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Research Article

Fiber Quality Studies with Respect to Different Cotton Insect Pests using Multivariate Analysis

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Abstract | Fifteen cotton genotypes were exploited to study the impact of insect pests on different fiber quality traits. The ANOVA results depicted considerable variation in almost all traits. Fiber length was greatly influenced by the population of thrips, jassid, whitefly, pink bollworm and dusky cotton bug. Fiber fineness was influenced by the population of jassid, pink bollworm and dusky cotton bug while fiber strength was slightly affected by the population of thrips. The advance lines of cotton viz. FH-404, FH-490, FH-152, FH-450, FH-457 and FH-313 having tolerance against insect pests, showed good fiber quality traits. To determine effective management approaches, additional work can be performed to recognize the impact of pests species on fiber quality by controlling certain pests.

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Introduction

Cotton (*Gossypium hirsutum*) is a widely studied crop and is grown mainly for its fiber. The quality and uniformity of the fiber are vital to its marketability and destined end-use (Jarvis, 2001). Being chief cash crop, and the lifeline of textile industry, it occupies a commendable location in the economy of Pakistan (Karar *et al*., 2016). Quality production of cotton is a dire need to fulfill fiber demands of the world's ever-increasing population (Farooq *et al*., 2013). Both biotic and abiotic stresses result in quality and yield reduction of agricultural commodities. While considering biotic stresses, insect pests pressure results in major crop losses ranging from 20-40% (Karar *et al*., 2016). Potential and real losses for wheat and cotton due to insect pests ranged between 50 to 80 %, respectively (Oerke, 2006). The sucking pests on cotton pose a major threat to the crop as the prevalence of most of the lepidopterous pests has been managed by the induction of transgenic genotypes of different crops (Kranthi *et al*., 2005). The sucking insect pests suck sap from tender parts of the plant and ultimately reduces the plant vigor. The unattended damage above threshold level may results in wilting and shedding of leaves (Abro *et al*., 2004). Thrips, jassid, whitefly and dusky cotton bug may cause 40–50% loss to cotton crop. (Amjad and Aheer, 2007). Screening of germplasm for insect pests of cotton and identification of good quality plays a key role to increase production and quality (Shahid *et al*., 2015).

Correlation is an important tool to examine the

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association between various factors contributing to fiber quality and insect pests populations. Correlation deals with the improvement in respect of one character at the expense of others. The increased value in the ginning percentage may result in the reduction of staple length and vice versa (Salahuddin *et al*., 2010).

Among multivariate techniques principal component analysis analyze data in such a way that observations are defined by various correlated dependent variables. Using this approach is aimed at extracting useful knowledge from the data and describing it as specific orthogonal variables called principal components. The sequence of the measurements and variables being identical is shown as points in maps (Abdi and Willams, 2010).

The present study of correlation and principal component analysis involves 15 genotypes of cotton to study the interrelationship between fiber quality traits and insect pests population which could be used as selection criteria in the breeding program aimed at the development of varieties having tolerance against sucking and lepidopterous insect pests.

Materials and Methods

Location of study and plant materials

To study the effect of insect pests incidence on fiber quality, a study was conducted on transgenic strains of cotton. For this purpose, 14 genotypes viz. FH-488, FH-342, FH-313, FH-404, FH-490, FH-152, FH-450, FH-451, FH-452, FH-453, FH-455, FH-456, FH-457 and FH-168 along with one check variety FH-142 were cultivated on 15th May 2019-20 at Cotton Research Station Faisalabad which is located at 31°41 N latitude and 73° 12 E longitude and of 175 meters elevation. The experiment was laid with three replications using a randomized complete block configuration (RCBD). Each treatment was a plot of 4.545 m length and 3.03 m width, consisting of 4 rows 75 cm apart. The spacing between plants was 45 cm. Normal agronomic and cultural procedures (applications for drainage, weeding, hoeing, and fertilizer) were implemented universally. Genotypes consisted of

Data on the population of sucking insect pests

The sucking pests' populations were monitored at weekly intervals selected from 20 leaves of 20 plants. The pest population was recorded by randomly selecting leaves from the upper, middle and lower parts of each plant (Amjad and Aheer, 2007).

Data on population of pink bollworms

The larval population in the leftover bolls was counted from each plot by picking up the entire leftover bolls and was kept in the laboratory for 3-4 days. The bolls were opened with a knife during this time and counted the larvae of pink bollworms. The following equation measured the percentage of larval damage:

$$\%\ Damage = Infested\ bolls\ /\ Total\ bolls \times 100$$

Data on population of dusky cotton bug

The population of the dusky bug was monitored by counting the number of immature as well as adults by randomly selecting 5 plants from each plot. The crop was monitored at weekly intervals throughout the cropping period (Sanghi *et al*., 2014; Qayyoum *et al*., 2014).

Fiber characteristics

The seed cotton was carefully picked at full maturation of the crop and left to dry under the shine of the sun. After that, sampling was done from each genotype for assessing the fiber quality parameters. Experimental small ginning machine ginned these samples. The USTER®-HVI 1000 was used to assess the fiber quality parameters (Sasser, 1981).

Statistical analysis

Using Minitab 17 and STATISTICA 8.1 statistical software packages, the mean value of all the attributes were compared for basic statistics and PCA (Sneath and Sokal, 1973). The first two PCs were graphed to find out the variability sequence among tested genotypes and association between them using Minitab 17.

Principal components analysis (PCA)

The data obtained from the 15 genotypes were investigated by using principal component analysis multivariate technique. This approach is based on the criterion of eigenvalue also known as the Kaiser criterion (Kaiser, 1960). Every component of lesser than 1.00 Eigenvalue was trimmed while components with greater than 1.00 Eigenvalue were used for interpretation. Thus, principal components with eigenvalue > 1 were used for further analyses. Important traits in each principal component were determined from the associated Eigenvectors.

Results and Discussion

Correlation studies

Mean performance and phenotypic correlations of the tested traits are demonstrated in Tables 1 and 2 respectively. The dusky cotton bug had a strong negative correlation with fiber length. Fiber fineness is also negatively correlated with the population of dusky cotton bug (as fiber fineness increases when its value decreases). Important genotypical and phenotypical correlations were assessed in the present studies. These results are at par with the findings of Desalegn *et al.* (2009), who reported the primary function of the genetic impact.

It is evident from Table 2 that fiber length has strong negative correlation with thrips, jassid, whitefly, pink bollworm and dusky cotton bug. Fiber strength has negative correlation with thrips. Fiber fineness has negative correlation with jassid, pink bollworm and dusky cotton bug. Similar findings were observed by (Shahid *et al.*, 2015), who reported that the varieties having relative resistance against insect pests showed good fiber length and strength. Seburuang *et al.* (2011) reported that jassid tolerant cotton genotypes have good fiber quality. Bo (1992) observed the reduction in cotton yield and quality due to attack of 145 different species of insect pests. Jarvis (2001) also stated that pests damage causes stained, damaged seed cotton and weak immature fibers.

Table 1: *Mean performance of 15 genotypes/ strains in terms of fiber length, fiber strength, fiber fineness, whitefly, jassid, pink bollworm and dusky cotton bug.*

Genotype	Fiber length (mm)	Fiber strength (g/tex)	Fiber fineness (mic)	Thrips	Jassid	Whitefly	Pink boll worm	Dusky cotton bug
FH-152	28.44	31.5	4.13	9.50	1.20	5.15	1.30	16.00
FH-342	26.81	31.2	4.50	10.50	3.50	11.25	3.75	22.00
FH-455	25.86	28.1	4.50	15.00	4.16	12.50	3.75	47.00
FH-490	28.11	29.2	4.62	8.50	1.10	4.25	1.50	17.00
FH-451	25.89	24.3	4.70	15.50	4.55	12.50	4.25	41.00
FH-452	26.87	29.6	4.70	14.00	3.95	11.50	3.50	36.00
FH-450	28.82	30.0	4.71	9.50	1.15	3.75	0.80	14.00
FH-142*	26.88	26.7	4.74	10.50	3.50	7.25	4.00	35.00
FH-457	27.25	28.6	4.75	12.00	2.50	5.25	2.50	21.00
FH-404	28.16	27.5	4.94	9.00	0.90	3.50	1.20	15.00
FH-168	27.24	27.9	5.00	15.10	4.95	11.35	6.40	49.00
FH-313	27.71	32.3	5.08	9.00	4.75	9.75	5.95	55.00
FH-453	27.85	27.5	5.23	15.00	4.25	9.35	5.25	52.00
FH-488	25.22	29.6	5.25	16.00	5.45	13.00	6.75	55.00
FH-456	25.86	24.5	5.40	16.20	5.15	12.70	6.50	53.00

Table 2: *Correlation of fiber length, fiber strength, fiber fineness, whitefly, jassid, pink bollworm and dusky cotton bug.*

Traits	Fiber length (mm)	Fiber strength (g/tex)	Fiber fineness (µg/inch)	Thrips	Jassid	Whitefly	Pink B.W.
Fiber strength(g/tex)	0.446						
Fiber fineness (µg/inch)	-0.308	-0.376					
Thrips	0.765*	-0.570*	0.467				
Jassid	0.772*	-0.286	0.575*	0.784*			
Whitefly	-0.841**	-0.263	0.352	0.806**	0.927**		
Pink B.W.	-0.662*	-0.244	0.701*	0.696*	0.958**	0.825**	
Dusky	-0.635*	-0.278	0.667*	0.729*	0.936	0.813**	0.938**

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Principal components analysis

Results from the principal component analysis for insects and fiber quality traits are presented in Table 3. Eigenvalues and variances associated with each principal axis were extracted by principal component analysis. Two out of the eight principal components (PC) extracted were selected and altogether explained 82.5% of the total variation among the 15 cotton genotypes and were thus considered for further analyses. Eigenvectors of Principal Components for 08 characters in 15 cotton genotypes are shown in Table 4. Principal component 1 contributed 69.8%, to the entire variability. This variation was solely attributed to the population of the jassid, followed by pink bollworm, dusky cotton bug, whitefly, thrips and fiber length. The PC-2 contributed 12.6% to the accumulative variability and was usually expressed in fiber strength. The PC-3 contributed 11.1% to the variability and was mainly credited to fiber fineness. Principal component 4 described an additional contribution of 2.7% in the variation, elucidated the difference in the fiber length.

Table 3: *Principle component analysis for fiber traits and insect pests in cotton.*

Variable	PC I	PC II
Eigen value	5.584	1.0118
% of total variance	69.8	12.6
Cumulative variance %	69.8	82.5

As it is depicted in biplot and score plot, the genotypes FH-404, FH-490, FH-152 and FH-450 have good potential for fiber length and resistance against thrips, jassid, whitefly, dusky cotton bug and pink bollworm (Figures 1 and 2). The genotypes FH-152, FH-342, FH-455, FH-490, FH-452, FH-142, FH-451 and FH-457 have good potential for fiber fineness while the genotypes FH-313, FH-152, FH-342 and FH-450 have good potential for fiber strength and resistance against thrips. It was also depicted in biplot that fiber length and fineness is negatively correlated with the population of sucking insect pests and pinkbollworm. Similar findings were observed by (Karar *et al*., 2016), who has confirmed that sucking pest-resistant genotypes have the highest staple length. A significant decrease of the staple length of various cultivars can result from an attack by insect pests (Shahid *et al*., 2015) as sucking pests usually suck the phloem that further affects the plant's photosynthesis and eventually leads to early defoliation (Wells, 2001). The findings obtained using the study of the principle components produced excellent knowledge that could be used to obtain genotypes that could be used in future breeding programs.

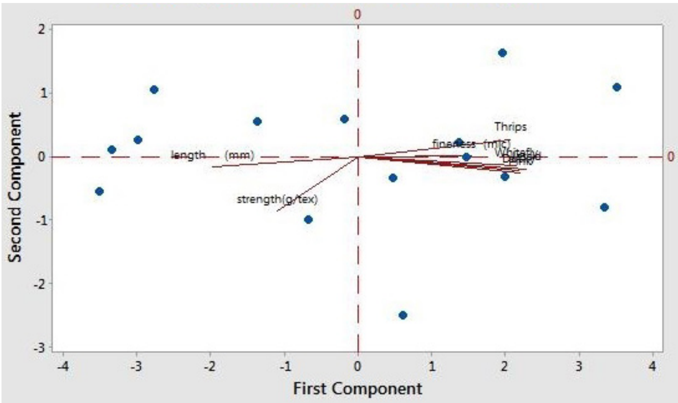

Figure 1: *Biplot of fiber quality traits and insect pests.*

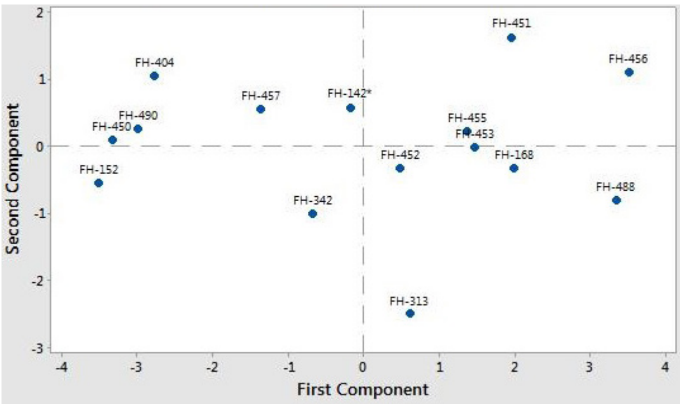

Figure 2: *Scope plot of fiber quality traits and insect.*

Table 4: *Factor loadings by various traits.*

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Fiber length(mm)	-0.35	-0.167	0.423	-0.724	-0.175	-0.332	-0.07	0.03
Fiber strength(g/tex)	-0.195	-0.85	-0.15	0.045	0.45	0.104	0.026	0.019
Fiber fineness(μg/inch)	0.276	0.006	0.768	0.306	0.4	-0.139	-0.242	0.053
Thrips	0.371	0.267	-0.159	-0.551	0.635	0.092	0.224	-0.011
Jassid	0.41	-0.199	-0.054	-0.037	-0.218	-0.165	0.157	0.83
Whitefly	0.385	-0.136	-0.36	-0.061	-0.033	-0.547	-0.578	-0.256
Pink Bollworm	0.395	-0.264	0.167	0.043	-0.244	-0.216	0.644	-0.474
Dusky Cotton Bug	0.392	-0.223	0.156	-0.263	-0.309	0.692	-0.335	-0.129

Conclusions and Recommendations

The genotypes having tolerance against insect pests showed good fiber quality traits. Therefore, it was concluded that fiber quality may be improved by minimizing the attack of sucking insect pests and pink bollworm on cotton genotypes. The information provided by different principal components can be utilized in future breeding strategies for fiber quality improvement.

Novelty Statement

Quality production of cotton is a dire need to fulfill fiber demands of different stake holders. Pink bollworm and sucking pests play a vital role in fiber quality deterioration. So, development of genotypes having tolerance against insect pests may be focused to obtain good fiber quality traits.

Author's Contribution

Ghulam Sarwar supervised the study and gave technical input. Muhammad Rizwan conducted the experiment, collected data and performed the statistical analysis. Jehanzeb Farooq managed crop in the field, helped in write-up and did overall management of article, Muhammad Farooq collected data of insect population, Hafiz Ghazanfar Abbas helped in data collection, Farrukh Ilahi helped in data analysis. Muhammad Asif collected literature.

Conflict of interest

The authors have declared no conflict of interest.

References

Abdi, H., and L.J. Williams. 2010. Principal component analysis. John Wiley and Sons, Inc. WIREs Comp Stat., 2: 433-459. https://doi.org/10.1002/wics.101

Abro, G.H., T.S. Syed, G.M. Tunio and M.A. Khuhro. 2004. Performance of transgenic bt cotton against insect pest infestation. J. Biotech., 3: 75-81. https://doi.org/10.3923/biotech.2004.75.81

Amjad, A. and G.M., Aheer. 2007. Varietal resistance against sucking insect pests of cotton under Bahawalpur ecological conditions. J. Agric. Res., 45: 205-208.

BO, B.Y., 1992. IPM on cotton in Asia and the Pacific region. Pak. Cottons, 36: 87-100.

Desalegn, Z., N. Ratanadilok and R. Kaveeta. 2009. Correlation and Heritability for yield and fiber quality parameters of ethiopian cotton (*Gossypium hirsutum* L.) estimated from 15 (diallel) Crosses. Kasetsart J. Nat. Sci., 43(1): 1-11.

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 *G. hirsutum* L. Plant Knowl. J., 2(1): 43-50.

Jarvis, R., 2001. Impact of seed quality and crop management practices on fiber quality. ICAC 60th Plenary Meeting, Technical Seminar Victoria Falls.

Kaiser, H.F., 1960. The application of electronic computers to factor analysis. Educ. Psychol. Meas., 20: 141–151. https://doi.org/10.1177/001316446002000116

Karar, H., M. Shahid and S. Ahmad. 2016. Evaluation of innovative cotton genotypes against insect pest prevalence, fiber trait, economic yield and virus incidence in Pakistan. Cercetări Agronomice în Moldova. 1(165): 29-39. https://doi.org/10.1515/cerce-2016-0003

Kranthi, K.R., C.S. Dhawad, S. Naidu, K. Mate, E. Patil and S. Kranthi. 2005. Bt cotton seed as a source of *Bacillus thuringiensis* insecticidal Cry1Ac toxin for bioassays to detect and monitor bollworm resistance to Bt-cotton. Curr. Sci., 88: 796800.

Oerke, E.C., 2006. Crop losses to pests. J. Agric. Sci., 144(10): 31-43. https://doi.org/10.1017/S0021859605005708

Qayyoum, M.A., B.S. Khan, N.A. Khan, A. Ghafar, M.H. Bashir. 2014. Effect of abiotic factors on population dynamics of dusky cotton bug, *Oxycarenuslaetus* (kirby), (Hemiptera: Lygaeidae) on cotton and its relationship with ginning factory areas. Int. J. Agric. Appl. Sci., 6(1): 22-25.

Sanghi, A.H., M. Aslam and L. Khalid. 2014. Efficacy of different insecticides against dusky cotton bug Oxycarenus Hyalinipennis (Hemiptera: Lygaeidae) in ecological zone of Rahim Yar Khan. Int. J. Compr. Res. Biol. Sci., 1(1): 49-54.

Sasser, P.E., 1981. The basics of high volume instrumentation for fiber testing. Proc. Beltwide

Cotton Prod. Res. Conf., New Orleans, LA 4-8 Jan., Natl. Cotton Counc. Am., Memphis, TN. pp. 191-193.

Salahuddin S., S. Abro, M.M. Kandhro, L. Salahuddin and S. Laghari. 2010. Correlation and Path Coefficient Analysis of Yield Components of Upland Cotton (*Gossypium hirsutum L.*) Sympodial. World Appl. Sci. J., 8: 71-75.

Seburuang, P., W. Sirichumpan, P. Nakapan, S. Thaitad, S. Lapbunjob, A. Traisiri, N.T. Khumla, S. Areerak, S.A. Juttupornpong, N. Panlai, A. Kasivivat, P. Sangsoda, R. Chuekittisak, B. Kumseub, P. Pulcha and K. Khockakang. 2011. Tak FA84-4: New Jassid Tolerant cotton variety. World Cotton Res. Conf. 5, Renaissance Conv. Centre, Mumbai. 7-11 Nov. pp. 89-91.

Shahid, M.R., J. Farooq, A. Mahmood, M.S. Iqbal, K. Mahmood and H.G. Abbas. 2015. Economic yield, fiber trait and sucking insect pest incidence on advanced genotypes of cotton in Pakistan. Cercetări Agronomiceîn Moldova. 1(161): 51-56. https://doi.org/10.1515/cerce-2015-0016

Sneath, P.H.A. and R.R. Sokal. 1973. Numerical taxonomy: the principles and practice of numerical classification. W. F. Free-Man and Co., San Francisco. pp. 573.

Wells, R., 2001. Leaf pigment and canopy photosynthetic response to early flower removal in cotton. Crop Sci., 41: 1522-1529. https://doi.org/10.2135/cropsci2001.4151522x