middle portion of five random plants were picked and ginned to get a composite sample of seeds. For recording seed traits viz., seed oil and seed protein the crossed seeds were designated as F_1 and the seeds obtained from F_1 plants were genetically considered as F_2 seeds. Acid delinted and dried seed from each sample were analysed by nuclear magnetic resonance (NMR) technique using NMR auto analyser. To estimate seed protein, seeds (embryo and endosperm) were analysed for total nitrogen content by Microkjeldhal method described by Humphries (1956) and seed protein content was calculated by multiplying the nitrogen content with a factor 6.25 and the result was expressed as percent.

RESULTS AND DISCUSSION

The data on mean expression and inbreeding depression in F_2 generations developed from the 40 hybrid combinations for seed traits viz., seed oil and seed protein are given in table 1. Seed oil content in F_2 ranged from 18.15 per cent in MCU 7 x Acala Q/6-1 to 24.60 per cent in MCU9 x ISC 78. Seed protein had a variation from 2.11 in MCU 9 x Acala Q/6-1 to 22.88 per cent in LRA 5166 x Saudi Arabia. The hybrids displayed high variability for these two characters. The mean expression of F_2 was lower than that of F_1. The loss in seed oil and seed protein contents in advance generation was due to inbreeding depression, which is caused by a decrease in heterozygosity which shows strong dominance or over dominance (William and Meredith, 1979). The prevalance of dominant gene action for seed oil and seed protein in cotton suggest that inbreeding depression is a major complicating factor. all the 40 cross combinations showed inbreeding depression for seed oil and seed protein. In the cross combinations inbreeding depression ranged from 3.73 to 30.13 per cent for seed oil and 9.50 to 55.83 per cent for seed protein. In the present investigation the cross MCU 5 x ELS 481 having high heterotic expression for seed oil showed high inbreeding depression also. This finding is in accordance with reports made by Kapoor *et al.*, (1994). Similarly for seed protein, the cross MCU 9 x Deltapine having 71.10 per cent of relative heterosis expressed 46.90 per cent of inbreeding depression. Thus, high inbreeding depression was associated with high heterotic expression. This suggests the importance of non additive gene action. Presence of such non additive gene action which enhance the vigour for seed protein can be attributed to epistatic gene action.

All the 40 combinations showing inbreeding depression in F_2 generation having 15.03 per cent and 43.55 per cent for seed oil and seed protein respectively indicated less scope for improving these traits. However, for achieving lines with high seed oil and seed protein contents sythesising double or multiple crosses and making selections will be useful. Special breeding methods like biparental mating to break the linkage and recurrent selection would also be useful.

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REFERENCES

HUMPHRIES, E.C. (1956). Mineral components and ash analysis In : Modern methods of plant analysis. Springer - Verlag, Berlin, 468 - 502.

KAPOOR, C.J., BHARDWAJ, R.P. and MATHUR, G.M. (1994). Heterosis for oil content in upland cotton. Indian Soc. Oil Seeds Res., 109 - 110.

KOHEL, R.J. (1978). Survey of *Gossypium hirsutum* germplasm collection for seed oil percentage and seed characteristics. Agril. Res. Series Bull 187 USDA. PP. 38.

PANDEY, S.N. (1976). Utilization of cotton seed and its produce. Cotton Dev., 6: 4 - 9

WILLIAM, R. and MEREDITH, W.R.JR. (1979). Inbreeding depression of selected F_1 cotton progenies. Crop Sci., 19(1) : 86 - 88.

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