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HERITABILITY AND GENETIC POTENTIAL OF UPLAND COTTON GENOTYPES FOR MORPHO-YIELD TRAITS

SUNDAS BATOOL[1*], NAQIB ULLAH KHAN[1], KHADIJAH MAKHDOOM[1], ZARINA BIBI[2], GUL HASSAN[3], KHAN BAHADAR MARWAT[3], FARHATULLAH[1], FIDA MOHAMMAD[1], RAZIUDDIN[1] AND IJAZ AHMAD KHAN[3]

[1]*Department of Plant Breeding and Genetics, NWFP Agricultural University Peshawar, Pakistan.*
[2]*Department of Soil and Environmental Sciences, Agricultural Faculty, Gomal University, Dera Ismail Khan, Pakistan.*
[3]*Department of Weed Science, NWFP Agricultural University Peshawar, Pakistan.*

Abstract

The studies determining genetic variability and heritability in upland cotton were carried out in a randomized complete block (RCB) design with three replications during 2008 at the NWFP Agricultural University Peshawar, Pakistan. The breeding material comprised of eight *Gossypium hirsutum* cultivars viz., SLH-284, CIM-446, CIM-473, CIM-496, CIM-499, CIM-506, CIM-554 and CIM-707. The cultivars manifested highly significant differences ($p \leq 0.01$) for plant height, monopodia and sympodia plant^{-1} and seed cotton yield plant^{-1}, while merely significant ($p \leq 0.05$) for days to first flowering and boll weight. However, first internode length showed non-significant variation among the cultivars. The cultivar CIM-506 was found top promising by having maximum seed cotton yield plant^{-1}, sympodia plant^{-1}, short stature plants, and medium early maturity and boll weight as compared to other seven cultivars. The cultivars CIM-707 and CIM-554 also showed comparable yield contributing traits and seed cotton yield. The heritability broad sense (bs) was high for the traits days to first flowering (0.96), plant height (0.95), monopodia plant^{-1} (0.88), sympodia plant^{-1} (0.89), boll weight (0.97) and seed cotton yield plant^{-1} (0.91) while first internode length (0.36) revealed low heritability. For majority of the traits the genetic variances were also greater than environmental variances and were found high heritable. Therefore, the said breeding material has the room for further improvement of morpho-yield traits and can safely be used in future breeding programmes.

Introduction

Cotton (*Gossypium hirsutum* L.) being a major cash and industrial crop of Pakistan plays a key role in the boosting of national economy. It earns 45-60% foreign exchange depending upon the production and consumption. Besides earning huge amount of foreign exchange through its export, also providing fiber for inland textile industry. Apart from the great economic importance of cotton as a fibre crop, its share in edible oil is obvious from the fact that it contributes 65-70% to the local edible oil industry and feed (seed cake) for animals consumption (Khan *et al*., 2000; Khan, 2003; Khan *et al*., 2007a).

Healthy cotton crop is a symbol of prosperity and strength for a nation. Pakistan is the fourth largest producer of cotton but our yield per unit area is still low due to multifarious factors like cotton leaf curl virus (CLCuV), pest attack, rains and floods as compared to other cotton growing countries (Khan *et al*., 2009a, 2009b). Cotton is grown on 12% of the total cultivated area in Pakistan. During 2007-08, cotton crop was grown on 3.054 million hectares and seed cotton production was 11.655 million bales with average seed cotton yield of 649 kg ha^{-1} (Anon., 2008). Cotton is considered as very sensitive and care needing crop. The cotton species and cultivars performance varies with location and mainly depending upon the environmental conditions.

*E-mail: sundasbatool@yahoo.com, Phone: +92-346-901-9112, Fax No: +92-91-921-6520

Heritability and the genetic potential studies of different cultivars in form of their expression for different morpho-yield traits were earnestly needed for selection of parental lines for breeding programme (Badr, 2003; Khan, 2003, Khan *et al*., 2010). The yield is highly complex character and is directly influenced by the different morphological and yield contributing traits. Knowledge about the genetic potential of different genotypes and inheritance of the morphological and yield traits is indispensable for the breeders to tackle with the problems of low yield (Ahmad *et al*., 2008; Khan *et al*., 2009a). Substantial genetic variances and high heritability estimates implied that characters could be improved through selection from segregating populations (Baloch, 2004; Khan *et al*., 2000, Khan *et al*., 2009b). Heritability estimates (broad/narrow sense) were generally found to be high in magnitudes in intraspecific crosses of *Gossypium hirsutum* comparative to *Gossypium barbadense* crosses except for days to first flower and lint percentage (Esmail, 2007; Khan *et al*., 2010). Genetic variability for seed cotton yield was also reported by Terziev *et al*., (1996) Abouzaid *et al*., (1997), Khan (2003) and Khan *et al*., (2009a, 2009b).

Copur (2006) determined the yield, its components and morphological traits of *Gossypium hirsutum* cultivars and observed significant variability. Soomro *et al*., (2005) also studied the seed cotton yield in upland cotton cultivars and found that the cultivars showed significant differences for yield of first pick and last pick. Khan *et al*., (2007b) also evaluated different *G. hirsutum* varieties for yield and other economic characters and observed significant variations for morphological and yield related traits. Therefore, a research project was planned to study the heritability broad sense (bs) and genetic potential in eight different *G. hirsutum* cultivars for different morphological and yield traits under climatic conditions of Peshawar, Pakistan.

Materials and Methods

Breeding material and experimental design: The experiment to study the genetic variability and heritability in upland cotton was conducted at NWFP Agricultural University, Peshawar, Pakistan. Peshawar lies between 34°, 02′ North latitude and 71°, 37′ East longitude. The breeding material involved in present studies comprised of 8 *G. hirsutum* cultivars viz., SLH-284, CIM-446, CIM-473, CIM-496, CIM-499, CIM-506, CIM-554 and CIM-707 having broad genetic base and varied by date of release, pedigree, seed cotton and fiber yield as well as fiber quality traits. The seed of all these cultivars were hand-sown on May 15, 2008 in a randomized complete block (RCB) design with three replications. Each sub-plot has four rows, 8 meter long with plants and rows spacing of 30 and 75 cm, respectively. Thinning was performed twice after 15 and 25 days of germination when the plant height was 10 and 20 cm, respectively to ensure single plant per hill. All the recommended cultural practices and inputs including fertilizer, hoeing, irrigation and pest control were applied same for all the entries from sowing till the harvesting and the crop was grown under uniform conditions to minimize environmental variations to the maximum possible extent. Picking was made during the months of November-December, 2008 on single plant basis.

Traits measurement and statistical analyses: At the time of maturity, for recording of data and picking, 10 plants were randomly selected from central two rows (as borders rows were left due to border effect). The data were recorded on days to first flowering, plant height, first internode length, monopodia and sympodia per plant, boll weight and seed cotton yield per plant. All the data were subjected to analysis of variance (ANOVA) techniques appropriate for RCB design through Mstatc computer programme as outlined by Steel & Torrie (1980) to compare the mean differences among cotton genotypes for different morpho-yield traits. The mean values of the genotypes for each parameter were further compared by using the least significant differences (LSD) test at 5% level of probability. Heritability broad sense (H^2) was estimated according to Burton (1951) on entry mean basis.

$$H^2 = \frac{Vg}{VP}$$

$$Vg = \frac{M_2 - M_1}{r}$$

$$Vp = \frac{Ve}{r} + Vg$$

Where
M_2 = Genotypic mean squares
M_1 = Error mean squares
r = Replication

Results and Discussion

According to analysis of variance (Table 1), the mean values for 8 cotton genotypes manifested highly significant differences ($p \leq 0.01$) for plant height, monopodia and sympodia per plant and seed cotton yield per plant. The mean values for days to first flowering and boll weight showed merely significant differences ($p \leq 0.05$). However the cultivars showed non-significant differences for first internode length.

Days to first flowering: Days to opening of first flower varied from 47.67 to 54.00 days among cotton genotypes (Table 2). The cultivar CIM-473 manifested minimum days to flowering (47.67) and it was also found statistically at par with cultivar CIM-499 which got 48.67 days for having first open flower. However, the maximum days were taken by the cultivar SLH-284 (54.00 days) which was also at par with CIM-446 (53.00 days). Other cultivars have medium days to first flowering. Genetic and environmental variances for the days to first flower were 4.563 and 0.571, respectively. The heritability (bs) estimate for the days to first flower (0.96) was high (Table 4). Due to high values of genetic variance and high heritability, it concluded that the trait was found high heritable and has scope for further improvement in getting early maturity in some genotypes. Breeders also mostly interested in early cotton genotypes as to be readily fitted in the cropping system and to have wheat cultivation in time after picking of cotton. Khan (2003) Khan *et al*., (2009a) also studied earliness in upland cotton genotypes and found significant variations among genotypes and high heritability for the said trait.

Table 1. Mean squares and coefficient of variation for different traits of upland cotton during 2008.

Parameters	Mean squares		CV %
	Genotypes	Error	
Days to first flowering	14.286*	0.571	1.49
Plant height	602.657**	31.455	4.57
First internode length	0.036 N.S.	0.023	6.40
Monopodia plant^{-1}	0.535**	0.062	29.73
Sympodia plant^{-1}	9.551**	1.053	7.03
Boll weight	0.152*	0.005	2.06
Seed cotton yield plant^{-1}	500.946**	45.161	8.11

*, ** Significant at $p \leq 0.05$ and $p \leq 0.01$, N.S. = Non-significant, CV = Coefficient of variation

Table 2. Genetic variability for days to first flowering, plant height, first internode length and monopodia per plant of upland cotton during 2008.

Genotypes	Days to first flowering	Plant height (cm)	First internode length (cm)	Monopodia plant^{-1}
SLH-284	54.00 a	134.17 b	2.41	1.23 a*
CIM-446	53.00 ab	136.30 ab	2.42	1.44 a
CIM-473	47.67 f	109.73 d	2.28	0.27 c
CIM-496	49.67 de	123.00 c	2.47	0.63 bc
CIM-499	48.67 ef	112.27 d	2.33	1.27 a
CIM-506	51.00 c	109.10 d	2.38	0.57 bc
CIM-554	52.33 b	145.43 a	2.12	0.53 bc
CIM-707	50.33 cd	112.17 d	2.41	0.73 b
$LSD_{(0.05)}$	**3.82**	**9.822**	**N.S.**	**0.43**

*Means followed by a common letter in the respective column do not differ by $LSD_{0.05}$.

Table 3. Genetic variability for sympodia per plant, boll weight and seed cotton yield of upland cotton during 2008.

Genotypes	Sympodia plant^{-1}	Boll weight (g)	Seed cotton yield plant^{-1} (g)
SLH-284	15.17 ab	3.82 a	78.00 b*
CIM-446	12.22 c	3.40 c	61.00 c
CIM-473	11.90 c	3.40 c	70.00 bc
CIM-496	14.20 b	3.58 b	91.00 a
CIM-499	14.57 b	3.28 c	79.00 b
CIM-506	16.93 a	3.33 c	96.00 a
CIM-554	15.83 ab	3.74 a	94.00 a
CIM-707	15.97 ab	3.83 a	94.00 a
$LSD_{(0.05)}$	**1.797**	**0.1238**	**11.77**

*Means followed by a common letter in the respective column do not differ by $LSD_{0.05}$.

Table 4. Genetic, environmental and phenotypic variances and heritability (bs) for different traits of upland cotton during 2008.

Parameters	Vg	Ve	Vp	Heritability (H^2)
Days to first flowering	4.563	0.571	4.753	0.96
Plant height	190.401	31.455	200.886	0.95
First internode length	0.004	0.023	0.012	0.36
Monopodia plant^{-1}	0.158	0.062	0.178	0.88
Sympodia plant^{-1}	2.833	1.053	3.184	0.89
Boll weight	0.049	0.005	0.051	0.97
Seed cotton yield plant^{-1}	151.928	45.161	166.982	0.91

Vg = Genetic variance, Ve = Environmental variance, Vp = Phonotypic variance.

Plant height: Mean square data regarding plant height showed highly significant differences. Plant height varied from 112.17 to 145.43 cm among the cotton genotypes (Table 2). The highest plant height (145.43 cm) was observed in cultivar CIM-554. It was found statistically at par with cultivar CIM-446 (136.30 cm). Minimum plant height (109.10 cm) was observed in CIM-506. All other cultivars showed medium plant height. Genetic variances (190.401) were seven times greater than environmental variances (31.455) for the plant height (Table 4). The heritability (bs) estimate for the plant height (0.95) was also high. Due to high genetic variance and heritability, it revealed that there are better chances of improvement and getting shorter plants in some genotypes.

Plant breeders are mostly interested in short stature plants due to lodging threat, but it has also been observed that plant height was found positively correlated with bolls per plant and seed cotton yield, if lodging didn't occur (Khan *et al*., 2003; Khan *et al*., 2009a), of the studies Khan *et al*., (2007a) also revealed that in upland cotton cultivars, the plant height and sympodia per plant were positively correlated with each other and also reported the genetic variability for plant height among different cotton cultivars and mentioned that plant height was found positively correlated with bolls per plant and seed cotton yield if lodging didn't occur. Suinaga *et al*., (2006), Taohua & Haipeng (2006) and Meena *et al*., (2007) studied the stability and adaptability of *G. hirsutum* cultivars and observed varied values for plant height and other yield components.

First internode length: First internode length was ranging from 2.12 to 2.47 cm among all the cotton genotypes. The mean values for first internode length (Table 2) were found non-significant. However, the minimum first internode length was observed in CIM-554 (2.12 cm), and the maximum first internode length was recorded in cultivar CIM-496 (2.47 cm). First internode length is contributing and showing early maturity when it has low value. Results revealed that the cultivars having early maturity have also higher yield as compared to cultivars having late maturity. Genetic variances (0.004) were smaller than environmental variances (0.023) for internode length (Table 4). The heritability (bs) for the first internode length (0.36) was also found low as the environmental variations play major role in manifestation of said trait and found little chances of improvement which may be due to nonsignificant variations among the cotton cultivars.

Monopodia per plant: The vegetative branches per plant varied from 0.27 to 1.44 among all the cotton genotypes. The lowest monopodia per plant (Table 2) were recorded in CIM-473 (0.27) which was also found statistically at par with three other cultivars viz., CIM-554, CIM-506 and CIM-496 ranging from 0.53 to 0.63. Three cultivars viz., CIM-446, CIM-499 and SLH-284 showed maximum monopodia per plant (1.23 to 1.44). Genetic and environmental variances for the monopodia per plant were 0.158 and 0.062, respectively (Table 4) and the heritability (bs) estimate for the said traits was high (0.88). It revealed that monopodia per plant were mainly controlled by genetic variances and there is an opportunity in the said genotypes for further decrease in vegetative branches as monopodia per plant is negatively correlated with seed cotton yield. Tyagi *et al*., (1996), Khan (2003) and Ahmad *et al*., (2008) obtained similar results and indicated variability for monopodia per plant. Monopodia per plant were mostly found negatively correlated with seed cotton yield in most of the literature, and that's why breeder were interested in low number of monopodia per plant. The results also revealed that mostly the cultivars have low number of monopodia per plant have higher seed cotton yield. Therefore in breeding for higher yield preference should be given to less vegetative branches per plant.

Sympodia per plant: The fruiting branches per plant were varied from 11.90 to 16.93 among all the cotton genotypes. The maximum sympodia per plant (Table 3) were revealed by CIM-506 (16.93). However, it was found statistically at par with three other cultivars viz., CIM-707, CIM-554 and SLH-284 having 15.17 to 15.97 sympodia per plant. The lowest and statistically at par sympodia per plant were noticed in cultivars CIM-473 (11.90) and CIM-446 (12.22). Genetic and environmental variances for the sympodia per plant were 2.833 and 1.053, respectively (Table 4), while heritability (bs) estimate for the sympodia per plant was high (0.89). Results revealed that due to greater genetic variances and high heritability there is room for further improvement and increase in fruiting branches, because sympodia is positively correlated with boll number and seed cotton yield. Tyagi *et al*., (1996) and Khan *et al*., (2000, 2007a & 2009a) obtained similar results and indicated variability among upland cotton genotypes for this particular trait. Sympodia per plant have direct influence on seed cotton yield and most of the previous researchers noticed positive association of fruiting branches with seed cotton yield.

Boll weight: Boll weight was ranging from 3.28 to 3.83 g among the said cotton genotypes (Table 3). The maximum and statistically at par boll weight was recorded in three cultivars viz., CIM-707, SLH-284 and CIM-554 with range of 3.04 to 3.83 g. These cultivars were also closely followed by CIM-496 (3.58 g). Four other cultivars (CIM-499, CIM-506, CIM-446 and CIM-573) showed lowest boll weight (3.28 to 3.40 g). Genetic and environmental variances for the boll weight were 0.049 and 0.005, respectively (Table 4). The heritability (bs) estimate for the boll weight (0.97) was high. The genetic variances were found greater than environmental variances and along with high heritability it authenticated that the cultivars have the potential to enhance the boll weight which is the second main contributor (after boll number) to seed cotton yield. Terziev *et al*., (1996) and Abouzaid *et al*., (1997), Ahmad *et al*., (2008) and Khan *et al*., 2009a also obtained similar proportion and variation for boll weight in relation to seed cotton yield in different upland cotton cultivars. Suinaga *et al*., (2006), Taohua & Haipeng (2006), Khan *et al*., (2007a) and Meena *et al*., (2007) studied the performance of cotton cultivars and observed varied values for boll weight. Khan (2003) also evaluated different *G. hirsutum* cultivars for yield and other economic characters and observed significant variations for boll weight and showed positive effect on seed cotton yield. Boll weight is also an important yield contributing trait and has direct effect on seed cotton yield. During selection of the genotypes, due respect should be given to the boll weight.

Seed cotton yield per plant: Data regarding seed cotton yield (Table 1) showed highly significant differences (p≤0.01) among the cotton cultivars. Seed cotton yield per plant varied from 61.00 to 96.00 g among the cotton genotypes (Table 3). The maximum and statistically at par seed cotton yield ranged from 91.00 to 96.00 g per plant was revealed by four cultivars viz., CIM-506, CIM-554, CIM-707 and CIM-494. These cultivars were also followed by SLH-284 (78.00 g) and CIM-473 (70.00 g). The lowest seed cotton yield was observed in cultivar CIM-446 (61.00 g) being also having low number of bolls per plant and boll weight which directly contributes to seed cotton yield. The cultivar having more sympodia per plant like CIM-506 has also shown maximum seed cotton yield, which also confirm positive association of these two traits. Genetic variances and environmental variances for the seed cotton yield were 151.928 and 45.161, respectively. The heritability (bs) estimate (Table 4) for the seed cotton yield was high (0.91). Results revealed that the seed cotton yield was mainly controlled by genetic variance due to it greater values and in presence of high heritability, there is an opportunity in the said genotypes for further improvement in seed cotton yield.

Genetic variability for seed cotton yield was reported by Terziev *et al*., (1996), Abouzaid *et al*., (1997) and Khan *et al*., (2010). Copur (2006) and Khan *et al*., 2009a also determined the yield and yield components of *G. hirsutum* cultivars and observed statistically significant differences. Soomro *et al*., (2005) studied the seed cotton yield in upland cotton cultivars and found that cultivars manifested significant differences for yield of first and last pick. Khan (2003) and Khan *et al*., (2000, 2007a, 2007b) also evaluated different *G. hirsutum* cultivars for yield traits and observed significant variations for bolls per plant and boll weight and contributed significant variation and positive effect on seed cotton yield.

Conclusion

The cultivars high genetic variability and potential for majority of the traits can be used in future cotton breeding programs. CIM-506 was found top promising cultivar by having maximum seed cotton yield, sympodia per plant, short stature plants and medium early maturing and boll weight. The cultivars CIM-707 and CIM-554 also showed comparable yield contributing traits and seed cotton yield. Most of the traits were also found high heritable and showed less environmental influence on the traits. Therefore, the said breeding material can be safely used for further improvement of cotton yield related traits. It is also suggested to grow cotton during mid of April in Peshawar valley, so the crop may have more time for better growth and timely maturity.

References

Abouzaid, A., M.A. Bashir and S.S. El-Tabbakh. 1997. Future of Egyptian cotton production in the new desert land of Egypt. 1. Effect of planting dates and cultivars on seed cotton yield and lint quality. *Alexandria. J. Agril. Res*., 42: 49-62.

Ahmad, W., N.U. Khan, M.R. Khalil, A. Parveen, U. Aiman, M. Saeed, Samiullah and S.A. Shah. 2008. Genetic variability and correlation analysis in upland cotton. *Sarhad. J. Agric*., 24: 195-201.

Anonymous. 2008. Pakistan Economic Survey 2007-08. Ministry of Finance, Govt. of Pakistan. (http://www.finance.gov.pk).

Badr, S.S.M. 2003. Evaluation of some Egyptian cotton varieties by the yield and seven methods of earliness of crop maturity measurements. *Egyp. J. Agric. Res*., 81: 671-688.

Baloch, M.J. 2004. Genetic variability and heritability estimates of some polygenic traits in upland cotton. *Pak. J. Sci. & Indus. Res*., 42: 451-454.

Baloch, M.J. and N.F. Vessar. 2006. Multiple parameters of ascertaining yield stability of upland cotton varieties tested over number of environments. *Pak. J. Sci. Indus. Res*., 49: 355-359.

Burton, G.W. 1951. Quantitative inheritance in pearl millet (*Pennisetum glaucum*). *Agron. J*., 43: 409-417.

Copur, O. 2006. Determination of yield and yield components of some cotton cultivars in semi and arid conditions. *Pak. J. Biol. Sci*., 9: 2572-2578.

Esmail, R. M. 2007. Genetic analysis of yield and its contributing traits in two intra specific cotton crosses. *J. Appl. Sci. Res*., 3: 2075-2080.

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 Dissertation, Sindh Agril. Univ. Tandojam, Pakistan.

Khan, N.U., G. Hassan, K.B. Marwat, Farhatullah, S. Batool, K. Makhdoom, I. Khan, I.A. Khan and W. Ahmad. 2009a. Genetic variability and heritability in upland cotton. *Pak. J. Bot*., 41(4): 1695-1705.

Khan, N.U., G. Hassan, K.B. Marwat, M.B. Kumbhar, I. Khan, Z.A. Soomro, M.J. Baloch and M.Z. Khan. 2009b. Legacy study of cottonseed traits in upland cotton using Griffing's combining ability model. *Pak. J. Bot*., 41(1): 131-142.

Khan, N.U., G. Hassan, M.B. Kumbhar, S. Kang, I. Khan, A. Parveen, U. Aiman and M. Saeed. 2007a. Heterosis and inbreeding depression and mean performance in segregating generations in upland cotton. *Eur. J. Scien. Res*., 17: 531-546.

Khan, N.U., H.K. Abro, M.B. Kumbhar, G. Hassan and G. Mahmood. 2000. Study of heterosis in upland cotton-II. Morphology and yield traits. *The Pak. Cottons*, 44: 13-23.

Khan, N.U., H.U. Khan, K. Usman, H.U. Khan and S. Alam. 2007b. Performance of selected cotton cultivars for yield and fibre related parameters**.** *Sarhad J. Agric*., 23: 257-259.

Khan, N.U., K.B. Marwat, G. Hassan, Farhatullah, S. Batool, K. Makhdoom, W. Ahmad and H.U. Khan. 2010. Genetic variation and heritability for cottonseed, fiber and oil traits in *G. hirsutum* L. *Pak. J. Bot*., 42(1): 615-625.

Meena, R., A.D. Monga and R. Kumar. 2007. Undiscriptive cotton cultivars of north zone: an evaluation. *J. Cotton Res. Dev*., 21: 21-23.

Soomro, A.R., R.G. Kakar, H. Ali and S.A. Abid. 2005. Comparison of yield and its components in some commercial cottons varieties. *Indus J. Plant Sci*., 4: 545-552.

Steel, R.G.D. and J.H. Torrie. 1980. *Principles and procedures of statistics, a biological approach*, 2nd ed. McGraw Hill, Inc. New York, Toronto, London.

Suinaga, F.A., C.S. Bastos and L.E.P. Rangel. 2006. Phenotype adaptability and stability of cotton cultivars in Mato Grosso State, Brazil. *Pesquisa Agropecuaria Trop*., 36: 145-150.

Taohua, Z. and Z. Haipeng. 2006. Comparative study on yield and main agri-characters of five hybrids colored varieties. *J. Anhui Agric. Uni*., 33: 533-536.

Terziev, Z.H., T. Kolev and B. Bozhinov. 1996. Yield and quality of two cotton cultivars grown under the agro-ecological conditions of the Plovdiv region. *Restenievdni-Nauki*., 33: 28-31.

Tyagi, A.P. 1994. Association of yield components and fibers traits and there functions in upland cotton. *Indian J. Agri. Res*., 28: 159-165.

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