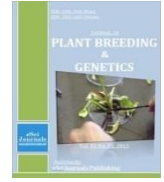




Available Online at ESci Journals
Journal of Plant Breeding and Genetics

ISSN: 2305-297X (Online), 2308-121X (Print)
<http://www.escijournals.net/JPBG>



CORRELATION AND GENETIC ARCHITECTURE OF SEED TRAITS AND OIL CONTENT IN *GOSSYPIUM HIRSUTUM* L.

^aMuneeb Munawar*, ^bTanwir A. Malik

^aVegetable Research Institute, AARI, Faisalabad, Pakistan.

^bDepartment of Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan.

ABSTRACT

The analysis of correlation and genetic architecture of 15 F₁ hybrids and their five parents were made. Objective of the study was to investigate the gene action governing cotton seed oil content and some seed physical characters as well as their correlation in cotton. Cotton seed oil content showed positive correlation with seed index. Seed volume contribute towards oil content through seed index. Significant GCA and SCA mean squares were observed for all traits except number of seeds per boll which had non-significant GCA effect. All the traits observed were controlled by non-additive gene action although additive genes were also involved in inheritance of seed index, seed volume, fibre mass per seed and cotton seed oil content. Cotton seed oil content can be improved both through selection or hybrid development.

Keywords: *Gossypium hirsutum* L., Correlation, Gene Action, Oil Contents.

INTRODUCTION

Edible oil is second largest import of Pakistan after petroleum. Edible oil of 1.29 million tons worth Rs. 84 billion have been imported during the year 2008-09. At domestic level, 0.778 million tons edible oil was produced, of which 47.68% was obtained from cottonseed (Economic survey of Pakistan 2008-09).

It is need of the time to increase the edible oil production locally. Cotton is not only our major fibre crop but also main source of edible oil, however, being ignored as an oilseed crop. Evaluation criteria for a cotton variety only consider its fibre yield and its oil yield is totally ignored. Through developing the cotton varieties having both high fibre and oil yield, it would be possible to reduce edible oil imports in the country.

This research was planned to find out gene action and correlation of oil content with some seed traits in cotton. Informations generated through this study will help breeders to plan strategy for development of a cotton cultivar having high fibre yield as well as good oil percentage.

* Corresponding Author:

Email ID: muneeb.pbg@hotmail.com

© 2013 ESci Journals Publishing. All rights reserved.

The work on genetics of cotton seed oil content and its correlation with other cotton seed traits is not extensively done in domain of cotton breeding. Previous studies revealed strong positive association of cotton seed oil content with seed index (Kohel, 1978; Pahlavani *et al.*, 2008). However Ahmad and Azhar (2000) reported no association of oil content with seed index. Both additive (Azhar and Ajmal, 1999; Khan *et al.*, 2007) and non-additive (Ahmad *et al.*, 2005; Khan *et al.*, 2007) gene actions had been reported for cotton seed oil content. However non additive gene action is more important (Azhar and Ahmad, 2000).

MATERIALS AND METHODS

Five parents namely MNH-513, VH-142, BH-163, VH-142XL-1 and LA-85-52-2 were selected. These were planted in pots in glass house and direct crosses were made when they started flowering to produce F₁ seed. The F₁ seed along with parents was planted in field following randomized complete block design with three replications. In each replication there was single row for each of the parents and F₁ generation. In each row there were 10 plants. Row to row and plant to plant distance was 75cm and 30cm respectively. All the recommended agronomic practices were followed from sowing till

harvest. At maturity five guarded plants in each row were selected. Seven bolls from each selected plant were harvested and ginned separately and data was collected for number of seeds per boll and fibre mass per seed. Fibre mass per seed was determined by dividing individual boll fibre mass with number of seeds in that boll. Seeds of seven bolls of all selected plants of a single row were then mixed. From this mixture samples of hundred seeds were taken. These samples were delinted with commercial sulphuric acid (95%) at the rate of 5 ml H₂SO₄ per gram of the seed. Then these samples were washed thoroughly with tap water and surface dried with filter paper. These seed samples were weighed to determine seed index. Seed volume was determined by alcohol displacement method (Hudson, 1920). For this purpose a graduated cylinder was used. Ethanol was added in cylinder upto 50cc. Sample of 100 seeds was then placed in cylinder. Total volume of ethanol and seeds was read directly from cylinder. Volume of ethanol was subtracted from total volume to determine the volume of 100 seeds. Then these samples were grounded to powder using electrical grinder. This cotton seed powder was used to determine cottonseed oil content using soxhlet extraction method.

Statistical analysis: The data collected was subjected to analysis of variance following the method as in Steel et al. (1997) in order to determine the significant differences among the genotypes under study. The characters showing significant genotypic differences among hybrids and their parents were further analyzed genetically for correlation coefficients, calculated by the formula as outlined by Dewey and Lu (1959) using Minitab programme of computer. Genetic architecture of parents and their hybrids and gene action of different

traits was determined by subjecting the data to diallel analysis using Griffing's approach model 1, method 2. (Griffing, 1956).

RESULTS

Analysis of variance revealed significant genetic differences among parents and their hybrids for all the traits observed i.e. number of seeds per boll, seed index, seed volume, fibre mass per seed and oil content. Correlation coefficients of these traits are given in table 1.

Table-1: Correlation coefficients among seed traits and oil content of *G. hirsutum*. L.

Characters	SI	SV	F/S	OC
S/B	-0.132 (0.386)	-0.214 (0.159)	-0.302* (0.044)	0.038 (0.802)
SI		0.667** (0.000)	-0.241 (0.110)	0.358* (0.016)
SV			-0.140 (0.359)	0.018 (0.907)
F/S				-0.063 (0.679)

Seeds per boll (S/B), Seed index (SI), Seed volume (SV), Fibre mass per seed (F/S), Oil content (OC), (Values in parenthesis are the P-Values).

Number of seeds per boll showed negative correlation with fibre mass per seed while seed index was positively correlated with seed volume and cotton seed oil content. Number of seeds per boll, seed volume and fibre mass per seed had no direct correlation with cotton seed oil content. GCA and SCA mean squares and variances are presented in table-2 and table-3 respectively. All the traits observed showed significant GCA and SCA mean squares indicating that both additive and non-additive genes are responsible for variations in parents and hybrids for these traits.

Table-2: Mean squares due to general combining ability (GCA) and specific combining ability (SCA) for seed traits and oil content in *G. hirsutum* L.

Source of Variation	DF	Seeds per Boll	Seed Index	Seed Volume	Fibre Mass per Seed	Oil Percentage
GCA	4	0.274 ^{NS}	0.897**	2.111**	1.48E-05**	6.337**
SCA	10	9.039**	0.574**	10.156**	2.61E-05**	3.003**
Error	28	1.014	0.120	0.276	2.38E-06	0.053

Table-3: General combining ability (GCA) and specific combining ability (SCA) variances for seed traits and oil content in *G. hirsutum* L.

Source of Variation	Seeds per Boll	Seed Index	Seed Volume	Fibre Mass per Seed	Oil Percentage
GCA	-0.106	0.111	0.262	1.781E-06	0.898
SCA	8.025	0.453	9.879	2.369E-05	2.950
Error	-0.013	0.245	0.027	0.075	0.304

Exception was number of seeds per boll which had significant SCA mean square and non-significant GCA mean square which shows non-additive genes are solely responsible for variations in number of seeds per boll. However SCA variance was greater than GCA variance for all traits. Ratio of GCA variance/SCA variance was also less than unity showing predominance of non-additive gene action over additive gene action for seed traits and oil content in *Gossypium hirsutum* L.

Estimates of GCA effects of parents for seed traits and oil content are presented in table-4. There was no need to

estimate GCA effects of parents for number of seeds per boll due to non-significant GCA mean square. LA-85-52-2 and BH-163 had highly significant ($p < 0.01$) positive and negative GCA effects for seed index respectively. It means that LA-85-52-2 had high frequency of additive genes which contribute positively towards seed index while BH-163 had additive genes which act towards low seed index. VH-142 had non-significant ($p > 0.05$) positive GCA effect while MNH-513 and XL-1 had non-significant ($p > 0.05$) negative GCA effect for seed index.

Table-4: General combining ability (GCA) effects of parents for seed traits and oil content in *G. hirsutum* L.

Source of Variation	Seeds per Boll	Seed Index	Seed Volume	Fibre Mass per Seed	Oil Percentage
MNH-513	-	-0.142	0.524*	0.0004	-0.469*
VH-142	-	0.211	-0.143	-0.0002	0.865*
BH-163	-	-0.438*	-0.381*	0.0012*	-1.278*
XL-1	-	-0.122	-0.619*	0.0011*	1.003*
LA-85-52-2	-	0.491*	0.619*	-0.0024*	-0.121

All the parents except VH-142 showed significant GCA effects for seed volume. MNH-513 and LA-85-52-2 had highly significant ($p < 0.01$) positive GCA effects for seed volume. BH-163 and XL-1 had highly significant ($p < 0.01$) negative GCA effects for seed volume. VH-142 had non-significant ($p > 0.05$) negative GCA effect for seed index. These results showed that MNH-513 and LA-85-52-2 had high frequency of additive genes which act positively towards seed volume while BH-163 and XL-1 had high frequency of additive genes which contribute negatively towards seed volume.

In case of fibre mass per seed, BH-163 and XL-1 had significant ($p < 0.05$) GCA effect showing that these varieties had high frequency of additive genes which contribute positively towards fibre mass per seed. LA-85-52-2 had high frequency of additive genes contributing negatively towards fibre mass per seed as indicated by its highly significant ($p < 0.01$) GCA effect for fibre mass per seed. MNH-513 and VH-142 had non-significant ($p > 0.05$) positive and negative GCA effects for fibre mass per seed respectively.

VH-142 and XL-1 had highly significant ($p < 0.01$) positive GCA effects while MNH-513 and BH-163 had highly significant ($p < 0.01$) negative GCA effects for cotton seed oil contents. LA-85-52-2 had non-significant ($p > 0.05$) negative GCA effect. These results showed that VH-142 and XL-1 had high frequency of additive genes which act towards high cotton seed oil contents while MNH-513

and BH-163 had high frequency of additive genes which contribute negatively towards cotton seed oil contents. LA-85-52-2 had no significant contribution towards GCA mean square for cotton seed oil contents.

Estimates for SCA effects of hybrids for seed traits and cotton seed oil content are presented in table-5. In case of number of seeds per boll, LA-85-52-2×MNH-513, BH-163×VH-142 and XL-1×BH-163 had highly significant ($p < 0.01$) positive while XL-1×MNH-513 had significant ($p < 0.05$) positive SCA effects showing that these hybrids had inherited dominant genes from their parents which acted towards increases number of seeds per boll. BH-163×MNH-513 was the only hybrid which had dominant genes contributing negatively towards seeds per boll as indicated by its highly significant ($p < 0.01$) negative SCA effect. VH-142×MNH-513, XL-1×VH-142 had non-significant ($p > 0.05$) positive while LA-85-52-2×VH-142, LA-85-52-2×BH-163 and LA-85-52-2×XL-1 had non-significant ($p > 0.05$) negative SCA effects.

In case of seed index, XL-1×MNH-513, LA-85-52-2×MNH-513 and XL-1×VH-142 had non-significant ($p > 0.05$) positive while BH-163×VH-142 and LA-85-52-2×BH-163 had non-significant ($p > 0.05$) negative SCA effects. No significant dominance operates in these hybrids for seed index. BH-163×MNH-513 and LA-85-52-2×VH-142 had highly significant ($p < 0.01$) positive while LA-85-52-2×XL-1 had significant ($p < 0.05$) positive SCA effects indicating that these hybrids had inherited

dominant genes which contributed towards increased seed index. VH-142×MNH-513 had highly significant ($p<0.01$) negative while XL-1×BH-163 had significant ($p<0.05$) negative SCA effect for seed index. These hybrids had dominant genes which acted negatively towards seed index. XL-1×MNH-513 was the only hybrid observed which had no significant contribution in SCA mean square for seed volume as indicated by its non-significant ($p>0.05$) negative SCA effect. BH-163×MNH-513, LA-85-52-2×MNH-513, XL-1×VH-142, LA-85-52-

2×VH-142 and LA-85-52-2×XL-1 had highly significant ($p<0.01$) positive SCA effects for seed volume. This shows that these hybrids had inherited dominant genes from their parents which acted towards increased seed volume. VH-142×MNH-513, XL-1×BH-163 and LA-85-52-2×BH-163 had highly significant ($p<0.01$) negative while BH-163×VH-142 had significant ($P<0.05$) negative SCA effects which indicates that these hybrids had inherited dominant genes from their parents which contributed towards decreased seed volume.

Table-5: Specific combining ability (GCA) effects of F1 Crosses for seed traits and oil content in *G. hirsutum* L.

Hybrid	Seeds per Boll	Seed Index	Seed Volume	Fibre Mass per Seed	Oil Percentage
VH-142 ×MNH-513	0.2650794	-1.4090952*	-3.7142857*	0.005112*	-3.2373016*
BH-163×MNH-513	-2.7549206*	1.1112857*	7.5238095*	0.0011034	-1.0777778*
XL-1× MNH-513	1.5746032*	0.0505238	-0.5714286	-0.0048476*	1.0079365*
LA-85-52-2 × MNH-513	3.3412698*	0.4522381	1.5238095*	0.0004596	1.1150794*
BH-163×VH-142	3.4031746*	-0.236	-0.8095238*	0.0063947*	1.5722222*
XL-1 X VH-142	0.8193651	0.2285714	1.7619048*	-0.0064235*	1.2746032*
LA-85-52-2 X VH-142	-1.2006349	0.802619*	1.5238095*	-0.0009188	1.6650794*
XL-1 X BH-163	5.4193651*	-0.6307143*	-2.6666667*	-0.0045591*	-1.2492063*
LA-85-52-2 X BH-163	-1.3939683	-0.4593333	-1.5714286*	0.003708*	-0.5420635*
LA-85-52-2 X XL-1	-0.2444444	0.5845714*	1.6666667*	-0.0012889	-2.2396825*

VH-142×MNH-513, BH-163×VH-142 and LA-85-52-2×BH-163 had highly significant ($p<0.01$) positive SCA effects for fibre mass per seed. In these hybrids dominance operates towards increased fibre mass per seed. XL-1×MNH-513, XL-1×VH-142 and XL-1×BH-163 had inherited dominant genes from their parents which contributed towards decreased fibre mass per seed. This is indicated by their highly significant ($p<0.01$) negative SCA effects. BH-163×MNH-513, LA-85-52-2×MNH-513 had non-significant ($p>0.05$) positive while LA-85-52-2×VH-142 and LA-85-52-2×XL-1 had non-significant ($p>0.05$) negative SCA effects for fibre mass per seed. These hybrids had no significant contribution towards SCA mean square for fibre mass per seed.

In case of cotton seed oil contents, all crosses had significant SCA effects. XL-1×MNH-513, LA-85-52-2×MNH-513, BH-163×VH-142, XL-1×VH-142 and LA-85-52-2×VH-142 had highly significant ($p<0.01$) positive SCA effects indicating that these hybrids had inherited dominant genes from their parents which acted towards increased cotton seed oil percentage. VH-142×MNH-513, BH-163×MNH-513, XL-1×BH-163, LA-85-52-2×BH-163 and LA-85-52-2×XL-1 had inherited dominant genes from their parents which acted towards decreased

cotton seed oil contents as indicated by their highly significant ($p<0.01$) negative SCA effects.

DISCUSSIONS

Cotton seed content has significant positive correlation with seed index. Positive association between seed index and oil content has been previously reported by Kohel (1978) and Pahlavani *et al.* (2008). Cotton seed oil content had no correlation with fibre mass per seed. These results showed that simultaneous improvement of fibre yield and cotton seed oil contents is possible. Arshad *et al.* (1993) had also reported positive association of cotton seed oil content with seed cotton yield. Seed index may be considered as only yield component in case of oil content because it is the only trait which showed direct positive correlation with cotton seed oil content while seed volume contribute towards oil content through seed index.

GCA variance is non-significant for number of seeds per boll. In selected parents and their crosses, only dominance is involved in inheritance of this trait. So hybrid development is recommended for improvement of this trait. Khan *et al.* (2009) also reported dominant gene action for number of seeds per boll. However Ahmad *et al.* (2001) reported additive gene action with

partial dominance for number of seeds per boll. Seed index, seed volume, fibre mass per seed and cotton seed oil content were controlled by both additive and non-additive type of genes as indicated by significant GCA and SCA mean squares for these traits. But SCA variance was greater than GCA variance, so non additive gene action is more important than additive gene action. Both heterosis breeding and selection can be used to improve these traits. Since SCA variance is greater than GCA variance, heterosis breeding is recommended. Ahmad *et al.* (2005) and Khan *et al.* (2007) also reported non additive gene action for cotton seed oil content. Azhar and Ahmad (2000) reported that non additive gene action is more important.

MNH-513 and LA-85-52-2 are best general combiner for seed volume and are recommended to be used in breeding programs to increase seed volume. BH-163×MNH-513, LA-85-52-2×MNH-513, XL-1×VH-142, LA-85-52-2×VH-142 and LA-85-52-2×XL-1 had significant positive SCA effects for seed volume and can be used in heterosis breeding. XL-1×VH-142 and LA-85-52-2×XL-1 are recommended to be used as single cross hybrid as these may show hybrid break down in later generations due to significant negative GCA effect of XL-1. LA-85-52-2×MNH-513 and LA-85-52-2×VH-142 can be used in recombination breeding due to significant positive GCA effects of at least one of their parents but selection of superior plants should be delayed to later generations due to presence of dominance as indicated by significant positive SCA effect of hybrid.

In case of cotton seed oil contents, VH-142 and XL-1 are recommended to be used in breeding programs due to their significant positive GCA effects. XL-1×MNH-513, LA-85-52-2×MNH-513, BH-163×VH-142, XL-1×VH-142 and LA-85-52-2×VH-142 had significant positive SCA effects and can be used in heterosis breeding for cotton seed oil contents. However XL-1×MNH-513, LA-85-52-2×MNH-513 and BH-163×VH-142 will show hybrid break down in F₂ generation as one of their parents had significant negative GCA effect. XL-1×VH-142 and LA-85-52-2×VH-142 are recommended for recombination breeding as at least one of their parents had significant positive GCA effect however selection should be delayed to later generations due to significant positive SCA effects in both hybrids.

REFERENCES

Ahmad, I., A. Ali, M. Zubair and I.A. Khan. 2001. Mode of gene action controlling seed cotton yield and

various components in *Gossypium hirsutum* L.. Pak. J. Agri. Sci., 38(3-4): 19-21.

Ahmad, M. and F.M. Azhar. 2000. Genetic correlation and path coefficient analysis of oil and protein contents and other quantitative characters in F₂ generation of *Gossypium hirsutum* L. Pak. J. Biol. Sci., 3(6): 1049-1051.

Ahmad, R.D., A.J. Malik, G. Hassan and M.U. Khan. 2005. Genetic architecture of some quantitative traits of cotton (*Gossypium hirsutum* L.). Gomal Univ. J. Res. 21: 55-57.

Arshad, M., M. Hanif, I. Noor, S.M. Shah and N. Ilani. 1993. Correlation studies on some commercial cotton varieties of *Gossypium hirsutum* L. Sarhad J. Agri., 9: 49-53.

Azhar, F.M. and M. Ahmad. 2000. Inheritance pattern of cotton seed oil in diverse germplasm of *Gossypium hirsutum* L.. Pak. J. Biol. Sci. 3(8): 1250-1252.

Azhar, F.M. and S.U.K. Ajmal. 1999. Diallel analysis of oil content in seed of *G. hirsutum* L.. J. Genet. And Breed., 53: 19-23.

Dewey, D.R and R.H. Lu. 1959, Acorelation and path coefficient analysis of components of crested wheat grass and its seed production. Agron, J. 51: 515-518.

Griffing, B., 1956. Concept of general and specific combining ability in relation to diallel crossing system. Australian J. Biol. Sci., 9: 463-93.

Hodson, E.A. 1920. Lint frequency in cotton with a method for determination., Bulletin no. 168. Univ. of Arkansas, Fayetteville.

Khan, F.M., F.M. Azhar, I. Afzal and S. Rauf. 2007. Effect of nitrogen regimes on combining ability variation in oil and protein contents in cottonseed (*Gossypium hirsutum* L.). Plant Prod. Sci., 10(3):367-371.

Khan, N.U., G. Hassan, K.B. Marwat, Farhatullah, M.B. Kumbhar, A. Parveen, Umm-E-Aiman, M.Z. Khan and Z.A. Soomro. 2009. Diallel analysis of some quantitative traits in *Gossypium hirsutum* L. Pak. J. Bot., 41(6): 3009-3022.

Khan, N.U., G. Hassan, M.B. Kumbhar, A. Parveen, Um-E-Aiman, W. Ahmad, S.A. Shah and S. Ahmad. 2007. Gene action of seed traits and oil content in upland cotton (*Gossypium hirsutum* L.). SABRAO J. Breedi. and Genet., 39(1): 17-29.

Kohel, R.J. 1978. Survey of *Gossypium hirsutum* L. gerrnplasm collections for seed-oil percentage and seed characteristics. USDA-ARS-S-187-38.

Pahlavani, M.H., A.A. Miri and G. Kazemi. 2008. Response of oil and protein content to seed size in cotton. *Int. J. Agri. Biol.*, 10: 643-647.

Pakistan economic survey. 2009. Govt. of Pakistan, Finance Division, Islamabad.

Steel, R.G.D., J.H. Torrie and D.A. Dicky. 1997. Principles and procedures of statistics- A Biometrical Approach 3rd Ed. McGraw Hill Book International Co., Singapore. p. 204-227.