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Study of genetic analysis of agronomic and fibre traits under normal and drought conditions in *Gossypium hirsutum* L.

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Abstract
This study was carried out for developing high yielding cotton genotypes equipped with attractive fiber superiority parameters under drought condition. Five upland cotton accessions were screened out as drought tolerant and three as drought susceptible on the basis of root shoot parameters. The results of root shoot screening experiment were verified in field screening on the basis of agronomical and physiological parameters. These eight genotypes were grown in glass house conditions and crossed in line ×tester mating design. During the next cotton season, these fifteen cotton hybrids and parents were sown in field conditions. Analysis of variance revealed existence of significance amongst the accessions for all the parameters i.e., Plant Height(PH), number of bolls (NB), boll weight (BW), seed cotton yield (SCY), seed index (SI), ginning out-turn (GOT), fiber length (FL), fiber fineness (FF), fiber strength (FS). Further, the line i.e., MS-64 and tester i.e., BH-176 had better yield performance under water stress. The cross combinations *viz*., GS-444 x MPS-11, and COOKER-315 x Cyto-62 were also recognized as best superior for yield contributing traits. These combinations might be helpful for fresh germplasm development on large scale under water stress condition.

Keywords: drought; *Gossypium hirsutum* L.; genetic analysis; line × tester; normal

Introduction

Upland cotton (*Gossypium hirsutum* L.) is well known around the globe as prime fiber and cash crop. This crop is grown in tropical and sub-tropical areas of the more than 80 countries including America, China, Brazil India and Pakistan. (Singh, 2004) [31]. Cotton crop covered the area of 2489 thousand hectares with production of 9.917 million bales which is 14.2% less in area and 7.6% increase in production as compared to the previous year. It contributes 1.0% and 5.2% in gross domestic product (GDP) and in value addition respectively in Pakistani agriculture (Anonymous, 2016-17) [3] in cotton, different stages like germination, emergence of seedling, and flowering are much sensitive than vegetative stages to drought (Loka and Oosterhuis, 2012) [18]. Cotton crop is not identified as drought tolerant and not well-organized in case of water use as compared to sorghum crop (Allen Jr *et al*., 2011) [2]. Due to deep and extensive root system of cotton crop that support it well adapted to semi-arid regions (Bruner, 2015) [7]. The effects of water stress on various cotton growth stages were investigated (Zhang *et al*, 2016) [35]. Drought affected adversely the staple length. Similarly, the physiological and morphological studies showed that these factors involved in seed cotton reduction and also revealed the less effect of normal condition on boll weight by (Papastylianou and Argyrokastritis, 2014) [23]. Many research scientists have studied the inheritance pattern of ginning out-turn. Additive type of gene action influenced the ginning out-turn (Khan *et al*., 2009) [13]. Prasad *et al*. (2005) [24] revealed the additive and non-additive type of gene action whereas Mukhtar *et al*. (2000a) [21] and Esmail (2007) [9] have observed the additive, dominance, partial dominance and epistatic effects in boll weight inheritance pattern. Nimbalkar *et al*. (2004) [19] showed that additive type of gene action control the fiber length. Azhar *et al*. (2004) [4] revealed that fiber length influenced by additive and non-additive gene action. Zhang *et al*. (2014) [36] studied epistatic type of gene action for staple length. Kumar *et al*. (2014) [17] calculated the gene action for bundle strength and showed non-additive type of gene action. Bertini *et al*. (2001) [5], Singh and Chahal (2005) [32], and Minhas *et al*. (2008) [20] showed the additive, dominant and epistatic effects for fiber strength. Several findings have been given for the existence of additive and partial dominance for fiber fineness (Mukhtar *et al*. 2000b; Singh and Chahal 2005; Minhas *et al*. 2008; Akhtar *et al*. 2008) [22, 32, 20, 1] that is much more important parameter for textile industry.

The above discussed literature plays key role for cotton breeders for initiating breeding programs. The main focus of the cotton breeding techniques is for fresh germplasm development having maximum seed cotton yield equipped with quality fiber parameters for textile industry point of view. For hybridization program, there is a need of the information about gene action and combining ability for selection of suitable parents. Therefore, this work was carried out for understanding the inheritance pattern of gene action and combining ability in the existing cotton germplasm yield and fiber quality parameters under drought condition.

Materials and methods

This study was conducted in the field at Central Cotton

Research Institute, Multan. Germplasm used herein was collected from CCRI, Multan. Five drought tolerant upland cotton genotypes (BH-176, MPS-11, DPL-45, Tree Cotton and CYTO-62) and three drought susceptible (GS-444, MS-64 and COOKER-315) were planted in glasshouse during offseason 2014-15. Upon emergence of flowering, in order to achieve genetic purity, self-fertilization procedure was adopted. Crossing was done in Line x Tester mating design. The developed F1 materials along with parents were planted in two regimes i.e., irrigated (control) and drought in three replication following split plot under randomized complete block design (RCBD) in field during cotton crop season 2015-16. At a 30 cm between plants and 75cm between rows about 10 plants belonging to each genotype were planted. All other practices kept as uniform. Data on morphological traits in the field as well as in laboratory conditions were collected on five plants from each family. The standard protocol for PH (cm), BW (g), NB/plant, SCY/ plant (g), GOT (%) and fiber characteristics were adopted. rotocol of each parameter is mentioned below.

The data taken on these above parameters from each treatment (controlled and stressed) were subjected for analysis by Steel *et al*. (1997) [33] Later on, data were subjected to Line × Tester technique (Kempthorne, 1957) [14] to assess the genetic variances.

Results and discussion

Genetic analysis of agronomic and fiber traits under normal water conditions

Table-1 shows significance of parameters under prevailing normal conditions. In crosses, regarding to parents all traits were highly significant. In parent × crosses all traits were highly significant except PH and SS showed non-significant differences while SL and FF were significant. In lines, all traits were highly significant except BW and FF which showed non-significance while SCY and NB which were significant. In case of tester, all traits were highly significant. For interaction of lines ×tester, showed significance in all traits except PH which was non-significant while SL and FF remained significant.

Genetic analysis of agronomic and fiber traits under drought condition

Under water stress conditions, all study parameters were found highly significant (Table-2) except SL which was significant for parents. In crosses, all traits remained significant. In parent × crosses, all traits remained highly significant except PH, NB, BW, SL and SS exhibited non-significant differences. In lines, all traits were highly significant except NB, BW, GOT and SL which were exhibiting non-significant results. In case of tester, all traits were highly significant and FF had non-significance. For interaction of lines x tester, all traits were highly significant except FF which were non-significant while G.O.T was significant

Natural or induced selection is the two main pre-requisites for cotton variety development against water stress. Firstly, the existence of genetic variations for certain characters and secondly, these variations must be controlled genetically. Now, hard work is being done to develop genetic population up to the maturity of the plants. Whole plant data against drought in the previous studies are not available in *G. hirsutum* (Iqbal *et al*., 2010) [10]. Keeping in view, five upland cotton genotypes (BH-176, MPS-11, DPL-45, Tree Cotton and CYTO-62) were screened as drought tolerant and In contrast, three genotypes (GS-444, MS-64 and COOKER-315) were identified as sensitive to drought. When the data were analyzed genetically for various traits showed the function of genetic components in normal and drought conditions. All the agronomic and fiber traits including PH, NB, BW, SI, SCY and GOT%, SL, SS and FF showed higher values of SCA than GCA under normal condition. The highest SCAvariance under normal condition was shown by PH and SCY. Same was the result for all the traits except FF under drought condition which showed non-additive type of gene action. The finding of Javid *et al*. (2014) [11] coincides with present results, whilst Karademir *et al*. (2009) [12] showed additive type of gene action for fiber length and fiber fineness. So this result agrees with present findings in case of fiber finenes.

Moreover, plant breeders must have known how about genetic variations of parents and combinations in Varity development through introgression for drought tolerance in field crops as explained by (Singh and Narayanam, 2000; Kirda *et al*., 2005) [30, 16]. Previous reports indicated non-additive type of gene action in cotton for tehes parameters under drought tolerance (Shakoor *et al*., 2010 and Sarwar *et al*., 2012) [29, 28]. Comparison of GCA for eight parents (three lines and five testers) showed that lines namely GS-444, MS-64 and COOKER-315 and testers (BH-176, MPS-11, DPL-45, Tree Cotton and CYTO-62) were the best in general combiners for most of the parameters. This material must be used for the improvement in drought tolerance with high yield in upland cotton. Amongst the different combinations, MS-64 x MPS-11 showed best results for plant height, fiber length and fiber strength (Roy *et al*., 2002) [26] by virtue of high GCA estimates. Cross of GS-444 x MPS-11 was best for number of bolls, seed cotton yield and fiber fineness due to the involvement of MPS-11 having good GCA but GS-444 had poor and negative GCA. For boll weight, seed index and ginning out turn %,crosses COOKER-315 x DPL-45, MS-64 x BH-176 and MS-64 x Cyto-62 revealed good presentation due to good general combining ability of DPL-45and MS-64 for certain characters (Caixeta *et al*., 2001) [8]. Therefore both GCA and SCA effects are important. The involevement of one parent with maximum GCA would enhance favourable allele’s occurrence. Most of the pairing having good SCA possessions is by virtue of good GCA of the parenrs showed additive genetic effects prevalence (Kenga *et al*., 2004) [15]. Higher SCA property of parents uder crossing with low GCA indicated non-additive genetic effects and appear to the researcher to delay early generation selection (Saidaiah *et al*., 2010, JHRD., 2001) [27,6]. Reverse the situation with having significant SCA because it helps early generation selection (Roy *et al*., 2002) [26].

The fluctuation in the performance of material (parents and hubrids) is due to variations in genetic paring and environmental factors (Pattersen *et al*., 2006) [25]. The non-additive type of geneaction presence exposed the application of this plant maerial for hybrids development (Vaghela *et al*., 2016) [34].

Conclusions

The information obtained on the basis of data analyzing by the use of different biometrical approaches, from these observations it is the message for breeders for the selection of wanted parameters must not be executed up to later generations.

These findings are restricted for plant material under trial and thus, may not be comprehensive most of the area under cotton cultivation undergo severe water shortage. Therefore, this knowledge should be substantiated by another trial which may comprise of reasonable cotton genotypes, conducted under various environmental conditions in order to boost adaptability of our presented commercial cotton varieties under stress and build up improved drought tolerance plant material.

Table 1: Mean Squares of agronomic and fiber traits of 15 crosses and 8 parents under normal conditions

S.O.V	d. f	Plant Height	Bolls Number	Weight of bolls	Seed Cotton Yield	Seed Index	Ginning Out Turn	Fiber Length	Fiber Strength	Fiber Finess
Replications	2	77.178ns	3.245ns	0.005ns	6.02ns	0.039ns	0.446ns	0.033ns	0.503ns	0.051ns
Treatments	22	255.148**	73.169**	0.049**	639.15**	1.152**	5.241**	1.304**	18.144**	0.115**
Parent	7	309.186**	141.776**	0.037**	12327.53**	1.592ns	4.750**	1.021**	26.239**	0.059ns
P x C	1	39.749ns	72.874**	0.066**	1100.01**	0.001**	3.436**	1.020*	0.725ns	0.151*
Crosses	14	254.079**	38.570**	0.054**	296.55**	1.015**	5.616**	1.466**	15.342**	0.140**
Lines	2	466.766**	12.021*	0.015ns	46.34*	0.602**	4.157**	3.449**	22.174**	0.040ns
Testers	4	366.933**	121.023**	0.070**	681.29**	2.143**	9.301**	2.368**	28.979**	0.294**
L x T	8	139.766	11.500	0.055	145.46	0.555	4.138	0.519	6.815	0.089
Error	44	64.062	2.393	0.001	9.60	0.084	0.433	0.186	0.301	0.037

Table 2: Mean Squares of agronomic and fiber traits of 15 crosses and 8 parents under drought conditions

S.O.V	d. f	Plant Height	Bolls Number	Weight of Bolls	Seed Cotton Yield	Seed Index	Ginning Out Turn	Length of Fiber	Fiber Strength	Fiber Finness
Replications	2	71.543ns	3.632ns	0.004ns	5.366ns	0.221ns	0.345ns	0.293ns	1.368ns	0.062ns
Treatments	22	202.899**	51.524**	0.076**	360.637**	0.815**	2.506**	1.093**	6.959**	0.308**
Parent	7	203.756**	111.214**	0.107**	721.385**	0.954**	2.287**	0.440*	6.588**	0.328**
P x C	1	76.665ns	3.210ns	0.007ns	917.700**	4.569**	23.031**	0.238ns	0.269ns	0.231**
Crosses	14	211.565**	25.133**	0.065**	140.394**	0.477**	1.149**	1.480**	7.622**	0.305**
Lines	2	408.289**	8.467ns	0.019ns	59.714**	0.360**	3.308ns	0.186ns	6.106**	1.542**
Testers	4	271.079**	31.645**	0.107328**	133.579**	0.01679ns	0.8181ns	1.28089**	14.6758**	0.22689ns
L x T	8	147.122	25.394	0.061434	171.417	0.74578	0.7903	1.90322	4.4744	0.03406
Error	44	63.052	2.493	0.001	9.50	0.084	0.433	0.186	0.301	0.037

References

1. Akhtar M, Azhar F, Ali Z. Genetic basis of fiber quality attributes in upland cotton (*G. hirsutum* L.) germplasm. Int. J. Agric. Bio. 2008; 10:217-220.
2. Allen Jr LH, Kakani VG, Vu JC, Boote KJ. Elevated CO2 increases water use efficiency by sustaining photosynthesis of water-limited maize and sorghum. J. Plant Physio. 2011; 168:1909-1918.
3. Anonymous. Economic Survey of Pakistan (20162017). Government of Pakistan, Finance Division. Economic Advisor's Wing. Islamabad, 2017.
4. Azhar F, Naveed M, Ali A. Correlation analysis of seed cotton yield with fiber characteristics in *G. hirsutum* L. Int. J. Agric. Biol. 2004; 6:656-658.
5. Bertini CHCM, Silva FPD, Nunes RDP, Santos JHRD. Gene action, heterosis and inbreeding depression of yield characters in mutant lines of upland cotton. Pesq. Agropec. Bras. 2001; 36(7). http://dx.doi.org/10.1590/S0100-204X2001000700003
6. Santos JHRD. Gene action, heterosis and inbreeding depression of yield characters in mutant lines of upland cotton. Pesq. Agropec. Bras. 2001; 36:941-948.
7. Bruner W. Root development of cotton, peanuts, and tobacco in central Oklahoma. Proceedings of the Oklahoma Academy of Science, 2015, 20-37.
8. Caixeta FM, Tulio Cassini S, Rodrigues Oliveira V, Vieira C, Mui Tsai S, Damiao Cruz C, *et al*. Combining ability for nodulation in common bean (*Phaseolus vulgaris* L.) genotypes from Andean and Middle American gene pools. Euphytica. 2001; 118:265-270.
9. Esmail R. Genetic analysis of yield and its contributing traits in two intra-specific cotton crosses. J. Appl. Sci. Res. 2007; 3:2075-2080.
10. Iqbal K, Azhar FM, Khan IA, Ullah E. Assessment of cotton (*G. hirsutum* L.) germplasm under water stress condition. Int. J. Agric. Biol. 2010; 12:251-255.
11. Javid A, Azhar FM, Khan IA, Rana SA. Genetic basis of some yield components in *G. hirsutum* L. Pakistan J. Agric. Sci. 2014; 51:143-146.
12. Karademir C, Karadem E, Idot Ek R, Idot, Oktay G. Combining ability estimates and heterosis for yield and fiber quality of cotton in line × tester design. Not. Bot. Horti. Agrobot. Cluj-Napoca. 2009; 37:228-233.
13. Khan NU, Hassan G, Marwat KB, Farhatullah KMB, Parveen A, Aiman U, *et al*. Diallel analysis of some quantitative traits in *G. hirsutum* L. Pakistan J. Bot. 2009; 41:3009-3022.
14. Kempthorne O. An introduction to genetic statistics. New York, John Wiley and Sons, Inc., New York, 1957.
15. Kenga R, Alabi S, Gupta S. Combining ability studies in tropical sorghum (*Sorghum bicolor* L. Moench). Field Crop Res. 2004; 88:251-260.
16. Kirda C, Topcu S, Kaman H, Ulger A, Yazici A, Cetin M, *et al*. Grain yield response and N-fertilizer recovery of maize under deficit irrigation. Field Crop Res. 2005; 93:132-141.
17. Kumar KS, Kumar KA, Ravikesavan R. Genetic effects of combining ability studies for yield and fibre quality traits in diallel crosses of upland cotton (*Gossypium hirsutum* L.). Afr. J. Biotechnol. 2014; 13:119-126.
18. Loka DA, Oosterhuis DM. Water stress and reproductive development in cotton. Flowering and Fruiting in Cotton. Cordova: The Cotton Foundation,

2012, 51-58.
19. Nimbalkar RD, Jadhav AC, Mehetra SS. Combining ability studies in desi cotton (*G. arboreum* and *G. Herbaceum*). J. Maharastra Agri. Uni. 2004; 29:166-170.
20. Minhas R, Khan IA, Anjam MS, Ali K. Genetics of some fiber quality traits among intraspecific crosses of American cotton (*Gossypium Hirsutum*). Int. J. Agric. Bio. 2008; 10:196-200
21. Mukhtar M, Khan T, Khan A. Genetic analysis of yield and yield components in various crosses of cotton (*G. hirsutum* L.). Int. J. Agric. Biol. 2000a; 2:258-260.
22. Mukhtar MS, Khan TM, Khan AS. Gene action study in some fiber traits in cotton (*G. Hirsutum* L.). Pakistan J. Bio. Sci. 2000b; 3:1609-1611.
23. Papastylianou PT, Argyrokastritis IG. Effect of limited drip irrigation regime on yield, yield components, and fiber quality of cotton under Mediterranean conditions. Agric. Water Manag. 2014; 142:127-134.
24. Prasad U, Reddy V, Reddy A. Studies on genetic variability in American cotton (*G. Hirsutum* L.). Karnataka J. Agric. Sci. 2005; 18:1095-1098.
25. Pettersen R, Mortensen L, Moe R, Gislerod H. Air humidity control essential for rose production under continuous lighting. Acta Hort, 2006, 323-331
26. Roy N, Jettopujov V, Solanik N. Combining ability for some agronomic characters in alfalfa (*Medicago sativa* L.). Pakistan J. Agric. Res. 2002; 17:346-350.
27. Saidaiah P, Kumar SS, Ramesha M. Combining ability studies for development of new hybrids in rice over environments. J. Agric. Sci. 2010; 2:225-233.
28. Sarwar MKS, Ashraf MY, Rahman M, Zafar Y. Genetic variability in different biochemical traits and their relationship with yield and yield parameters of cotton cultivars grown under water stress conditions. Pakistan J. Bot. 2012; 44:515-520.
29. Shakoor MS, Malik TA, Azhar FM, Saleem MF. Genetics of agronomic and fiber traits in upland cotton under drought stress. Int. J. Agric. Biol. 2010; 12:495-500.
30. Singh P, Narayanan SS. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi, India, 2000.
31. Singh P. Cotton Breeding. 2nd ed. Kalyani Publishers, New Delhi India, 2004.
32. Singh P, Chahal G. Estimates of additive, dominance and epistatic variation for fiber quality characters in upland cotton (*G. Hirsutum* L.). J. Cotton Res. Dev. 2005; 19:17-20.
33. Steel RGD, Torrie JH, Dickey DA. Principles and procedures of statistics: A biometrical approach. (3rd ed.) McGraw Hill, New York, 1997.
34. Vaghela P, Thakkar D, Bhadauria H, Sutariya D, Parmar S, Prajapati D, *et al*. Heterosis and combining ability for yield and its component traits in Indian mustard (*Brassica juncea* L.). J. Oilseed Brassica. 2016; 1:39-43.
35. Zhang D, Luo Z, Liu S, Li W, Dong H. Effects of deficit irrigation and plant density on the growth, yield and fiber quality of irrigated cotton. Field Crops Res. 2016; 197:1-9.
36. Zhang J, Percy RG, Mccarty JC. Introgression genetics and breeding between Upland and Pima cotton: a review. Euphytica. 2014; 198:1-12.