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Correlation analysis of morphological and fiber quality traits in upland Cotton (*Gossypium hirsutum* L.)

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Abstract

Fiber quality is the main consideration for ginners and most complex trait for breeder point of view as it depends on interaction of genetic makeup of plant and environment. To meet this objective, two parents B557, FH153 and their F_2 population were evaluated for the existence of genetic variability for the characters under study during 2014-2015, at University of Agriculture, Faisalabad. The experiment was carried out in a randomized complete block (RCB) design with three replications. Data were recorded for Plant height (cm), Internodal distance (cm), Number of monopodia, Number of sympodial, Leaf hairiness, Pedicel length (cm), Boll size, Number of bolls per plant, Boll weight (g), Ginning out turn (%), Fiber fineness (µg/inch), Fiber strength (g/tex), Staple length (mm), Seed cotton yield per plant (g). The obtained data were analyzed through correlation analysis at 0.01 and 0.05 significance level. The traits under study showed considerable range of genetic variability. The parent FH153 had maximum mean value for plant height (96.4cm), sympodial branches (10.33), boll weight (3.02g), fiber finess (5.13 µg/ inch), fiber strength (21.49g/tex) and staple length (27.53mm). Parent B557 showed maximum (1.68cm) pedicel length whereas, F^2 population had maximum (3.45cm) internodal distance, monopodial branches per plant (3.01), leaf hairiness was of profuse, medium and sparse, boll size was of small, medium and large, number of bolls per plant (24.91) and lint percentage (38.62%). The results also show that linkage of these traits did not affect yield so can be used as selection criteria for future cotton breeding programs.

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Introduction

Cotton (*Gossypium hirsutum* L.) is becoming an increangly important crop in modern textile industry (Feiyu *et al*., 2012). It is native to tropical and sub-tropical regions of the world. The species *G. hirsutum* is called upland cotton which is grown on 90% of the cotton area in the world (Poehlman and Sleper, 1995).The primary product of cotton plant is lint that covers the seed (Freeland *et al*., 2006). Cotton fiber is a single cell elongation from the epidermis of the seed coat. Its growth is completed in 15-25 days after anthesis (Chaudhry and Guitchounts, 2003).

It is cultivated in irrigated areas of Sindh, Punjab and some parts of Khyber Pakhtunkhwa (KPK). It covers more than 99% of cotton cultivated area which is 2.879 million hectares (mha) with production of 13 million bales (Pakistan Economic Survey, 2014-15) in Pakistan.It provides livelihood to 1.5 million farming families (Hussain *et al*., 2010). Its share in gross domestic product (GDP) is 1.5% and 7.0% in value added(Pakistan Economic Survey, 2014-15). Pakistan is third consumer and fourth largest cotton producer in the world (Pakistan Economic Survey, 2014-15).

The demand of cotton fiber is high due to its unique qualities. In addition to fiber, cotton seed is big source of cooking oil which is 70 % of the total vegetable oil production in Pakistan (Batool *et al*., 2010). The demand of the textile industry is to improve fiber quality especially staple length, fiber fineness and fiber strength along with lint yield.

Spinning advances in technology have led to greater emphasis on the cultivation of cotton for better fiber properties. The ginned cotton fiber quality decides the economic value and final usage of cotton. Fiber length is one of the important quality parameters in the textile sector. For spinners the most important quality parameter is fiber strength and for ginners the most important parameter is lint percentage.

Due to its importance, cotton crop has attracted the attention of plant breeders and they have made remarkable and sustained efforts to improve the genetic architecture of cotton plant.

These efforts have led to the evolution of high yielding cultivars by improving production potential and quality traits through breeding.

It is an indeterminate plant in which development of morphological traits is easily influenced by environment and cultivation conditions. Since genetic improvement process never ends; therefore, cotton breeders continue their efforts to evolve varieties with higher yield and better fiber quality. Seed cotton yield is a polygenic trait and depends on its components. These components traits may be linked or segregate independently, so to conduct a breeding program, study of linkage relationship of plant traits related to yield and fiber quality is important.

The correlation analysis is important to determine the linkage among the traits related to yield and fiber quality. The objective of this study was to investigate the linkage relationship of important traits (plant height, intermodal distance, number of monopodial and sympodial branches, leaf hairiness, pedicel length, boll size, number of bolls per plant, boll weight, ginning out turn (GOT), fiber fineness, fiber strength, staple length and seed cotton yield per plant).

Materialsand methods

Plant material and site description

Two parents B557, FH153 and their F_2 population received from the department were used in study. The parents and their F_2 population were sown in randomized complete block design (RCBD) with three replications in the experimental area of the Department of Plant Breeding and Genetics, University of Agriculture Faisalabad during the normal growing season of cotton in the year 2014-15.

Each replication contained a single row for each parent and fifteen rows for F_2 population. In each row there were 10 plants with a row to row and plant to plant distance of 75cm and 30cm respectively. All the recommended agronomic practices were followed from sowing till harvest.

Agronomic measurements

At maturity, the data was collected from five guarded plants of each parent and 25 F_2 plants from one replication for the following traits; Plant height (cm), Internodal distance (cm), Number of monopodia, Number of sympodial, Leaf hairiness, Pedicel length (cm), Boll size, Number of bolls per plant, Boll weight (g), Ginning out turn (%), Fiber fineness (µg/inch), Fiber strength (g/tex), Staple length (mm), Seed cotton yield per plant (g). The data collected was subjected to analysis of variance to test the level of significance among the genotypes by following the method of Steel *et al.* (1997) in order to determine the significant differences in plant characters among the parents/F_2 population.

Statistical analysis

The characters showing significant genotypic differences among the parents/F_2 population were further analyzed for correlation coefficients, calculated by the formula as outlined by Dewey and Lu (1959) using Minitab programme of computer.

Result and discussion

The analysis of variance revealed that the parents and the F_2 population showed significant difference for various traits under study, indicating a considerable range of genetic variability.

The Parents FH153, B557 and F_2 population had a mean plant height of 96.4cm, 90.65cm and 94.97cm respectively. Plant height had positive influence on the characters under study (Table 1). Naveed *et al.*, (2004), Tutega *et al.*, (2006), Zeng *et al.*, (2007), Khan *et al.*, (2009), Thiyagu *et al.*, (2010), Kazerani, (2012), Magadum, (2012), Fiaz *et al.*, (2016) and Farooq *et al.*, (2013) had reported similar results.

Table 1. Mean of the two parents B557 and FH 153 and their F_2 Population.

Genotype	PH	ID	MB	SB	Hairiness	PL	BS	B/P	BW	GOT%	FF	FS	SL	SCY/P
B 557	90.65	3.16	1.33	8.2	Profuse	1.68	Medium	17.87	2.61	36.42	4.48	20.62	26.33	46.54
FH 153	96.4	3.37	2.2	10.33	Medium	1.65	Medium	20.6	3.02	37.40	5.13	21.49	27.53	62.15
F_2	94.97	3.45	3.01	9.15	Sparse Medium Profuse	1.47	Small Medium Large	24.91	2.96	38.62	4.77	20.31	24.31	71.42

Plant height (PH), Internodal Distance (ID), Monopodial Branches (MB), Sympodial Branches (SB), Leaf hairiness (Hairines), Pedicel length (PL), No of Bolls per Plant (B/P), Boll Weight (BW), Boll size(BS), Ginning Out Turn (GOT), Staple Length (SL), Fiber Strength (FS), Fiber Fineness (FF) and seed cotton yield/plant(SCY/P).

Plant Height (PH, cm), Internodal Distance (ID, cm), Number of Monopodia (MB), Number of Sympodia (SB), Leaf Hairiness (Hairiness), Pedicel Length (PL, cm), Boll size (BS), Number of Bolls per Plant (B/P), Boll Weight (BW, g), Ginning out turn (GOT %), Fiber Fineness (FF, µg/inch), Fiber Strength (FS, g/tex), Staple Length (SL, mm) and Seed cotton Yield per plant (SCY/P, g).

The parents FH-153, B-557 and F_2 population had mean value 3.16cm, 3.37cm and 3.45cm for internodal distance. Internodal distance had positive correlation with number of monopodial branches per plant, number of sympodial branches per plant, number of bolls per plant, staple length, fiber fineness and seed cotton yield per plant (Table 2).

Satpute *et al.*, (2007), Preetha and Raveendran, (2008) and Feiyu *et al.*, (2012) had observed positive association whereas, Rauf *et al.*, (2004), Ahmad *et al.*, (2008) and Alkuddsi *et al.*, (2013) had observed negative association seed cotton yield and number of bolls per plant.

The parents FH153, B557 and F_2 population have mean value 1.33, 2.20 and 3.01 respectively for number of monopodial branches per plant (Table 1).Monopodial branches have a positive correlation with number of sympodial branches per plant, number of bolls per plant, boll weight, staple length, fiber fineness and seed cotton yield per plant (Table 2).

Table 2. Correlation matrix of fiber quality traits in upland cotton.

	PH	ID	MB	SB	Hairines	PL	B/P	BW	BS	GOT	SL	FS	FF
ID	0.511**												
MB	0.355**	0.190*											
SB	0.504**	0.312**	0.534**										
Hairnes	0.101	-0.070	0.055	0.096									
PL	0.129	0.033	0.002	0.037	0.071								
B/P	0.425**	0.449**	0.566**	0.792**	0.109	-0.057							
BW	0.132	0.104	0.224*	0.029	-0.046	-0.086	-0.201*						
BS	0.115	-0.035	0.166	0.055	0.074	0.000	-0.129	0.593**					
GOT	-0.081	-0.146	-0.211*	-0.193*	-0.185	-0.062	-0.248**	0.382**	0.277**				
SL	0.358**	0.290**	0.410**	0.545**	0.319**	0.235*	0.512**	0.013	-0.067	-0.403**			
FS	-0.143	-0.090	-0.049	-0.130	-0.078	0.004	-0.183	0.058	-0.210*	-0.111	0.095		
FF	0.243**	0.272**	0.264**	0.248**	-0.069	0.020	0.187	0.131	0.084	-0.111	0.343**	-0.040	
SCY/P	0.467**	0.456**	0.651**	0.838**	0.144	-0.063	0.936**	0.093	0.067	-0.178	0.520**	-0.158	0.212*

Plant height (PH), Internodal Distance (ID), Monopodial Branches (MB), Sympodial Branches (SB), Leaf hairiness (Hairines), Pedicel length (PL), No of Bolls per Plant (B/P), Boll Weight (BW), Boll size(BS), Ginning Out Turn (GOT), Staple Length (SL), Fiber Strength (FS), Fiber Fineness (FF) and seed cotton yield/plant(SCY/P).

It is also observed by Murthy (1999), Hussain *et al*., (2000), Ahuja *et al*., (2006), Karademir *et al*., (2009) and Ekinci *et al*., (2010). Meanwhile, the results showed the negative association among number of monopodial branches and GOT %.

The results for sympodial branches per plant showed that parent FH153, B557 and F_2 population have 10.33, 8.2 and 9.15 respectively (Table 1). The results confirmed the findings of Rauf *et al*., (2004), Muthuswamy and Vivekanandan (2004), Mustafa *et al*., (2007), Ashokkumar and Ravikesavan (2010), Bibi *et al*., (2011), Shabbir *et al*., (2016) and Natera *et al*., (2012) having a positive correlation with number of bolls per plant, fiber fineness, staple length and seed cotton yield per plant, but it was negatively correlated with GOT %. The parents differs in leaf hairiness as the FH-153 had leaves with medium hairiness, B-557 had profuse hairy leaves and F_2population had leaves with profuse, medium and sparse hairiness. Leaf hairiness had positive association with staple length, micronaire value, lint percentage, fiber fineness and hairiness index (Table 2).

The results confirmed the finding of Feiyu *et al*., (2009) and Nawab *et al*., (2011). The parents FH153, B557 and F_2 population pedicel length showed the mean value of 1.65cm, 1.68cm and 1.47 cm respectively (Table 1).

The correlation between pedicel length and staple length was positive. The parents FH153, B557 had medium boll size whereas, F2 population had plants with small, medium and large boll size. Boll size had positive correlation with GOT % while negatively correlated with fiber strength also confirmed by Imran *et al*., (2012). In case of number of bolls per plant the parents FH153, 557 and F_2 population had mean value of 20.6, 17.87 and 24.91 respectively (Table 1).

Number of bolls per plant showed positive correlation with staple length and seed cotton yield while it showed negative correlation with boll weight and GOT% (Table 2).

Chao-zhu *et al*., (2007), Khan *et al*., (2009), Ahmad *et al*., (2011) and Farooq *et al*., (2013) also observed that number of bolls per plant had positive association with yield of seed cotton. Whereas, Wu *et al*., (2004) and Mc Carty *et al*., (2008) reported number of bolls per plant have negative association with boll weight.

The boll weight of parents FH153, B557 and F_2 population showed positive association with boll size and GOT% with mean value of 3.02g, 2.61g and 2.96g respectively (Table 2, 1).

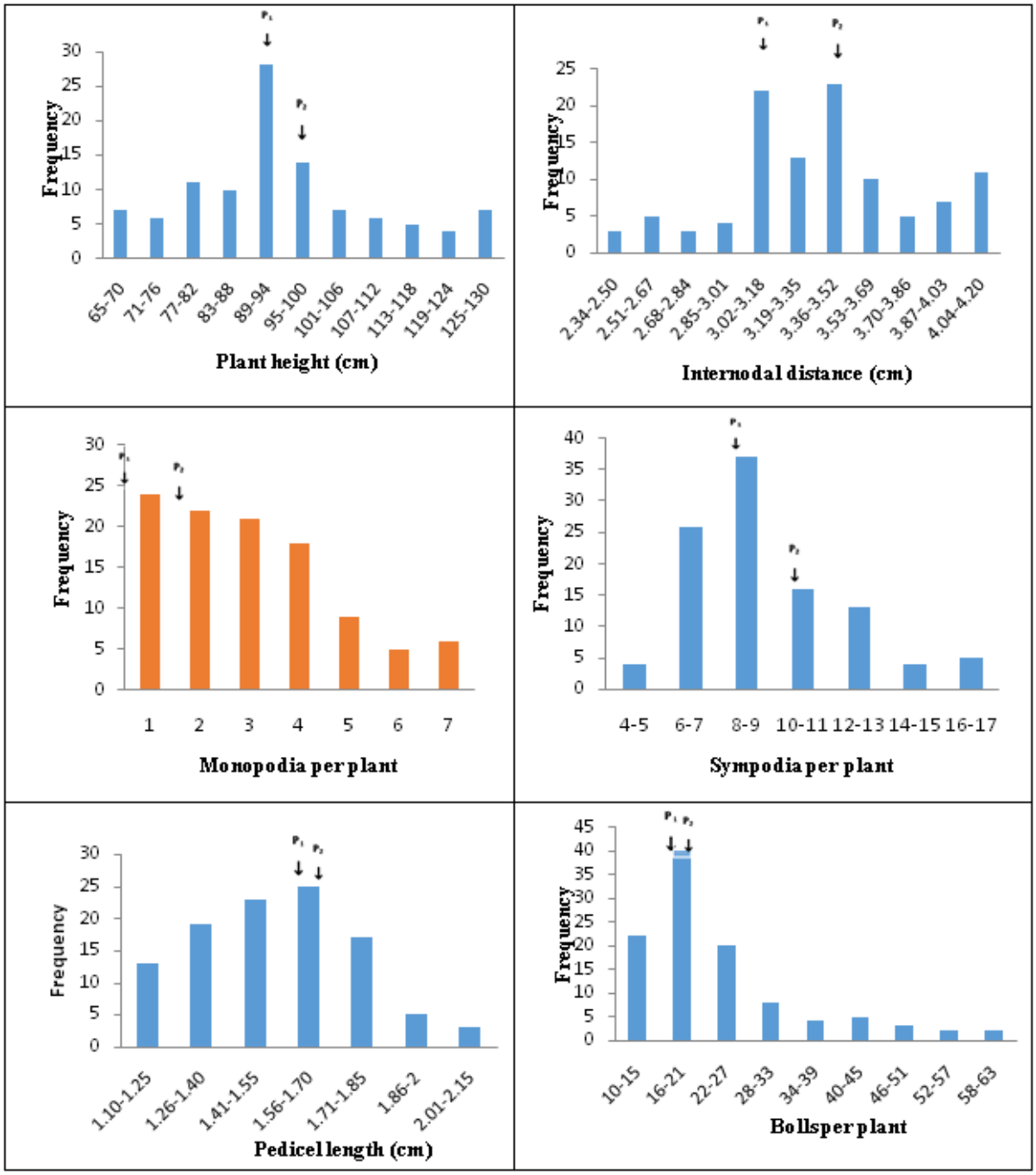

Fig. 1. Frequency distribution of F_2 population for plant height, internodal distance, number of monopodia, number of sympodia, pedicel length and number of bolls per plant.

These were in accordance with Tang and Xiao (2014) whereas, Xu *et al*., (2003), Wu *et al*., (2004) and McCarty *et al*., (2008) observed negative association with number of bolls per plant, lint percentage and seed cotton yield per plant. The F_2 population had highest mean value for lint percentage 38.62 % while parents B557 and FH153 had 36.42 % and 37.40% mean values for lint percentage respectively (Table 1).

The correlation between GOT and staple length was negative. It was also Dinakaran *et al*. (2012) found that ginning out-turn had negative correlation with yield of seed cotton. The parent FH153 had highest mean value (5.13 µg/ inch) whereas, B 557 had lowest (4.48 µg/ inch) and the F_2 population had 4.77 µg/ inch mean value for fiber fineness. Fiber fineness had positive correlation with seed cotton yield per plant (Table 2).

Asif *et al.* (2008) reported that fiber fineness negatively associated with fiber length and fiber strength. Ashokkumar and Ravikesavan (2010) found that seed cotton yield positively correlated with micronaire value The F_2 population had mean value for fiber strength 20.31g/tex and the parents B557 and FH153 had mean values for fiber strength 20.62g/tex and 21.49g/tex respectively. Fiber strength had no association with other characters in the present study.

The parents FH153 and B557 had mean staple length 27.53 mm and 26.33 mm respectively whereas, the F_2 population had lowest mean staple length 24.31 mm (Table 1). Staple length showed positive correlation with fiber fineness and seed cotton yield per plant (Table 2). It was also observed by Chen and Zhao (1991) that staple length had negative correlation with number of bolls per plant and GOT%. Frequency distributions for different traits were depicted in the figure 1 & 2for F_2 population of cotton crop.

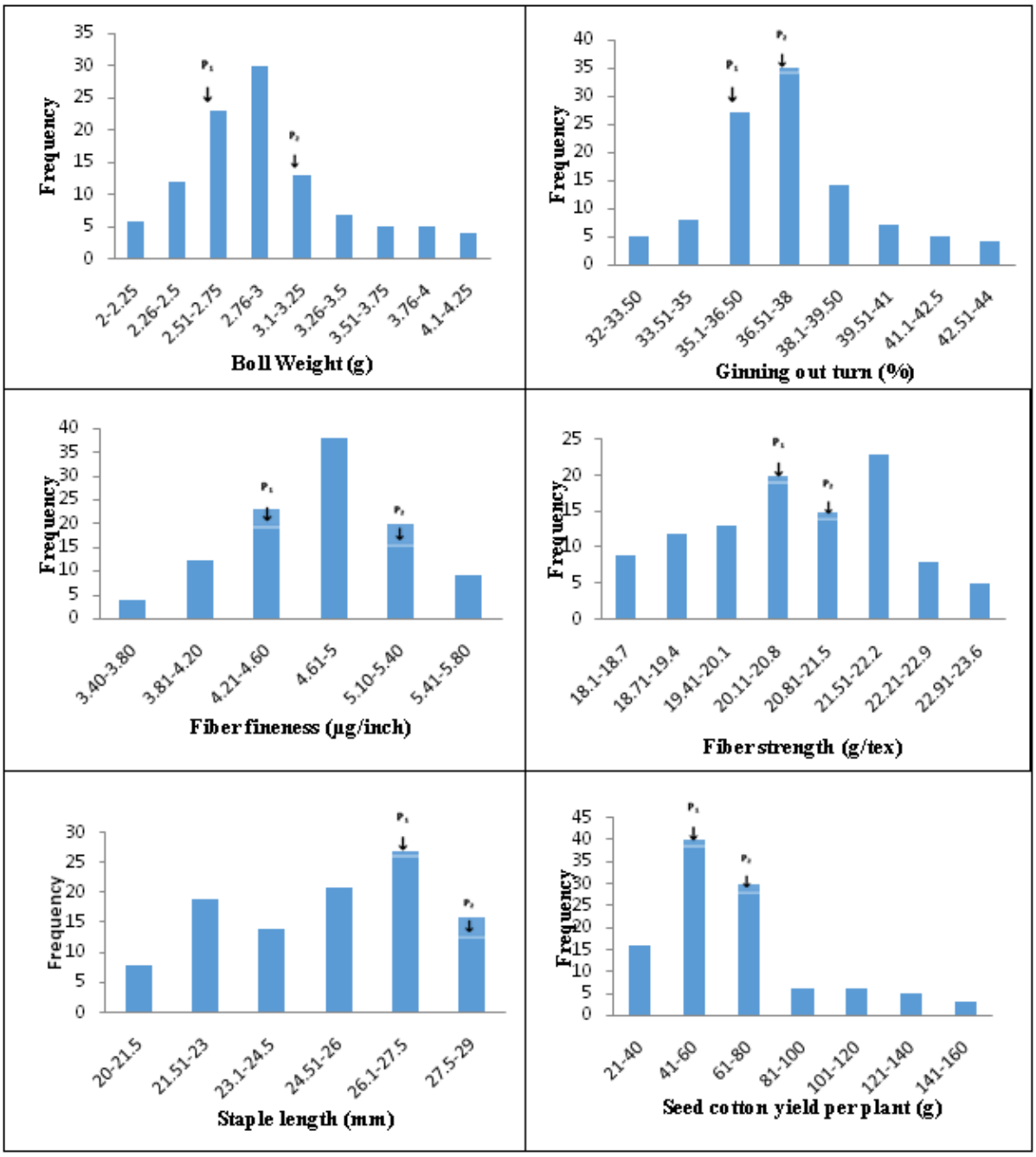

Fig. 2. Frequency distribution of F_2 population for bolls weight, ginning out turn, fiber fineness, fiber strength, staple length and cotton yield per plant.

Conclusion

The study revealed that plant height had positive correlation with internodal distance, number of monopodial branches and number of sympodial branches per plant, number of bolls, staple length, fiber fineness and seed cotton yield. Internodal distance had positive correlation with number of monopodial branches per plant, number of sympodial branches per plant, number of bolls, staple length, fiber fineness and seed cotton yield. It showed that by increasing internodal distance seed cotton yield would be increased.

Number of monopodial branches per plant had positive correlation with number of sympodial branches, number of bolls, staple length, fiber fineness and seed cotton yield whereas ginning out turn negatively correlated with number of monopodial branches per plant. Number of sympodial branches had strong positive correlation with number of bolls per plant, staple length, fiber fineness and seed cotton yield while negatively correlated with ginning out turn. Leaf hairiness and pedicel length showed positive correlation with staple length. Number of bolls per plant showed positive correlation with staple length and seed cotton yield while negatively correlated with boll weight and ginning out turn. Boll weight had positive correlation with ginning out turn. Staple length had strong positive correlation with fiber fineness and seed cotton yield while negatively correlated with ginning out turn. Association between fiber fineness and seed cotton yield was positive. Seed cotton yield was not associated with leaf hairiness, pedicel length, boll weight, boll size, ginning out turn and fiber strength. So selection of plants for these traits would not affect yield and can be used as a selection criteria for future breeding programs.

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