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SELECTION OF SUPERIOR PARENTAL CULTIVARS THROUGH COMBINING ABILITY ANALYSES FOR FIBER TRAITS IN UPLAND COTTON

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ABSTRACT

Combining ability was studied in five inbred parents and 10 F_1 hybrids in upland cotton during 2013-14 at Halani, District Naushehro Feroze, Pakistan. Mean squares due to general (GCA) and specific combining ability (SCA) variances were highly significant for all the fiber traits; which suggested that additive and non-additive gene actions were involved for controlling the traits. The GCA variances were found greater than SCA which revealed predominance of additive genes action for lint index, staple length, fiber fineness and fiber strength, while SCA variances were higher in magnitude than GCA which manifested the involvement of dominance gene action for uniformity ratio. Among the parental cultivars, MNH-886, CIM-506 and CRIS-134 proved as best general combiners for all the fiber traits. Results further suggested that these parental inbreds could be used for crop improvement. As per hybrid combinations, MNH-886 × CIM-506, CRIS-134 × MNH-886 and CRIS-134 × CIM-506 were specific combiners for fiber quality traits which could be exploited for hybrid crop development.

Keywords: combining ability, fiber traits, GCA and SCA, upland cotton

INTRODUCTION

Cotton is most important cash and fiber crop of Pakistan. Cotton earns huge amount of foreign exchange through export of raw cotton, cotton yarn, grey clothes, garments and other cotton manufactured products. Cotton seed is also used for edible oil which formulates 80% of the national oil production (Agha, 1994).

Diallel analysis is one of the mating designs in which parental genotypes are crossed in all possible combinations and is used in predicting General Combining Ability (GCA) and Specific Combining Ability (SCA) of parents and their hybrids. The GCA therefore designates additive genes which are used to determine the evaluation of the parents; whereas, SCA effect is determined by dominant genes and is used to designate the hybrid performance in specific terms. Knowing the types of gene actions through GCA and SCA will also facilitate cotton breeders to formulate an effective breeding strategy to improve various characters in cotton. *Sprague and Tatum (1942)* presented that general combining ability which is due to genes are mostly additive in nature, whereas specific combining ability for the genes with dominance and epistatic in consequence. Patil *et al.,* (2011) stated that combining ability is the performance of a parent for producing superior offspring when make cross between two parent. Previous studied showed that fiber quality traits were inclined to additive and non-additive gene action. Myers and Lu (1998) reported that general combining ability effects were highly significant as compared to specific combining ability effects for fiber strength and micronaire which indicated that additive gene action was imperative for fiber traits. Green and Culp (1990) findings revealed that general combining ability effects were significant for majority of the fiber quality characters except uniformity index. Cheatham *et al.* (2003) mentioned that fiber fineness and staple length revealed dominance genes effects, whereas additive gene action effects controlled the ginning outturn percentage and fiber strength. Kumar *et al*. (2014) reported that the fiber traits were mostly controlled by additive gene action. Shaukat *et al.* (2013) presented findings that GCA and SCA effects were highly significant in F1 generation. Genetic components (GCA and SCA) showed high proportion of additive gene action for characters, viz. staple length, fiber strength and fiber fineness in F1 generation because of larger GCA variances than SCA.

Cotton breeders are trying to develop cotton varieties; those well adapted to our environmental conditions with maximum yield, high ginning outturn, desirable fiber quality and higher fertilizer response along with increased tolerance to complexes of diseases and insect pests. The objectives of this study therefore, were to identify potential parents for hybridization and selection programmes.

MATERIALS AND METHODS

The experiment was conducted at Halani, district Naushehro Feroze during 2013 and 2014 in upland cotton. The experimental material was consisted of five parental cultivars (CRIS-134, BH-36, MNH-886, CIM-506 and CIM-511) and their 10 F_1 hybrids to study combining ability estimates. The F_1 seed of 10 hybrids was produced by crossing five cultivars in half diallel fashion. The 5 x 5 diallel crosses which included the parents and one set of the hybrids, thus formed a total of 15 genotypes (10 F_1 hybrids and 5 parents) were studied. The F_1 hybrids and their parents seed were planted in a randomized complete block design with four replications. Plant to plant and row to distances were kept as 30 and 75 cm, respectively. For recording the data, 15 plants of each genotype from each replication were randomly tagged. Data were recorded on fiber quality traits viz., staple length, fiber strength, fiber fineness, uniformity index and lint index. The estimates of general combining ability (GCA) and specific combining ability (SCA) and their variances (mean squares) were determined by adopting *Griffing's (1956)* method-2, model-I as described by *Singh and Choudhry (1979)*.

RESULTS AND DISCUSSIONS

Analysis of variance for general combining ability and specific combining ability presented in Table 1. Mean squares values due to GCA were highly significant for traits viz. lint index, staple length, strength and fineness, which indicate that additive gene action involve for controlling these characters, whereas SCA were highly significant for uniformity index for involve the non-additive gene action. Mean squares due to genotypes (hybrid & parents) as well as parents and hybrids individually were significant for all the traits. Significance of GCA and SCA variances further suggested that both additive and dominant genes controlled the traits. These results hence suggested that data is worth for further processing and interpretations. Results of GCA and SCA effects are presented trait wise as under.

Lint index

The GCA and SCA effects presented in Tables 2 and 3. Among the parents, CIM-506 was good general combiner and given positive GCA effect for lint index, followed by MNH-886 and CRIS-134 for same trait. Among the hybrids, CRIS-134 × MNH-886 were produced maximum positive SCA effects, followed by MNH-886 × CIM-506 and CRIS-134 × CIM-506 also given positive SCA effects for the same trait. Same results produced by *Kumar et al. (2014)* reported that GCA variance was greater than SCA for the character lint index; it indicated preponderance of additive gene action. Baloch et al., (2002) and Mert and Boyaci (2003) proposed that GCA variance was superior to the SCA; it indicated that preponderance of dominance genes as compared to additive.

Staple length

Staple length is a significant standard for spinning fiber, as short fibers are also difficult to spin than longer, the farmer are also ensuing in more hairy yarns. The GCA and SCA effects depicted in Table 2 and 3 respectively. The parent CIM-506 was good general combiner for staple length, followed by CRIS-134 and MNH-886 was also best combiner for the same trait. Among the hybrids combination MNH-886 × CIM-506 were observed maximum positive SCA effects, followed by CRIS-134 × MNH-886 and MNH-886 × CIM-511 also give positive SCA effects for staple length. Several other scientists Shaukat *et al.* (2013), Nimbalkar *et al.* (2004), Kansik and Kapoor (2006), and Iqbal *et al.* (2003) reported that staple length controlled by additive gene action.

Fiber strength

Fiber strength is an imperative character to determining yarn spin ability, because weak fiber ultimately its low strength is complicated to handle during production at textile manufacturing process. The GCA and SCA effect for fiber strength is illustrated in table 2 and 3. Among parents MNH-886 produced highest GCA effects for this trait and proved good general combiner. Whereas CIM-506 and CRIS-134 was also shown best combiner for the same trait. As discussed hybrids combinations the effects of SCA was greater produced by cross MNH-886 × CIM-506 for fiber strength, meanwhile hybrid CRIS-134 × MNH-886 and CRIS-134 × CIM-506 also given positive SCA effects for same trait. Similar results obtained by Shaukat *et al.* (2013), Nimbalkar *et al*. (2004), Kansik and Kapoor (2006), and Iqbal *et al*. (2003) indicated that additive gene action is involve to influence the trait fiber strength.

Fiber fineness

The GCA and SCA effects are presented in Table 2 and 3. Among the parent CRIS-134 given maximum positive GCA effects, which proved to be best general combiner for fiber fineness. Whilst parent MNH-886 and CIM-506 also best general combiner for the same trait. Within hybrids performance the cross CRIS-134 × BH-36 produced maximum SCA effects for fiber fineness, followed by cross MNH-886 × CIM-506 and CRIS-134 X MNH-886 also obtain positive SCA effects for the trait fiber fineness. Present findings also reported by Iqbal *et al.* (2003), Kansik and Kapoor (2006), Nimbalkar *et al.* (2004) and Shaukat *et al.* (2013) suggested that fiber fineness is controlled through additive gene action.

Table 1. Analysis of variance (mean squares) values of GCA and SCA of fiber traits.

Source of variance	**D.F**	**Lint index**	**Staple length**	**Fiber strength**	**Fiber fineness**	**Uniformity %**
Replication	3	0.27	1.92	5.89	0.09	5.14
Genotypes	14	2.13**	0.72**	7.61**	0.71**	13.02**
Hybrids	9	1.75**	0.34**	4.14**	0.52**	9.22**
Parents	4	1.29**	0.09**	1.25**	0.18**	4.28**
GCA	4	65.23**	1.85**	5.24**	0.41**	5.11**
SCA	10	21.37**	1.17**	3.12**	0.12**	8.23**
Error	42	35.22	0.027	8.126	0.098	1.652

** Significant at (5%) and (1%) probability

Table 2. GCA effects of parents by for fiber traits in upland cotton.

Parents	**Fiber traits**				
	Lint index	**Staple length**	**Fiber strength**	**Fiber fineness**	**Uniformity %**
CRIS-134	0.18	0.99	1.07	0.61	-1.51
BH-36	-2.15	-1.81	-3.71	-1.05	0.11
MNH-886	0.75	0.84	3.28	0.55	0.39
CIM-506	0.91	1.04	2.19	0.52	-2.81
CIM-511	-1.17	-0.6	-0.67	-1.37	0.21
SE (gi.)	**0.817**	**0.056**	**1.017**	**0.034**	**0.072**

Table 3. SCA effects of hybrids for fiber traits in upland cotton.

Hybrids	**Fiber traits**				
	Lint index	**Staple length**	**Fiber strength**	**Fiber fineness**	**Uniformity %**
CRIS-134 × BH-36	-3.12	-0.92	0.02	0.91	-2.01
CRIS-134 × MNH-886	4.61	1.29	0.06	0.67	-0.89
CRIS-134 × CIM-506	3.28	0.80	0.04	-1.07	0.62
CRIS-134 × CIM-511	-2.09	-1.06	-0.08	0.05	-1.05
BH-36 × MNH-886	-1.82	-1.20	-0.06	-0.78	-0.33
BH-36 × CIM-506	-1.21	0.09	-0.15	-1.11	0.06
BH-36 × CIM-511	-4.71	-0.26	-1.24	-0.62	-1.23
MNH-886 × CIM-506	3.63	2.01	0.09	0.80	1.79
MNH-886 × CIM-511	-0.81	1.07	-0.17	-0.45	0.69
CIM-506 × CIM-511	-0.61	-2.81	-0.26	-0.88	0.08
SE (si.)	**1.291**	**0.965**	**0.061**	**0.127**	**0.724**

Uniformity %

The GCA and SCA affects for the character uniformity percentage depicted in Table 2 and 3. Among the parent MNH-886 obtained maximum positive GCA effects and demonstrated best general combiner for uniformity index. Whereas CIM-511 and CRIS-134 also proved good combiner for this trait. As per hybrids combinations the cross MNH-886 × CIM-506 manifested highest positive values of SCA effects for uniformity index, followed by MNH-886 × CIM-511 and CRIS-134 × CIM-506 with positive SCA effects for same trait. Many workers obtained the same results Baloch *et al.* (2000) founded that deviation due to general combining ability for uniformity ratio is considerable suggesting that this trait is utterly controlled by dominant genes. Another scientist expressed that the variance due to specific combining ability was larger than the variance of GCA for uniformity ratio by Pushpam (2005). Srinivas (2014) and Baloch *et al.* (2000) presented findings that uniformity ratio predominantly under control of non-additive (dominance & epistatic) gene action as indicated by higher magnitude of SCA variance than GCA variance.

Conclusion

The differentiation due to general combining ability and specific combining ability for mean squares was highly significant, which indicated that additive and non-additive (dominance and epistatic) gene action involve for controlling all the characters. Among the parents MNH-886, CIM-506 and CRIS-134 proven best general combiner for all the fiber traits which were studied. It further suggested that these parents can be exploited in crop improvement for maintain the traits studied. As per hybrid combinations MNH-886 × CIM-506, CRIS-134 × MNH-886 and CRIS-134 × CIM-506 were specific combiners for all the quality traits. Therefore, these can be used for exploitation for hybrid crop development program.

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