**Genetic variability for yield, its components and quality traits in upland cotton *(****Gossypium hirsutum* L.***)***

Hafiz Ghazanfar Abbas1, Abid Mahmood1, Qurban Ali2, Saif-ul-Malook2, Muhammad Waseem3 and Nazar

Hussain Khan4

1Cotton Research Institute, Ayub Agricultural Research Institute, Faisalabad.

2National Centre of Excellence in Molecular Biology, University of the Punjab Lahore, Pakistan

3Faculty of Agriculture, Lasbela University of Agriculture, Water and Marine Sciences Uthal, Pakistan

4Department of Continuing Education, University of Agriculture Faisalabad, Pakistan

Corresponding E-mail: saim1692@gmail.com

**Abstract:** The study was carried out at Ayub Agricultural Research Institute Faisalabad Pakistan during 2012 to evaluate twelve cotton genotypes for the development of high yielding cotton varieties. The genotypes were sown in completely randomized block design with three replications. Data was recorded for various quantitative traits and analyzed to access genetic variability among genotypes. It was found that the boll size of FH-207 (1) and FH-207 (22) was large, tapering shape, good opening and leaf was of broad size as compared to all other varieties. Higher values of heritability and genetic advance were recorded for first bud days (98.186%, 126.640%), sympodial branches (53.846%, 63.992%), monopodial branches (99.392%. 51.475%), number of bolls (95.937%, 181.233%), plant height (94.233%, 151.062%), boll weight (89.912, 23.485%), GOT% (56.938%, 39.959%) and fibre strength (66.545%, 51.332%) respectively. Significant correlations were found for boll weight, number of bolls, staple length, fibre strength and fibre fineness. From prescribed study it was concluded that higher heritability indicated that selection for hybrid cotton may be helpful to improve yield and quality of cotton while genetic advance suggested that selection for synthetic variety may be fruitful and significant correlation among traits suggested that selection may be useful for the enhancement of yield and quality of cotton.

**[**Hafiz Ghazanfar Abbas, Abid Mahmood, Qurban Ali, Saif-ul-Malook, Muhammad Waseem and Nazar, Hussain Khan. **Genetic variability for yield, its components and quality traits in upland cotton *(****Gossypium hirsutum* L.***)*.** *Nat Sci* 2014;12(11):31-35]. (ISSN: 1545-0740). <http://www.sciencepub.net/nature>. 5

**Keywords**: heritability, genetic advance, correlation, *Gossypium hirsutum*

**Introduction**

Cotton plays a vital role in the whole economy of Pakistan. It is an important industrial, fiber and cash crop. It is grown over 12% of the total cultivated area of Pakistan. Cotton contributes about 60% in the shape of raw cotton and its byproducts in the total economy of Pakistan. In count to its textile industry uses, edible oil and animal feed are also obtained from cotton seed cake. There is about 60-70% of edible oil obtained from cotton (Khan, N.U. 2003). In Pakistan it was grown over an area of 2835 thousand hectares with a production of 13595 thousand bales and an average yield of 815 kg ha-1 (Anonymous (2011-12). The production of seed cotton of Pakistan is considered as low if compared to other cotton growing countries like India, China, USA, Mexico and Australia. The seed cotton yield as a complex trait, is the product of relationship among its components fixed with unstable environmental conditions. The correlation among the various yielding traits may be helpful to improve the seed cotton yield. The correlation analysis reflects the retort of a specific trait with its analogous trait and it also provides an excellent index to predict the corresponding change which occurs in one trait due to the change in the other traits. Khan *et al.,* 2007; Meena *et al.,* 2007; Suinaga *et al.,* 2006; Taohua and Haipeng 2006 and Farooq *et al*., [11] reported strength and adaptability of cotton genotypes and found varied values for different morphological, agronomic and yielding traits. Iqbal *et al.,* [12]; Wang *et al.* 2004; Farooq *et al*., 20013 and saif-ul-malook et al., 2014abc reported genetic variability with positive correlation among seed cotton yield and contributing yielding traits in upland cotton. The present study was conducted to evaluate genetic variability cotton genotypes for staple length, fibre strength, fibre fineness and their related traits of cotton.

**Materials and Methods**

The study was carried out at Cotton Research Institute, Ayub Agricultural Research Institute Faisalabad Pakistan during 2012. The germplasm comprised of FH-207 (1), FH-207 (22), FH-207 (28) (YP), Bt-63 (88), Bt-79, Sbne-259m, Fh4243 Pl-4, Fh4243Spp32 (okra), Fh941Spp33, FH-941spp-46, FH-2015BP-10 and FH-2015BP-10. All of the twelve genotypes were sown in three replications following complete randomized block design with plant to plant distance 30cm and row to row 75cm in plot of size 4×4 meter. All agronomic practices were kept same in all of the three replications and data of 10 plants from each replication of each genotype was recorded for monopodial branches, sympodial branches, nodes to first flower days, first bud day, boll weight, number of bolls, staple length, fibre strength, GOT%, fibre fineness and plant height, boll size, maturity, boll shape, boll opening and leaf size. The data was subjected for analysis of variance (Steal et al., 1997). The genotypic correlations were calculated by Kwon and Torrie 1964) technique through Minitab 16.1 software. The genetic advance was calculated by using Falconer formula 1989.

**Results and discussions**

It is cleared from Table 2 and Table 4 that significant differences were found for all traits for all of twelve genotypes. Higher genotypic and phenotypic variance and coefficient of variance was recorded for first bud days, plant height, number of bolls, boll weight, fibre strength and sympodial branches [Abbas *et al*., 2013; Amir *et al*., 2012; Iqbal, *et al*., 2003; Amin, *et al.,* 2014ab and Ali *et al*., 2011). Higher values of heritability and genetic advance were recorded for first bud days (98.186%, 126.640%), sympodial branches (53.846%, 63.992%), monopodial branches (99.392%. 51.475%), number of bolls (95.937%, 181.233%), plant height (94.233%, 151.062%), boll weight (89.912, 23.485%), GOT% (56.938%, 39.959%) and fibre strength (66.545%, 51.332%) respectively. It was found that higher environmental variance and coefficient of variance was recorded for sympodail branches, plant height, nodes to first flower days and fiber strength. Higher heritability showed dominance type of gene action and genetic advance showed additive type of gene action indicated that selection of higher yielding cotton genotypes may be helpful to improve cotton seed yield and quality through developing hybrids while using higher heritability and synthetic varieties by using additive types of gene action (Ali *et al*., 2011). The boll size of FH-207 (1), FH-207 (22) and Sbne-259m was large, tapering shape, good opening and leaf was of broad size as compared to all other varieties (Table 1). The mean significant differences are given in table 4 and also it is clear from Fig. 1 that Fh941Spp33 and Fh4243Spp32 (Okra) showed higher values for first bud days, nodes to first flower days and sympodial branches while Fh-207 (28) (YP) and Bt-63 (88) showed higher monopodial branches. It is persuaded from Fig. 2 that Sbne-259m, Fh-207 (28) (YP), FH-2015BP10 and FH-207 (22) showed higher values of plant height, number of bolls, GOT% and boll weight respectively. FH-207 (22) and Fh4243Spp32 (Okra) showed higher values of fibre strength, staple length and fibre fineness (Fig. 3). Better average performance of genotypes for various traits suggested that the genotypes with higher number of bolls, boll weight, fibre strength, fibre fineness, monopodila branches per plant and GOT% can be selected for improving the cotton seed yield and quality (Abbas *et al*., 2013;Saif-ul-malook *et al.,* 2014d Ali *et al*., 2013ab). It was suggested from table 3 that higher and significant correlation was found for node to first day flower with number of monopodial branches, number of bolls per plant and fibre strength while negatively correlated with first buds days. A significant and positive correlation of monopodial branches was found with sympodial branches, number of bolls, plant height, node to first flower, GOT% and boll weight while negatively correlated with first bud days and staple length Taohua , *et al*., 2006; Meena, *et al*., 2007; Batool, *et al*., 2010 and Farooq *et al.,* 2013. Sympodial branches were significantly correlated with monopodial branches, number of bolls, plant height, staple length and boll weight while negatively correlated with GOT%, first bud days and fibre fineness. Number of bolls was significantly correlated with first bud days, sympodial branches, node to first day flower, monopodial branches and GOT% while negatively correlated with boll weight, staple length and fibre strength. Higher number of monopodial branches per plant may be used to improve number of bolls per plant which may be helpful to improve cotton yield and quality (Ahsan *et al*., 2013). Plant height was significantly correlated with sympodial branches, monopodial branches, number of bolls, staple length and fibre fineness while negatively correlated with fibre strength. Boll weight was significantly correlated with sympodial branches, monopodial branches, plant height, fibre strength, staple length, fibre fineness and boll weight while negatively correlated with number of bolls, first bud days and GOT%. GOT% was positively and significantly correlated with monopodial branches, fibre fineness and number of boll while negatively correlated with sympodial branches, fibre strength and staple length. Significant correlation between monopodial branches per plant and fibre fineness suggested that cotton quality may be improved by selecting on the basis of monopodial branches per plant Khan, 2013; Suinaga,*et al*., 2006 and Wang,*et al*., 2004. Staple length was positively and significantly correlated with sympodial branches, first bud days, plant height and boll weight while negatively correlated with monopodial branches, number of bolls and GOT%. Fibre fineness was positively and significantly correlated with plant height, GOT%, fibre strength and boll weight while negatively correlated with sympodial branches. Fibre strength was positively and significantly correlated with number of nodes to first day flower, fibre fineness and boll weight while negatively correlated with plant height, number of bolls, first bud days and GOT%. Higher boll weight suggested that fibre fineness and yield may be increased on the basis of selecting genotypes for better cotton yield and production Ali, *et al*., 2011b; Amir, *et al*., 2012; Steel, *et al*., 1997 and Wang, *et al*., 2004.

**Figure 1. Mean performance of cotton genotypes for First bud days, nodes to first flower days, sympodial branches, monopodial branches**

**Figure 2. Mean performance of cotton genotypes for Number of bolls, plant height, boll weight, GOT%**

**Figure 3. Mean performance of cotton genotypes for Staple length, fibre fineness, fibre strength**

**Table 1:** **Grading traits of cotton varieties**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ENTRIES** | **Boll size** | **Boll shape** | **Boll opening** | **Maturity** | **Leaf size** |
| FH-207 (1) | large | tapering | good | early | broad |
| FH-207 (22) | large | tapering | good | early | broad |
| FH-207 (28) (YP) | large | round to oval | good | medium | medium |
| Bt-63 (88) | medium | tapering | good | medium | small |
| Bt-79 | medium | oval | very good | early | small to medium |
| Sbne-259m | large | round to oval | good | early | broad |
| Fh4243 Pl-4 | medium | round | good | early | broad |
| Fh4243Spp32(okra) | medium | round | good | medium | narrow |
| Fh941Spp33 | small to medium | round | good | medium | small to medium |
| FH-941spp-46 | medium | round to oval | good | early | broad |
| FH-2015B P-10 | medium | oval | good | early | small to medium |
| FH-2015B P-10 | medium | oval | good | early | small to medium |

**Table 2: Genetic components for various yield component traits of cotton**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Traits** | **Mean sum of square** | **Grand mean** | **Genotypic variance** | **Genotypic coefficient of variance%** | **Phenotypic variance** | **Phenotypic coefficient of variance %** | **Environmental variance** | **Environmental coefficient of variance %** | **Heritability h2bs%** | **Genetic advance%** |
| **1st Bud Days** | 81.6888\* | 29.615 | 27.063 | 95.594 | 27.563 | 96.473 | 0.500 | 12.994 | 98.186 | 126.640 |
| **Node to 1st Flower Days** | 4.5\*\* | 6.667 | 0.961 | 37.969 | 2.578 | 62.182 | 1.617 | 49.244 | 37.284 | 50.300 |
| **Sympodial Branches** | 20.25\* | 22.500 | 5.250 | 48.305 | 9.750 | 65.828 | 4.500 | 44.721 | 53.846 | 63.992 |
| **Monopodial Braches** | 0.49167\*\* | 1.083 | 0.164 | 38.856 | 0.165 | 38.975 | 0.001 | 3.038 | 99.392 | 51.475 |
| **Number of Bolls** | 168.442\* | 29.583 | 55.366 | 136.804 | 57.711 | 139.671 | 2.345 | 28.155 | 95.937 | 181.233 |
| **Plant Height cm** | 625.242\* | 157.08 | 204.247 | 114.030 | 216.747 | 117.467 | 12.500 | 28.209 | 94.233 | 151.062 |
| **Boll Weight** | 0.40083\*\* | 4.098 | 0.129 | 17.727 | 0.143 | 18.695 | 0.014 | 5.938 | 89.912 | 23.485 |
| **GOT℅** | 12.4167\* | 36.333 | 3.306 | 30.163 | 5.806 | 39.973 | 2.500 | 26.231 | 56.938 | 39.959 |
| **Staple length (mm)** | 0.26667\*\* | 28.333 | 0.089 | 5.600 | 0.089 | 5.603 | 0.0001 | 0.188 | 99.888 | 7.419 |
| **Fibre fineness (µg/inch** | 0.11217\*\* | 4.533 | 0.022 | 7.028 | 0.067 | 12.192 | 0.045 | 9.963 | 33.225 | 9.310 |
| **Fibre strength(tppsi)** | 50\* | 95.075 | 14.275 | 38.748 | 21.451 | 47.500 | 7.176 | 27.474 | 66.545 | 51.332 |

**Table 3: Correlation among various** **yield component traits of cotton**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Traits** | **1st Bud Days** | **Node to 1st Flower Days** | **Sympodial Branches** | **Monopodial Braches** | **Number of Bolls** | **Plant Height** | **Boll Weight** | **GOT** | **Staple length** | **Fibre fineness** |
| **Node to 1st Flower Days** | -0.254\*\* |  |  |  |  |  |  |  |  |  |
| **Sympodial Branches** | 0.1605\*\* | 0.0917 |  |  |  |  |  |  |  |  |
| **Monopodial Braches** | -0.6509\* | 0.4299\* | 0.1411\*\* |  |  |  |  |  |  |  |
| **Number of Bolls** | 0.1728\*\* | 0.3967\* | 0.2005\*\* | 0.5443\* |  |  |  |  |  |  |
| **Plant Height** | -0.0912 | -0.1102 | 0.7451\* | 0.2331\*\* | 0.1474\*\* |  |  |  |  |  |
| **Boll Weight** | -0.5786\* | 0.0497 | 0.2942\*\* | 0.2342\*\* | -0.3227\* | 0.3518\* |  |  |  |  |
| **GOT** | 0.0001 | -0.0905 | -0.4351\* | 0.2651\*\* | 0.2631\*\* | -0.0059 | -0.3667\* |  |  |  |
| **Staple length** | 0.1768\*\* | -0.0898 | 0.5108\* | -0.3682\* | -0.2688\*\* | 0.6396\* | 0.3837\* | -0.18\*\* |  |  |
| **Fibre fineness** | 0.0535 | 0.0068 | -0.1673\*\* | 0.0278 | -0.0406 | 0.1142\*\* | 0.579\* | 0.6502\* | -0.0189 |  |
| **Fibre strength(tppsi)** | -0.3008\* | 0.6083\* | -0.1151 | -0.0167 | -0.1948\*\* | -0.3204\*\* | 0.3079\*\* | -0.5194\* | -0.0236 | 0.3692\* |

\* = Significant at 1% level, \*\* = Significant at 5% level

**Table 4. Significant mean differences for various yield components traits of cotton**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **1st buds Days** | **Node to 1st Flower Days** | **Sympodial Branches** | **Monopodial Braches** | **No of Bolls** |
| Bt-63 (88) 93.410DE | FH-207 (1) 9.0100 A | Fh941Spp33 29.010 A | Bt-63 (88) 2.0100 A | FH-207 (28 53.010 A |
| Bt-79 85.110 | Bt-63 (88) 8.0100 AB | FH-941spp- 27.010 AB | FH-207 (1) 2.0100 A | Bt-63 (88) 46.010 AB |
| FH-2015B P 95.210D | Fh4243 Pl- 8.0100 AB | Sbne-259m 26.010 AB | FH-207 (28 2.0100 A | Bt-79 40.010 BC |
| FH-207 (1) 102.61A | FH-207 (28 7.0100 AB | FH-207 (22 25.010 BC | Bt-79 1.0100 B | Fh4243 Pl- 38.010 BC |
| FH-207 (22 95.810D | Fh941Spp33 7.0100 AB | FH-207 (28 25.010 BC | FH-207 (22 1.0100 B | FH-207 (1) 31.010 CD |
| FH-207 (28 93.710DE | FH-2015B P 6.5100 AB | Bt-63 (88) 24.010 BCD | FH-941spp- 1.0100 B | FH-941spp- 29.010 CDE |
| FH-941spp- 95.510D | FH-207 (22 6.0100 AB | Fh4243 Pl- 22.010 CDE | Fh4243 Pl- 1.0100 B | Fh4243Spp3 25.010 DEF |
| Fh4243 Pl- 94.910DE | FH-941spp- 6.0100 AB | FH-207 (1) 21.010 DEF | Sbne-259m 1.0100 B | Fh941Spp33 25.010 DEF |
| Fh4243Spp3 100.51B | Fh4243Spp3 6.0100 AB | Bt-79 20.010 EF | FH-2015B P 1.0100 B | Sbne-259m 19.010 EF |
| Fh941Spp33 94.710DE | Bt-79 5.0100 B | FH-2015B P 18.510 F | Fh4243Spp3 0.0100 C | FH-207 (22 18.010 EF |
| Sbne-259m 94.310DE | Sbne-259m 5.0100 B | Fh4243Spp3 14.010 G | Fh941Spp33 0.0100 C | FH-2015B P 15.510 F |
| **Plant Height cm** | **Boll Weight** | **GOT℅** | **Staple length (mm)** | **Fibre fineness (µg/inch** | **Fibre strength(tppsi)** |
| Sbne-259m 191.01A | FH-207 (22 5.3500 A | Bt-63 (88) 42.010 A | FH-207 (22 29.010A | Bt-63 (88) 5.0100 A | Bt-63 (88) 94.430D |
| FH-207 (22 182.01B | FH-207 (1) 5.1100 B | Bt-79 41.010 A | Fh4243 Pl- 29.010A | Fh4243 Pl- 5.0100 A | Bt-79 86.130E |
| Fh4243 Pl- 182.01B | Sbne-259m 4.7400 C | Fh4243 Pl- 39.010 AB | Fh941Spp33 29.010A | FH-2015B P 4.8600 A | FH-2015B P 96.230C |
| FH-941spp- 175.01C | Fh941Spp33 3.9600 D | FH-2015B P 37.510 BC | Sbne-259m 29.010A | Bt-79 4.5100B | FH-207 (1) 103.63A |
| Bt-63 (88) 167.01D | FH-207 (28 3.9000 D | Sbne-259m 37.010 BCD | Bt-63 (88) 28.010B | FH-941spp- 4.5100B | FH-207 (22 96.830C |
| Bt-79 156.01E | FH-941spp- 3.8600 D | Fh4243Spp3 36.010 BCD | Bt-79 28.010B | Sbne-259m 4.5100B | FH-207 (28 94.730E |
| Fh941Spp33 156.01E | FH-2015B P 3.8450 D | FH-207 (28 35.010 CDE | FH-2015B P 28.010B | Fh941Spp33 4.4100BC | FH-941spp- 96.530C |
| FH-207 (28 155.01E | Bt-79 3.8300 DE | FH-207 (1) 34.010 DEF | FH-207 (1) 28.010B | Fh4243Spp3 4.3100BC | Fh4243 Pl- 95.930D |
| FH-207 (1) 143.01F | Bt-63 (88) 3.6600 EF | FH-207 (22 34.010 DEF | FH-207 (28 28.010B | FH-207 (22 4.2100BC | Fh4243Spp3 101.53B |
| FH-2015B P 133.51G | Fh4243 Pl- 3.6400 F | Fh941Spp33 32.010 EF | FH-941spp- 28.010B | FH-207 (28 4.2100BC | Fh941Spp33 95.730D |
| Fh4243Spp3 111.01H | Fh4243Spp3 3.5600 F | FH-941spp- 31.010 F | Fh4243Spp3 28.010B | FH-207 (1) 4.1100C | Sbne-259m 95.330D |

**Conclusions**

It was concluded that genetic variability in cotton for various traits may be used for the development of higher yielding cotton varieties. Higher heritability, genetic advance indicated that selection may be useful for the enhancement of yield and quality of cotton *(Gossypium hirsutum* L.). Signifiacnt ccorrelation among sympodial branches, plant height, staple length and GOT% suggested that theses traits may be helpful to develop higher yielding cotton genotypes.

**Authors’ contributions**

This work was carried out in collaboration between all authors. “Authors QA and HGA’ designed the study, QA wrote the first draft of the manuscript. ‘Authors ‘AM’ SM, NHK’ and ‘MW’ managed the literature search. All authors read and approved the final manuscript.”

Original Research Article

Corresponding E-mail: saim1692@gmail.com

**Reference**

1. Abbas, H.G., A. Mahmood and Q. Ali. 2013. Genetic variability, heritability, genetic advance and correlation studies in cotton *(Gossypium hirsutum* L.). Int. Res. J. Microbiol. 4(6): 156-161.
2. Ahsan, M., A. Farooq, I. Khaliq, Q. Ali, M. Aslam and M. Kashif. 2013. Inheritance of various yield contributing traits in maize (Zea mays L.) at low moisture condition. African J. Agri. Res. 8(4): 413-420.
3. Ali, Q. and M. Ahsan, 2011a. Estimation of Variability and correlation analysis for quantitative traits in chickpea (Cicer arietinum L.). IJAVMS, 5(2): 194-200.
4. Ali, Q., M. Ahsan, F. Ali, M. Aslam, N.H. Khan, M. Manzoor, H.S.B. Mustafaa and S. Muhammad. (2013a). Heritability, heterosis and heterobeltiosis studies for morphological traits of maize (*Zea* *mays* L.) seedlings. Adv. life Sci., 1(1): 52-63.
5. Ali, Q., M. Ahsan, M.H.N. Tahir and S.M.A. Basra. 2012. Genetic evaluation of maize (Zea mays L.) accessions for growth related seedling traits. IJAVMS, 6(3): 164-172.
6. Ali, Q., M. Elahi, M. Ahsan, M.H.N. Tahir and S.M.A. Basra. 2011b. Genetic evaluation of maize (Zea mays L.) genotypes at seedling stage under moisture stress. IJAVMS, 5(2):184-193.
7. Amin W., Saif-ul-malook, S. ashraf and Amir Bibi. 2014b. A review of screening and conventional breeding under different seed priming conditions in sunflower (*Helianthus annus* L.) Nature and Science, 12: 23- 37.
8. Amin,W., Saif-ul-malook, A. Mumtaz, S. ashraf, H. M. ahmad, K. Hafeez, M. Sajjad and A. Bibi. 2014a. Combining ability analysis and effect of seed priming on seedling traits in Sunflower (Helianthus annus). Report and Opinion, 6: 19-30.
9. Amir, S., J. Farooq, A. Bibi, S.H. Khan and M.F. Saleem. 2012. Genetic studies of earliness in Gossypium hirsutum L. IJAVM S, 6 (3):189-207.
10. Anonymous (2011-12). Pak. Econ. Survey, Ministry of Finance, Govt. of Pakistan.
11. Batool, S., N.U. Khan, K. Makhdoom, Z. Bibi, G. Hassan, K.B. Marwat, Farhatullah, M., F. Raziuddin and I.A. Khan. 2010. Heritability and genetic potential of upland cotton genotypes for morpho-yield traits. Pak. J. Bot., 42(2):1057-1064.
12. Falconer, D.S. 1989. Introduction to Quantitative Genetics. 3rd Ed. Logman Scientific and Technical, Logman House, Burnt Mill, Harlow, Essex, England.
13. Farooq, J., M. Anwar, M. Riaz, A. Mahmood, A. Farooq and M.S. Iqbal. 2013. Association and path analysis of earliness, yield and fiber related traits under cotton leaf curl virus (CLCuV) intensive conditions in *Gossypium hirsutum* L. Plant Knowledge Journal. 2(1): 43-50.
14. Iqbal, M., M.A. Chang, M.Z. Iqbal, M.U. Hassan, M. Nasir and N.U. Islam 2003. Correlation and path coefficient analysis of earliness and agronomic characters of upland cotton in Multan. Pak. J. Agron. 2(3): 160-168.
15. Khan, N.U. 2003. Genetic analysis, combining ability and heterotic studies for yield, its components, fibre and oil quality traits in upland cotton *(G. hirsutum* L*.).* Ph.D Dissert. Sindh Agric. Univ. Tandojam, Pakistan.
16. Khan, N.U., G. Hassan, M.B. Kumbhar, S. Kang, I. Khan, A. Parveen, U. Aiman and M. Saeed. 2007. Heterosis and inbreeding depression and mean performance in segregating generations in upland cotton. Europ. J. Scient. Res. 17:531-546.
17. Kwon, S.H. and J.H. Torrie. 1964. Heritability and interrelationship of two soybean (*Glycine max* L.) populations. Crop Sci. 4: 196-198.
18. Meena, R.A., D. Monga and R. Kumar. 2007. Undescriptive cotton cultivars of north zone: an evaluation. J. Cotton Res. Dev. 21(1):21-23.
19. Saif-ul-malook, M. Ahsan, Q. Ali and A. mumtaz. 2014a. Genetic variability of maize genotypes under water stress and normal conditions. Researcher, 6: 31 – 37.
20. Saif-ul-malook, M. Ahsan, Q. Ali, A. mumtaz. 2014b. Inheritance of yield related traits in maize under normal and drought condition. Nature and Science, 12: 36 – 49.
21. Saif-ul-malook, Q.Ali, A. Shakeel, M. Sajjad and I. Bashir. 2014c. Genetic variability and correlation among various morphological traits in students of UAF, Punjab Pakistan. 2014. International Journal of Advances in Case Reports, 1:1-4.
22. Saif-ul-malook, Qurban ali, Muhammad Ahsan and Aamer Mumtaz. 2014d. An overview of conventional breeding for drought tolerance in *Zea* *mays*. Nature and Science, 12: 7-22.
23. Steel,R.G.D., J.H. Torrie and D.K. Dicky. 1997. Principles and procedures of Statistics. A Biometrical Approach 3rd Ed. McGraw Hill Book Co. Inc. New Yark, pp: 400-428.
24. Suinaga, F.A., C.S. Bastos and L.E.P. Rangel. 2006. Phenotypic adaptability and stability of cotton cultivars in Mato Grosso State, Brazil. Pesquisa Agropecuaria Trop. (PAT). 36(3):145-150.
25. Taohua, Z. and Z. Haipeng, 2006. Comparative study on yield and main agri-characters of five hybrids coloured cotton varieties. J. Anhui Agric.Univ. 33(4):533-536.
26. Wang, C., A. Isoda and P. Wang. 2004. Growth and yield Performance of some cotton cultivars in Xinjiang, China, an arid area with short growing period. J. Agron. Crop Sci.190 (3):177–183.

9/21/2014