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Genetic Correlation and Path Coefficient Analysis of Oil and Protein Contents and Other Quantitative Characters in F_2 Generation of *G. hirsutum* L.

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Abstract: The analyses of genetic correlation and path coefficient were made using 56 F_2 families and their 8 parents of *G. hirsutum* L. It was revealed that number of bolls and lint percentage had positive and significant relationship with seed cotton yield, boll weight, lint index, staple length and fibre fineness. Boll weight showed strong association with lint percentage, fibre fineness and plant yield. Staple length and fibre fineness exhibited positive correlation with plant yield. Oil and protein contents were positively related with almost all the characters studied in the present investigations. Path analysis revealed that number of bolls and boll weight made the greatest contribution towards seed cotton yield. In addition boll weight, lint percentage, lint index, staple length, fibre fineness and protein content also affected plant productivity through number of bolls. However oil content contributed via boll weight.

Key words: Genetic correlation, path analysis, plant yield, oil and protein contents

Introduction

The F_2 population originated from diverse germplasm of self pollinated crop species contains enormous amount of genetic variability and thus the plant materials offer the greatest opportunities to a research worker to select the most promising genotypes combining desirable plant features. Seed cotton yield and its components and quality characteristics of a plant are heritable in nature (Poehlman and Sleper, 1995) and thus genetic improvement in all these characters through selection and breeding is possible. However, sometimes the occurrence of negative genotypic correlations among these characters create problems for cotton breeders, while looking for plants in segregating progenies possessing high yield of seed cotton and improved quality characters. The work of selecting the plants possessing desired traits is facilitated if some working knowledge about the nature of genetic correlation between the characters is available. Further the extent to which various characters influence the final productivity directly or indirectly, is also helpful. Thus correlation studies and path coefficient analysis of plant material is an important part of plant improvement exercise.

The previous reports revealed that seed cotton yield was positively and significantly correlated with number of bolls and boll weight (Tyagi *et al.,* 1988; Alam and Islam, 1991; Alam, 1995; Azhar and Hussain, 1998). In other studies lint percentage, staple length, seed and lint indices showed positive association with seed cotton yield (Khan *et al*., 1985; Arshad *et al*., 1993; Akbar *et al*., 1994, Azhar *et al*., 1999). However, information on the nature of correlation of oil and protein with seed cotton yield and other characters is not well documented. The few reports that exist in the literature revealed that seed oil was positively correlated with seed index (Kohel, 1980) but it had negative association with fibre yield (Sokolova and Avtonomov, 1985). However Dani (1989) noted that oil content had positive but non significant association with lint yield and fibre quality. In the present studies, F_2 data on oil and protein content, seed cotton yield and other quality characters were analysed to find nature of genetic correlation among various characters and their direct and indirect influence on seed cotton yield of *Gossypium hirsutum* L.

Materials and Methods

The plant materials used in the present study were developed by crossing four exotics and four indigenous cultivars/lines of *Gossypium hirsutum* L. The eight parents were selected from the gene pool maintained in the department. The genotypes used in crossing programme were BJA, Reba-B50, A89/FM, Changmiah (exotics), CIM250, S12, NIAB78 and AUH50 (local). The parents were crossed in glasshouse according to diallel system of crossing. A large number of pollinations were made to produce sufficient quantity of F_1 seed. The seeds of 56 hybrids and their parents were field planted in single row plot to develop F_2 seed. All the plants growing in F_1 generation were covered with glassine bags to effect self pollination. The F_2 population was grown in the field during 1993-94. The experimental design was randomized complete block with 3 replications. The seeds of each of 56 F_2 hybrids and their parents were spaced at the distance of 30 cm within the row and 75 cm between the rows and thus there were 12 plants in a row. There were 8 rows of each genotype and thus each entry was planted on a plot measuring 3.3×6 m^2, having 96 plants in total. One plant on either end of each row was left as non experimental. At maturity of plants the data on number of bolls per plant, yield of seed cotton per plant (g), boll weight (g), lint percentage, seed index, lint index, staple length (mm), fibre fineness (µg/inch), oil content and protein content were taken on individual plant basis.

For genotypic correlation analysis, F_2 data were subjected to analysis of variance and covariance technique (Steel and Torrie, 1980). Correlation coefficients among various characters were calculated following the formula by Kwon and Torrie (1964). The formula is as under:

$$r_g = Cov_{gij}/[(Var_{gi})\ (Var_{gj})]^{0.5}$$

Where:

'r_g' is the genotypic correlation coefficient, Cov_{gij}, Var_{gi} and Var_{gj} are the genetic estimates of covariance and variance of genotypes respectively for ith and jth traits.

Path coefficient analysis was performed according to the method described by Dewey and Lu (1959). In this analysis seed cotton yield was kept as resultant variable (effect) and other characters as causal variables (causes).

Results

The mean squares and mean products obtained from the analysis of variance and covariance respectively are not given here. Correlation coefficients (r_g) indicate that number of bolls had strong and positive association with other characters; r_g with boll weight being 0.488, with lint percentage being 0.718, with lint index being 0.036, with staple length being 0.656, with fibre fineness 0.490, with protein content 0.772 and with seed cotton yield 0.904 (Table 1). Although genotypic correlation of number of bolls with seed index and oil content were low, these are significant statistically. Boll weight showed negative association with seed index, while 'r_g' with lint percentage, lint index, staple

Table 1: Genotypic correlation coefficients "r_g" among various characters in F_2 generation of *G. hirsutum* L.

Characters		Boll weight	Seed index	Lint percentage	Lint index	Staple length	Fibre fineness	Oil Content	Protein content	Yield of seed cotton
Number of Bolls	"r_g"	0.4882*	0.1949*	0.7186*	0.6361*	0.6566*	0.4902*	0.1476*	0.7726*	0.9047*
		(0.0384)	(0.0443)	(0.0145)	(0.0336)	(0.0194)	(0.0422)	(0.0330)	(0.0157)	(0.0010)
Boll weight	"r_g"		-0.2743	0.7232*	0.2308*	0.3780*	0.9285*	0.6544*	0.4144*	0.8092*
			(0.1532)	(0.0516)	(0.1925)	(0.1051)	(0.0275)	(0.0693)	(0.1160)	(0.0072)
Seed index	"r_g"			-0.0336	0.7678*	0.0176	-0.3749	-0.3759	0.0355	0.0014
				(0.0989)	(0.0762)	(0.1120)	(0.1569)	(0.0951)	(0.1278)	(0.0192)
Lint percentage	"r_g"				0.6132*	0.7942*	0.6061*	0.4930*	0.7040*	0.8354*
					(0.0758)	(0.0270)	(0.0755)	(0.0548)	(0.0422)	(0.0038)
Lint index	"r_g"					0.5391*	0.0787*	0.0317	0.4952*	0.5449*
						(0.0976)	(0.2227)	(0.1359)	(0.1185)	(0.0166)
Staple length	"r_g"						0.3105*	0.5000*	0.7826*	0.6374*
							(0.1220)	(0.0615)	(0.0367)	(0.0084)
Fibre fineness	"r_g"							0.6337*	0.3698*	0.7776*
								(0.0800)	(0.1332)	(0.0091)
Oil content	"r_g"								0.2437*	0.4441*
									(0.0881)	(0.0113)
Protein content	"r_g"									0.7113*
										(0.0080)

Values in parenthesis are the standardad error of "r_g"

Table 2: Results of path coeffcient analysis of various characters in F_2 gereration of *G. hirsultum L.* (The values in the diagonel indiate direct effect of the chactr

Characters	Number of bolls	Boll weight	Seed index	Lint percentage	Lint index	Staple length	Fibre fineness	Oil content	Protein content
Number of Bolls	0.7008	0.2095	0.00822	0.0290	-0.0263	-0.0042	0.00022	0.00990	-0.02240
Boll weight	0.3421	0.4291	-0.01156	0.0292	-0.0095	-0.0024	0.00041	0.04387	-0.01202
Seed index	0.1366	-0.1177	0.04215	-0.0014	-0.0318	-0.0001	-0.00017	-0.02520	-0.00103
Lint percentage	0.5036	0.3103	-0.00142	0.0404	-0.0254	-0.0051	0.00027	0.03300	-0.02042
Lint index	0.4457	0.0990	0.03236	0.0248	-0.0414	-0.0034	0.00004	0.00213	-0.01436
Staple length	0.4601	0.1662	0.00075	0.0321	-0.0223	-0.0064	0.00014	0.03352	-0.02270
Fibre fineness	0.3435	0.3984	-0.01580	0.0244	-0.0033	-0.0020	0.00045	0.04248	-0.01073
Oil content	0.1035	0.2808	-0.01580	0.0199	-0.0013	-0.0032	0.00029	0.06704	-0.00707
Protein content	0.5415	0.01778	0.00150	0.0284	-0.0205	-0.0050	0.00017	0.01634	-0.02900

length, fibre fineness, oil and protein content and seed cotton yield, are positive and significant ($p \leq 0.01$). Relationship of seed index with lint percentage, fibre fineness and oil content is negative but it had strong and positively significant association with lint index. Lint percentage had positive and significant correlation with lint index, staple length, fibre fineness, oil percentage, protein content and yield of seed cotton.

Degree and nature of association of lint index with staple length, protein content and seed cotton yield is positive and significant, r_g being 0.539, 0.495 and 0.545 respectively. Staple length also showed positive relationship with fibre fineness, oil and protein content and seed cotton yield, r_g are significant in all the cases ($p \leq 0.01$). Correlation coefficients of fibre fineness with oil content, protein content and seed cotton yield are positive and significant. Oil content is shown to have positive correlation with protein and plant yield and protein content showed positive and significant correlation with seed cotton yield.

The results of path analysis revealed that amongst all the characters studied number of bolls and boll weight had made maximum direct contribution to seed cotton yield, the coefficients being 0.700 and 0.429 respectively (Table 2). The remaining of the characters had either negative effects or not considerably positive on plant yield. The indirect effects of some of the characters on seed cotton yield were also appreciable, for example, boll weight with coefficient, lint percentage, lint index, staple length, fibre fineness and protein content made the greatest contribution via number of bolls. Seed index and oil content also contributed positively via number of bolls but their effects were negligible. Similarly number of bolls (0.209), lint percentage (0.310), fibre fineness (0.398) and oil content (0.281) contributed via boll weight to seed cotton yield. The indirect contribution of lint index, staple length and protein content to seed cotton yield were also positive but their effects were very small.

Discussion

The success of finding the plants combining desirable features like increased number of bolls, good boll weight, acceptable fibre properties and high oil and protein contents depends upon the availability of genetic variation in the characters and the nature and strength of genetic correlation existing among them (Poehlman and Sleper, 1995). Genotypic correlation analysis of the segregating families provided some useful information about the plant material studied here. The 'r_g' for different character combinations were positive and significant, number of bolls, boll weight, lint percentage, lint index, all had strong positive association with seed cotton yield, as advocated by Akbar *et al.* (1994), Alam (1995), Azhar and Hussain (1998) and Azhar *et al.* (1999). Similarly the positive relationship of seed cotton yield with staple length, fibre fineness, oil and protein contents is according to the findings of Dani (1989) and Arshad *et al.* (1993). Thus in the present material seed index seems to be a character not of much importance. However other characters have shown their promise and thus be given due consideration. Thus F_2 material offers greater opportunities for selecting plants possessing high yield of seed cotton and other quality characteristics. However from practical point of view, the concurrent improvement in all these features may not be possible; sometimes negative correlation may hinder the job of selection, a suggestion given by Poehlman and Sleper (1995).

Path coefficient analysis of F_2 data figured out the extent to which each of the characters contributed towards plant seed cotton yield. In these studies, number of bolls per plant and boll weight were revealed to have positive and the greatest direct effect on seed cotton yield. The direct effects of lint percentage, lint index, staple length, fibre fineness, oil and protein contents on seed cotton yield were shown to be either small or negative, however contributions of these characters via number of bolls and boll weight were considerable. The studies of Arshad *et al* (1993) and Azhar and Hussain (1998) also revealed that number of bolls and boll weight had strong and positive association with seed cotton yield and both the components had profound direct effects on final productivity of plants.

In the present material, the two plant characters i.e., number of bolls and boll weight were shown to be important characters and may be used as selection criteria in the present breeding programme. However, the extent to which the knowledge gained from the present investigation may be applicable to whole of the germplasm of *hirsutum* species seems to be uncertain, because the parents used to develop the genetic material were specifically chosen and thus did not constitute a representative sample of cotton germplasm. Therefore it will be worthwhile that the information derived here may be substantiated by involving large number of genotypes in a crossing programme.

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