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COMBINING ABILITY AND HERTEROSIS ANALYSIS ON SOME TRAITS IN INTRASPECIFIC F_1 LINE X TESTER CROSS OF UPLAND COTTON

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ABSTRACT

The present research was carried out at Nuclear Institute of Agriculture (NIA), Tando Jam for the combination of capacity and magnitude of heterosis in line x tester during Kharif 2013. The experiment was laidout in a randomized complete block design (RCBD) with three replications. Observations for sympodial branches plant^{-1}, the number of bolls plant^{-1}, Ginning Out Turn (GOT %), staple length (mm) and seed cotton yield plant^{-1} (g) were recorded. The line Sadori and IR-2620 tester, show positive general combining ability (GCA) effects indicating that these parents were good general combiners and cross both parents showed higher specific combining ability (SCA) effects that specific combining ability for better performance and quality traits. Line Sadori x IR-2620 showed greater heterosis and heterobeltiosis by sympodial branches and GOT%. While NIA-80 x Bt-555 produced greater heterosis for weight of the bolls.

Keywords: line x tester analysis, combining ability estimates, American cotton heterosis.

INTRODUCTION

The cotton breeder has to increase high yielding varieties, through selection and hybridization, utilizing available genetic resources. The final product of the cotton plant, i.e. the seed cotton yield is the result of the interaction between genetic and non-genetic components due to the complex nature of the interaction. The selection of plants showing spawning harmonious combination of desirable traits which depend on the objectives of the profession from a breeder. Therefore, for the development of promising genotypes, cotton breeder is required to study the material culture for nature and the degree of correlation between the yield of raw cotton and other numerical characteristics. Furthermore, the availability of information on the extent to which the variation in the character of each plant to the next generation is transmitted is also important to accelerate the process of screening the breeding population in order to find a plant that has a greater potential performance.

The combination of the ability or productivity is the combination of cross line potential in relation to the transfer of desirable genes to their progeny. The ability of combination between two parents has been classified into general combining ability, defined as the average performance of a line in a series of crosses, and specific combining ability is known as performance in specific combination consanguineous parents (Sprague and Tatum, 1942).

The heterosis has also been observed in many self-pollinated crops and has been the subject of considerable study as a means of increasing the productivity of crop plants. Development of hybrid cotton seed has been carried out in many countries like China, India, Vietnam and Myanmar (Ansari, 2011). About 90% area in India and 40% in China has been growing hybrid cotton. In China, field experiments on hybrid cotton has resulted in a 20-30% increase in production (Ansari, 2011). Yield is a complex character and is controlled by multiple genes whose individual effect is very small and greatly influenced by the environment. The highest priority should be, therefore, to increase the productivity of better quality raw cotton. One of the most recent developments in plant breeding has been the use of heterosis in many crop plants, particularly in allogamous crops (Larik *et al*., 2004). Hybrid cotton seeds offers many advantages over conventional seed variety, such as increased productivity, tolerance to abiotic stresses (drought, heat, cold) and is very sensitive to inputs (Ali, 2011).

MATERIALS AND METHODS

The present study was conducted at the Nuclear Institute of Agriculture (NIA) Tandojam, during Kharif 2013. The experimental material used in this study consists of three lines and three testers with its 9 F_1 hybrids to estimate general combiners and demonstration and specific heterosis in the F_1 generation (*Gossypium hirsutum* L). The experiment was laidout in a randomized completely block design (RCBD) with three replications. Parents and hybrids were planted in rows, four rows of genotypes; row length was 20 feet and genotype were planted by hand dibbling plant to plant I feet and row to row 2.5 feet distance was maintained. Data were recorded on 5 randomly selected plants from each genotypes in all replicates and the mean of 5 plants was taken for further analysis. After thinning one plant per hill was maintained and all normal agronomic and cultural practices were done at the right time.

Statistical analysis: The data collected for statistical analysis (ANOVA) were subjected as suggested by Gomez and Gomez (1984), heterosis and heterobeltiosis according to Falconer (1989) and the analysis of line x tester by Kempthorne (1957).

RESULTS AND DISCUSSION

According to the analysis of variance, F_1 hybrids and its parental lines were highly significant for all traits at the 1% significance differences. Mean squares due to general combining ability (GCA) and specific combining ability (SCA) also showed significance by ANOVA for all traits and allowed arbitration of the genetic components of variance due to GCA and SCA (Table 1). Mert *et al.* (2003) and Baloch *et al.* (2004) got the same result as the results obtained in the study under report. The mean squares of crosses are little bit higher than the mean squares of parents, showing the additive in nature for majority of traits.

Sympodial branches plant^{-1}

With respect to sympodial branches plant^{-1} hybrids, Sadori x *Bt*-008 (22.33) and NIA-Ufaq x IR-2620 (22.93) showed more while the *Bt*-555 (15.20) parents showed fewer sympodial branches plant^{-1} Table 2. Line Sadori and two tester IR-2620 and *Bt*-008 expressed significant GCA effect for the trait number of sympodial branches plant^{-1} Table 3. There were only four hybrids Sadori x *Bt*-555, Sadori x *Bt*-008, NIA-Ufaq x IR-2620 and NIA-80 x *Bt*-008 represented positive SCA effects for the trait number of sympodial branches plant^{-1} Table 4. It is suggested that there is a possibility of isolating potential segregating progenies of these hybrids. These results are in agreement with the results of Soomro et al. (2012) and Jatoi *et al.* (2011). While the cross of Sadori x IR-2620 had greater positive value for mid-parent, better parent and standard for the trait sympodial braches plant^{-1} followed by Sadori x *Bt*-008 Table 5. As the plant height increases decreases the lateral vegetative growth. These results agree with those obtained by Khan and Qasim (2012).

Table 1. Mean squares from analysis of variance for various characters of cotton.

Source of variance	D.F	Sympodial branches plant^{-1}	Boll weight (g)	GOT (%)	Staple length (mm)	Seed cotton yield plant^{-1} (g)
Replications	2	9.60	0.015	0.37	1.62	42.35
Genotypes	14	11.82**	0.19**	8.70**	2.01*	613.23**
Parents	5	12.38*	0.02^{ns}	10.09**	0.78^{ns}	715.12*
P vs.C	1	52.97**	0.82**	11.28*	2.70^{ns}	1217.49*
Crosses	8	6.32^{ns}	0.10**	7.52*	2.69*	474.02*
Lines (female)	2	2.50^{ns}	0.15^{ns}	4.89^{ns}	3.33^{ns}	2.61^{ns}
Testers (male)	2	16.19^{ns}	0.12^{ns}	15.97^{ns}	2.50^{ns}	1594.28^{ns}
Lines xTesters	4	3.30^{ns}	0.06^{ns}	4.61^{ns}	2.46*	149.61^{ns}
Pooled error	28	4.71	0.04	2.50	0.90	163.68

* = Significant at 5% level of Probability, ** = Significant at 1% level of Probability, NS = Non Significant

Boll weight (g)

The NIA-Ufaq x hybrid IR-2620 (3.59) and NIA-80 x-008 *Bt* (3.60) gave greater weight of the bolls between the parents and the weight of the lower bolls was recorded in *Bt*-008 (2.80) Table 2. The NIA-Ufaq (female parent), IR-2620 and *Bt*-008 pollen parents expressed positive additive type of gene action for the bolls weight Table 3. However, hybrids Sadori x IR-2620, NIA-Ufaq x IR-2620, NIA-Ufaq x *Bt*-555 and NIA-80 x *Bt*-008 displayed positive SCA effects for the weight of the bolls Table 4. Our findings are supported by the results of Natera *et al*, (2012), Huangjun and Myers (2011) and Jatoi *et al.* (2011). The character boll weight refers that all crosses showed positive crossings except a cross of Sadori x *Bt*-555 showing negative heterosis. The cross NIA-80 x *Bt*-008 had a higher value for relative heterosis and heterobeltiosis Table 5. Our results are supported by Nassar (2013).

Ginning out turn (%)

As a result ginning percentage, hybrid Sadori x IR-2620 (40.51) showed a higher percentage of ginned result, while the *B*t-008 (34.50) produced lower parent Table 2. The data presented in Table 03 in relation to the percentage of delivery indicates ginning two lines, i.e. Sadori, NIA-Ufaq and tester IR-2620 showed positive GCA effects Table 3. Almost similar performance with respect to the effects of SCA to the three hybrids i.e. Sadori x IR-2620, NIA-Ufaq x *B*t-008 and NIA-80 x *B*t-555 showed positive SCA effects on percentage results Table 4. Present results are supported by the results of Kumar et al. (2013). If GOT% only six hybrids ie Sadori x IR-2620, Sadori x *B*t-008, NIA-Ufaq x IR-2620, NIA-Ufaq x *B*t-008, NIA-80 x IR-2620 and NIA-80 x *B*t -555 had higher value for mid parent heterosis. Other crosses had higher value demonstrates better father NIA-Ufaq cross x IR-2620 and heterobeltiosis positive heterosis (Table 5). Our results are in line with those obtained by Nassar (2013).

Table 2. Mean Performance of parents and their hybrids for various characters of cotton.

Genotypes	Sympodial branches plant^{-1}	Boll weight (g)	GOT (%)	Staple length (mm)	Seed cotton yield plant^{-1} (g)
Sadori	19.47 ab	3.33 abc	39.50 ab	28.46 bcd	126.82 abc
NIA Ufaq	21.07 ab	3.41 abc	38.40 abcde	28.06 bcd	119.26 bcd
NIA-80	20.00 ab	2.90 de	37.50 bcdef	28.53 bcd	113.09 cd
IR-2620	18.00 bc	3.32 abc	36.62 cdefg	28.53 bcd	119.60 bcd
Bt-555	15.20 c	2.92 de	35.60 fg	28.06 bcd	84.49 e
Bt-008	18.93 abc	2.80 e	34.50 g	27.20 d	101.39 de
Sadori x IR-2620	22.27 ab	3.40 abc	40.51 a	28.93 abc	143.45 a
Sadori x Bt-555	20.20 ab	3.10 cde	37.53 bcdef	29.46 ab	108.65 cd
Sadori x Bt-008	22.33 a	3.40 abc	37.99 abcdef	28.06 bcd	112.39 cd
NIA-Ufaq x IR-2620	22.93 a	3.59 a	39.61 ab	28.53 bcd	128.25 abc
NIA-Ufaq x Bt-555	19.07 abc	3.50 ab	36.03 defg	27.30 cd	114.78 bcd
NIA-Ufaq x Bt-008	19.93 ab	3.52 ab	38.99 abc	28.06 bcd	122.58 abcd
NIA-80 x IR-2620	21.00 ab	3.20 bcd	38.53 abcd	28.83 bcd	136.63 ab
NIA-80 x Bt-555	19.20 abc	3.20 bcd	37.53 bcdef	30.53 a	107.17 cd
NIA-80 x Bt-008	22.00 ab	3.60 a	35.64 efg	28.06 bcd	118.63 bcd

Table 3. Effect of General combining ability on various characters of cotton.

Parents	Sympodial branches plant^{-1}	Boll weight (g)	GOT (%)	Staple length (mm)	Seed cotton yield plant^{-1} (g)
Sadori	0.61	-0.09	0.64	0.18	0.10
NIA- Ufaq	-0.35	0.15	0.17	-0.68	0.48
NIA-80	-0.26	-0.06	-0.81	0.50	-0.58
IR-2620	1.07	0.01	1.51	0.12	14.72
Bt-555	-1.50	-0.12	-1.01	0.46	-11.19
Bt-008	0.43	0.12	-0.50	-0.58	-3.52

Staple Length (mm)

Long fiber length was obtained from cross-NIA 80 x *Bt*-555 (30.53) and the average length of short fiber cross was produced by NIA-Ufaq x *Bt*-555 (27, 30) Table 2. Four parents Sadori and NIA-80 of seeds and IR-2620 and *Bt*-555 matrix pollen showed positive effects for GCA staple length indicating that the trait was conditioned by additives in these parents' genes, suggesting the importance of these genotypes to obtain varieties with long staple length Table 3. There were only four hybrids i.e. Sadori x *Bt*-555, NIA-Ufaq x IR-2620, NIA-Ufaq x *Bt*-008 and NIA-80 x *Bt*-555 displayed positive SCA effects for the trait staple length Table 4. It is suggested that there is a possibility of isolating potential segregating progeny of the four hybrids. Same results are reported by other scientists Baloch *et al*. (2012) and Natera *et al*. (2012). For fiber length character five crosses had positive mid parent heterosis. Cross NIA-80 x *Bt*-555 had greater positive value relative heterosis for fiber length character and could be exploited in long staple length Table 5. These types of results are also reported by scientist as Geddam *et al.*, (2013) and Yuksel Bolek *et al*., (2010).

Table 4. Effects of Specific combining ability on different traits of cottton.

Crosses	Sympodial branches plant^{-1}	Boll weight (g)	GOT (%)	Staple length (mm)	Seed cotton yield plant^{-1} (g)
Sadori x IR-2620	-0.41	0.09	0.32	-0.011	7.00
Sadori x Bt-555	0.10	-0.08	-0.14	0.189	-2.00
Sadori x Bt-008	0.30	-0.02	-0.18	-0.178	-6.00
NIA-Ufaq x IR-2620	1.21	0.05	-0.11	0.444	-8.00
NIA-Ufaq x Bt-555	-0.07	0.09	-1.17	-1.122	4.00
NIA-Ufaq x Bt-008	-1.14	-0.14	1.28	0.678	4.00
NIA-80 x IR-2620	-0.81	-0.14	-0.21	-0.433	1.00
NIA-80 x Bt-555	-0.03	-0.01	1.31	0.933	-2.00
NIA-80 x Bt-008	0.84	0.15	-1.10	-0.500	1.00

Table. 5. Estimate of Heterosis and Heterobeltiosis for various characters in F_1 hybrid generation *Gossypium hirsutum* L.

Cross combination	Sympodial branches plant^{-1}		Boll weight (g)		GOT (%)		Staple length (mm)		Seed cotton yield plant^{-1} (g)	
	Percent increase (+) or decrease (-) over									
	MPH	**HB**	**MPH**	**MPH**	**HB**	**HB**	**MPH**	**HB**	**MPH**	**HB**
Sadori x IR-2620	+18.86	+14.38	+3.03	+3.03	+6.43	+2.55	+1.50	+1.40	+14.10	+13.11
Sadori x Bt-555	+16.52	+3.74	-0.95	-6.90	-0.05	-4.98	+4.24	+3.51	+2.83	-14.32
Sadori x Bt-008	+16.30	+14.68	+10.92	+2.10	+2.70	-3.79	+0.86	-1.40	-1.49	-11.37
NIA-Ufaq x IR-2620	+17.37	+8.82	+6.82	+5.57	+5.62	+3.17	+0.81	+0.00	+7.83	+7.23
NIA Ufaq x Bt-555	+5.15	-9.49	+10.41	+2.63	-2.62	-6.17	-2.74	-2.74	+13.22	-2.94
NIA-Ufaq x Bt-008	-0.35	-5.41	+13.36	+3.22	+6.99	+1.56	+1.59	+0.00	+2.51	-4.80
NIA-80 x IR-2620	+10.52	+5.00	+2.89	-3.90	+3.96	+2.74	+1.05	+1.05	+17.02	+14.23
NIA-80 x Bt-555	+9.09	-4.00	+9.96	+9.21	+2.68	+0.08	+7.87	+7.01	+8.03	-5.90
NIA-80 x Bt-008	+13.02	+10.00	+26.31	+24.13	-1.00	-4.96	+0.75	-1.61	+10.20	+4.15

Seedcotton yield plant $^{-1}$

For seedcotton yield trait hybrid Sadori x IR-2620 (143.45) and NIA-80 X IR-2620 (136.63) produced higher yields of cotton, while among parents Sadori (126.82) produced maximum performance seed cotton plant^{-1}, while *Bt*-555 (84.49) gave lower seedcotton yield plant^{-1} (Table 2). In case of GCA, Sadori and NIA-Ufaq female parent and IR-2620 expressed positive additive type of gene action for seed cotton yield plant^{-1}. The data presented in Table 03 suggest that no parent exhibits remarkable performance regarding overall performance of trait seedcotton plant^{-1}. However, hybrid Sadori x IR-2620, NIA-Ufaq x *Bt*-555, NIA-Ufaq x *Bt* -008, NIA-80 x IR-2620 and NIA-80 x *Bt*-008 show positive effects on plant SCA seedcotton yield plant^{-1} (Table 4). In later generations hybrid selection is suggested to isolate promising genotypes for the development of cultivars / hybrids to boost seed cotton yield / unit area. These type of results are also presented by Kumar *et al*. (2013), S.Abro et al (2009), Natera *et al.* (2012), Soomro *et al.* (2012), Huangjun and Myers (2011), Jatoi *et al.* (2011). The yield is polygenic had the highest value of mid-parent and better parent Sadori shown by x *Bt*-008. Eight crosses showed positive mid parent and better parent for seed cotton yield plant^{-1} seed character Table 5. These type of results are also reported by El-Hashash (2013).

Conclusion

The Sadori line and tester IR-2620 appeared positive GCA indicating that these parents were good general combiners and cross of both parents reported higher SCA demonstrating best specific combiner for some quantitative and qualitative traits effect. The cross Sadori x IR-2620 gave more heterosis and heterobeltiosis for all traits under study. While NIA-80 x Bt-555 produced greater heterosis for the trait boll weight.

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