INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
08–355/HUT/2009/11–5–581–585
http://www.fspublishers.org

Full Length Article

Genetic Evaluation of Fiber Yield and Yield Components in Fifteen Cotton (*Gossypium hirsutum*) Genotypes

AAMIR RASHEED, WAQAS MALIK, ASIF ALI KHAN[1]†, NAVEED MURTAZA, ABDUL QAYYUM AND ETRAT NOOR
Department of Plant Breeding and Genetics, University College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan
†*Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan*
[1]Corresponding author's e-mail: asifpbg@hotmail.com

ABSTRACT

This study was conducted to evaluate the genetic potential of 15 cotton (*Gossypium hirsutum* L.) genotypes by analysing genotypic, phenotypic correlation, path co-efficient analysis and broad sense heritability, as these are common approaches used to detect association and inheritance of the target and component traits. Analysis of correlation co-efficient indicated a positive and highly significant association between bolls per plant and boll weight with seed cotton yield. Path co-efficient analysis indicated that a positive direct effect of fiber fineness and fiber strength on seed cotton yield, which predicted that direct selection through these traits may lead to an increase in seed yield. Moderately high to high heritability estimates of seed yield, bolls per plant, fiber fineness and fiber strength indicated the presence of strong to very strong genetic expression. Therefore, there seems a potential for the concurrent genetic improvement of these traits at least in the plant material used here through selection and breeding. Heritability and correlation both help to determine the selection criteria for the improvement of yield and quality traits while path co-efficient analysis helps to determine the direct effect of traits and their indirect effects on other traits. The information reported here would be helpful for the breeders engaged in development of high yielding better quality of the cotton genotypes.

Key Words: Correlation; Cotton; Fiber fineness; Fiber strength; Heritability; Path analysis

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) crop is a white gold for Pakistan due to its share of about (1.6%) in the GDP (Anonymous, 2007-2008). The importance of cotton crop in the economy of a country compels plant breeders to make consistent efforts for the genetic improvement of fiber yield and quality of cotton. For simultaneous exploitation of the genetic potential of cotton plant for fiber characters and yield, the information on the nature of the relationships among these characters is very important as genotypic correlation is the inherent relationship between any two variables (Fonseca & Patterson, 1968), which could be due to pleiotropic gene effects or linkage (Iqbal *et al*., 2003). In cotton, correlation between monopodial branches and seed cotton yield was positive (Iqbal *et al*., 2003) and between quality characters and yield was generally negative (Singh, 1982 & Azhar *et al.*, 1984). However, another study (Zhou, I986) reported non-significant, but positive associations were found between yield and fiber quality traits. Path co-efficient analysis is a time tested statistical methodology of partitioning and quantifying genetic correlation into direct and indirect effects especially, where genetic variability for yield is limited. Tyagi *et al*. (1988) reported that boll number, boll weight and plant height contribute directly towards seed cotton yield and were used for the selection of high yielding genotypes. Improvement of different characters depends on the existence of heritable variation and heritability is a measure of degree of genetics determination of traits and facilitates the selection process. Bahadar *et al.* (1993) and May and Green (1994) reported varying degree of heritability for different traits, which ranged from low to moderately high. Aim of this study was to estimate the heritability, correlations and path analysis among important yield and quality traits in fifteen cotton (*Gossypium hirsutum* L.) genotypes.

MATERIALS AND METHODS

This study was conducted at the Department of Plant Breeding and Genetics at University College of Agriculture, Bahauddin Zakariya University, Multan, which is situated at longitude: 71°, 30.79′ E; latitude: 31°, 16.4′ and altitude 128 m (Ahmad *et al*., 2008). During 2007, in cotton growing season the average day temperature was 38°C and average night temperature was 28°C. The Fifteen cotton genotypes (CIM 541, CRIS 134, TH 35/99, MNH 786, CIM 538, NIAB 824, FH 127, CRIS 342, BH 167, TH 84/99, CRIS

To cite this paper: Rasheed, A., W. Malik, A.A. Khan, N. Murtaza, A. Qayyum and E. Noor, 2009. Genetic evaluation of fibre yield and yield components in fifteen cotton (*Gossypium hirsutum*) genotypes. *Int. J. Agric. Biol.*, 11: 581–585

466, FH 113, NIBGE-4, SLH-284 & MNH 789) were used as an experimental material. The soil was of clay type having pH 8.5 thus farmyard manure was added to make is appropriate for cotton cultivation. The cotton seeds were planted on 18 May, 2007 keeping inter and intra-row distances of 0.75 m and 0.30 m, respectively. The experimental design was arranged as randomized complete block design with three replications. At maturity, from 22-25 November, 2007 number of sympodial and monopodial branches and number of bolls per plant were counted, plant height was measured in cm with a measuring rod from first cotyledonary node to the tip of the plant and fully developed bolls were weighed in g. The mature bolls were picked on 26 November, 2007 and the seed cotton was weighed in g. The dried and cleaned seed cotton samples were ginned and lint obtained was expressed as ginning out turn (%). The weight of lint obtained from 100 seeds was recoded as lint index (g) and 100 seed weight was recoded as seed index. (g) The fiber characters, staple length (mm), fiber fineness (micronear), fiber strength (g/tax) were determined using HVI (High Volume Instrument).

Analysis of data. The data was subjected to analysis of variance (Steel *et al*., 1997) using MSTAT-C statistical software. Phenotypic correlations among traits were calculated from mean values and genetic variance was obtained from the combined analysis of variance for each replication. Path co-efficient analysis was performed according to the method prescribed by Dewey and Lu (1959). Broad sense heritability was calculated using the formula given by Falconer (1981).

RESULTS

There were significant differences ($p \leq 0.001$) among the genotypes for number of bolls plant^{-1}, boll weight, number of monopodial branches, number of sympodial branches, seed index, yield of seed cotton, ginning out turn (%),fiber fineness and fiber strength (Table I).

Correlation analysis. Positive and significant correlation was observed between the pairs of traits i.e., number of sympodial branches with number of monopodial branches, number of bolls Plant^{-1} with seed cotton yield, seed index with lint index and ginning out turn with lint index both at genotypic and phenotypic levels. Boll weight showed positive and significant genotypic and phenotypic association with seed index and seed cotton yield (Table II). Positive and significant correlation values were found between bolls plant^{-1} with boll weight, boll weight with ginning out turn, staple length with lint index and fiber fineness, fiber strength with seed cotton yield and staple length with seed cotton yield was observed only at genotypic level, but it was non-significant at phenotypic level. Number of sympodial branches, monopodial branches and plant height had positive but non-significant correlation with seed cotton yield both at genotypic and phenotypic levels, while it was negative between ginning out turn and seed cotton yield (Table II). Number of sympodial branches and number of monopodial branches showed positive, but non-significant association with ginning out turn, lint index, staple length and fiber fineness both at genotypic and phenotypic levels. But, fiber strength had negative association with seed cotton yield (Table II).

Path co-efficient analysis. Positive direct effect of number of bolls plant^{-1}, seed index, ginning out turn, lint index, fiber fineness and fiber strength on seed cotton yield was observed. There was negative direct effect of number of sympodial branches, monopodial branches, boll weight, plant height and staple length on seed cotton yield (Table III). A positive indirect effect of number of sympodial branches on seed cotton yield via number of monopodial branches, boll plant^{-1}, boll weight, plant height, seed index, lint index, staple length and fiber strength was observed. While indirect effect of sympodial branches via ginning out turn and fiber fineness on seed cotton seed yield was negative. Number of monopodial branches showed positive indirect effect via all fiber traits except staple length on seed cotton yield (Table III). Number of bolls plant^{-1} and boll weight both showed negative indirect effect via sympodial branches, ginning out turn and lint index, while it was positive via staple length, fiber fineness and fiber strength on seed cotton yield. Table III revealed that plant height and seed index both showed positive indirect effect on seed cotton yield via lint index, staple length, fiber fineness and fiber strength on the other hand it was negative via monopodial branches and number of boll^{-1}. A positive indirect effect of ginning out-turn via sympodial branches, monopodial branches, plant height, lint index, fiber fineness and fiber strength on seed cotton yield was observed, it was negative via number of boll^{-1}, boll weight, seed index and staple length. The indirect effect of staple length via all traits under study except number of bolls^{-1} and plant height was positive on seed cotton yield. Fiber fineness showed negative indirect effect via only two traits i.e., boll weight and staple length. Indirect effect of fiber strength was negative on seed cotton yield via number sympodial branches, boll weight, lint index, staple length and fiber fineness and it was positive via number of monopodial branches, number of bolls $^{-1}$, plant height, seed index and ginning outturn (Table III).

Broad sense heritability. The broad sense heritability for sympodial branches, monopodial branches, plant height, seed index and staple length was very low. Moderately high heritability estimates were recorded for number of bolls plant^{-1}, boll weight, lint index and seed cotton yield (Table IV). Heritability was high for ginning out turn (89%), fiber fineness (98.41%) and fiber strength (97.80%).

DISCUSSION

Correlation co-efficient is a measure of intensity of association among the traits (Iqbal *et al*., 2003). Higher genotypic correlation than phenotypic correlation indicated

Table I. Analysis of Variance of different cotton genotypes

		Mean squares											
SOV	**D.F**	**No. of sympodial branches**	**No. of monopodial branches**	**No. Bolls plant^{-1}**	**Boll weight (g)**	**Plant height (cm)**	**Seed index (g)**	**Ginning out turn (%)**	**Lint index (g)**	**Staple length (mm)**	**Fiber fineness (micronear)**	**Fiber strength (g tax^{-1})**	**Yield (kg)**
Reps	2	3.876	0.506	1.683	1.033	350.539	0.246	0.935	0.071	0.017	0.118	0.217	1840.766
Genotypes	14	0.242^{NS}	0.315**	15.293**	1.518**	493.440^{NS}	0.381*	6.803**	0.510**	0.027^{NS}	22.009**	4.310**	316.892**
Error	28	0.506	0.275	3.551	0.254	508.694	0.255	0.420	0.132	0.041	0.177	0.048	122.998

*= Significant ($p \leq 0.05$), ** = Highly significant ($p \leq 0.01$), NS = Non-significant ($p \leq 0.01$), SOV =Source of variability, DF =Degree of freedom

Table II. Genotypic and phenotypic correlation coefficients in examined yield and yield components

Variables		**No. Sympodial branches**	**No. Monopodial branches**	**No. of Bolls plant^{-1}**	**Boll weight (g)**	**Plant height (cm)**	**Seed index (g)**	**Ginning out turn (%)**	**Lint index (g)**	**Staple length (mm)**	**Fiber fineness (micronear)**	**Fiber strength (g/tax)**	**Yield (kg)**
Sympodial	rg		0.4031*	0.1550^{NS}	-0.0714^{NS}	0.0082^{NS}	0.0750^{NS}	0.1218^{NS}	0.1257^{NS}	0.0246^{NS}	0.2595^{NS}	-0.0170^{NS}	0.0602^{NS}
branches	rp		0.4196*	0.2195^{NS}	-0.079^{NS}	0.0350^{NS}	0.0717^{NS}	0.0686^{NS}	0.1011^{NS}	0.1297^{NS}	0.1328^{NS}	-0.0163^{NS}	6.3201^{NS}
Monopodial	rg			0.2282^{NS}	0.0542^{NS}	-0.0595^{NS}	-0.1068^{NS}	-0.0937^{NS}	-0.1432^{NS}	-0.0788^{NS}	-0.3945^{NS}	0.2831^{NS}	0.1880^{NS}
branches	rp			0.0680^{NS}	-0.0291^{NS}	2.6508^{NS}	-0.0922^{NS}	0.0203^{NS}	-0.0525^{NS}	0.0421^{NS}	-0.2671^{NS}	0.1901^{NS}	0.0115^{NS}
Bolls plant^{-1}	rg				0.4359*	-0.1835^{NS}	-0.1395^{NS}	0.3487^{NS}	0.1913^{NS}	0.0157^{NS}	0.1533^{NS}	0.3980^{NS}	0.6099**
	rp				0.3200^{NS}	-0.1532^{NS}	-0.0466^{NS}	0.2484^{NS}	0.1315^{NS}	0.0666^{NS}	0.1509^{NS}	0.3097^{NS}	0.3747*
Boll weight	rg					0.2131^{NS}	0.6553**	0.4594*	-0.6761**	0.7072**	-0.2485^{NS}	-0.5057*	0.9430**
	rp					0.1814^{NS}	0.5191**	0.3688^{NS}	-0.5826**	0.2119^{NS}	0.2165^{NS}	-0.4334^{NS}	0.8279**
Plant height	rg						-0.3515^{NS}	-0.4621*	-0.5156*	0.1439^{NS}	-0.1190^{NS}	-0.1033^{NS}	0.1025^{NS}
	rp						-0.1223^{NS}	-0.2775^{NS}	-0.2460^{NS}	0.2988^{NS}	-0.0480^{NS}	-0.0918^{NS}	0.0742^{NS}
Seed index	rg							0.2318^{NS}	0.6885**	-0.1456^{NS}	0.3796^{NS}	0.0320^{NS}	-0.6287**
	rp							0.1571^{NS}	0.7720**	-0.0643^{NS}	0.2664^{NS}	0.0270^{NS}	0.4158*
Ginning out	rg								0.8637*	-0.4457^{NS}	0.4134^{NS}	0.0602^{NS}	-0.2576^{NS}
turn	rp								0.7465*	-0.1865^{NS}	0.3779^{NS}	0.0803^{NS}	-0.2127^{NS}
Lint index	rg									-0.4358^{NS}	0.5244*	0.0515*	0.5088*
	rp									-0.0369^{NS}	0.4302^{NS}	0.0603^{NS}	-0.4018^{NS}
Staple length	rg										-0.3331^{NS}	-0.1415^{NS}	0.6054*
	rp										-0.1435^{NS}	-0.3232^{NS}	0.1923^{NS}
Fibre	rg											0.0675^{NS}	-0.1785^{NS}
fineness	rp											0.06396^{NS}	1.1778^{NS}
Fibre	rg												-0.5055*
strength	rp												-0.3688^{NS}

rg = Genotypic correlation, rp = phenotypic correlation, * = Significant ($p \leq 0.05$), ** = Highly significant($p \leq 0.01$), NS = Non-significant ($p \leq 0.01$)

that genetic causes were greater than the environmental causes in expression of these traits (Tyagi, 1986). Positive associations both at genotypic and phenotypic levels between number of sympodial branches with number of monopodial branches, number of bolls plant^{-1} with seed cotton yield, seed index with lint index and ginning out turn with lint index both revealed that there was strong association between them and with the increase of one trait its associated trait was also increasing as reported by Naveed *et al.* (2004) and Rauf *et al.* (2004). Boll weight is a very important trait for the breeders for developing high yielding genotypes, due to its positive linkage with seed index and seed cotton yield both at genotypic and phenotypic level. But, the finding of Naveed *et al.*, 2004 showed non-significant and negative association between boll weight and seed cotton yield, this contradiction may be due the use of different experimental material. The positive association between bolls per plant^{-1} with boll weight, boll weight with ginning out turn, staple length with lint index and fiber fineness, fiber strength with seed cotton yield and staple length with seed cotton yield only at genotypic level represents the true genetic association and presence of some common genes controlling these traits and it suggested that selection based upon these traits would be helpful for producing high yielding varieties. The negative association of fiber strength with seed cotton yield showed that an increase of the fiber strength, yield would be decreased. Hence, this negative linkage among the genes controlling these traits could be broken by selection of plants from populations generated by random matting (Miller & Rawlings, 1967).

Most of the characters of cotton plant showed multi directional relationship with each other and yield. The path analysis may be useful in prediction of the correlation responses to directional selection and in the identification of some characters that may have no importance themselves, but can be used as precursors of more important ones under study. This is useful to evolve cotton varieties with higher yield than existing ones. Number of bolls plant^{-1}, seed index, ginning out turn, lint index, fiber fineness and fiber strength showed positive direct effect on seed cotton yield, which indicated that cotton breeding programme for evolving high yielding varieties could be successful, when selection is based upon these traits. (Asad *et al.,* 2002; Iqbal *et al.*,2003; Rauf *et al.*, 2004). The negative indirect effect of boll plant^{1} and boll weight via ginning outturn and lint index was much pronounced. This revealed that selection of both boll plant^{1} and boll weight would not be effective for increasing seed cotton yield. In the present plant material the characters having low heritability appeared to be more influenced by

Table III. Path co-efficient analysis in the examined yield and yield components

Traits	Direct effect	No. sympodial branches	No. monopodial branches	No. bolls plant^{-1}	Boll weight (g)	Plant height (cm)	Seed index (g)	Ginning out turn (%)	Lint index (g)	Staple length (mm)	Fiber fineness (micronear)	Fiber strength (g tax^{-1})
		Indirect Effect										
No.sympodial branches	-0.0079		0.4509	0.2891	0.0053	0.0000	0.0065	-0.1514	0.1193	0.0008	-0.2945	0.0022
No.monopodial branches	-0.0058	1.1185		0.4256	-0.0040	-0.0056	-0.0093	0.1164	0.1360	-0.0026	0.4478	0.3761
No. boll plant^{-1}	0.3025	-0.2553	1.8648		-0.3284	-0.1742	-0.1225	-0.5708	-0.6420	0.2418	0.2820	0.6719
Boll weight (g)	-0.4184	-0.0060	0.8129	0.0753		0.2023	0.5753	-0.5708	-0.6420	0.2418	0.2820	0.6719
Plant height (cm)	-0.8288	0.0666	-0.3423	-0.1606	0.9489		-0.3086	0.5742	0.4896	0.0092	0.1350	0.1372
Seed index (g)	0.2907	0.1195	-0.2602	-0.4936	-0.3336	0.8779		-0.2880	0.6538	0.4981	0.0049	0.4309
Ginning outturn (%)	0.6876	0.1048	0.6504	-0.3460	-0.4385	0.2035	-1.2425		0.8202	-0.1524	0.4692	0.0080
Lint index (g)	0.6821	0.1602	0.3568	0.5093	-0.4893	0.6045	-1.073	0.9496		-0.1490	-0.5951	-0.0068
Staple length (mm)	-0.5910	0.0082	0.0029	-0.5328	0.1366	-0.1278	0.5538	0.4138	0.3420		0.3780	0.1879
Fibre fineness (micronear)	0.8316	0.4413	0.2859	0.1872	-0.1129	0.3333	0.5137	0.4980	0.1139	-1.1348		0.0089
Fibre strength (g/tax)	0.3161	-0.3166	0.7422	0.3810	-0.9804	0.0028	0.0074	0.0048	-0.0048	-0.0076	-1.3286	

Table IV. Heritability estimates in the examined yield and yield components

Variables	No. sympodial branches	No. monopodial branches	No. Bolls plant^{-1} (cm)	Boll weight (g)	Plant height (cm)	Seed index (g)	Ginning out turn (%)	Lint index (g)	Staple length (mm)	Fiber fineness (micronear)	Fiber strength (g tax^{-1})	Yield (kg)
(Vg)	3.394	4.411	214.103	21.246	6908.161	5.329	95.243	7.142	0.379	308.124	60.339	4436.489
(Vp)	17.558	12.117	313.528	28.349	21151.583	12.48	107.013	10.849	1.59	313.076	61.692	7880.426
h^2_{BS} (%)	19.33	36.40	68.28	74.94	32.66	42.70	89.00	65.83	23.83	98.41	97.80	56.29

Vg = Genotypic variance, Vp = Phenotypic variance, h^2_{BS} = Broad sense heritability

environment (Azhar *et al.*, 2004). Moderately high heritability estimates were recorded for number of bolls per plant, boll weight, lint index and yield ranging from 55 to 74%. Therefore, these traits were mostly genetically determined (Bahadar *et al.,*1993; Banumathy *et al.,* 2000; Bertini *et al.,* 2001 & Joshi *et al.,* 2006). High heritability estimates up to 98% for ginning out turn, fiber fineness and fiber strength revealed higher degree of genetic determination for these traits (Banumathy *et al.,* 2000).

CONCLUSION

Obtaining the positive and highly significant correlation co-efficient between boll weight and seed cotton yield, it may be concluded that increase of the boll weight would increase seed cotton yield and negative correlation between fiber strength and yield may lead the two traits in opposite directions. Random matting among genotypes could be a good technique to break negative association among genes. Path analysis depicted that direct selection of sympodial branches, monopodial branches, plant height and staple length would be less important in the development of high yielding cotton genotypes. High heritability estimates of fiber fineness and strength showed that both characters are genetically determined and there is an ample scope for the genetic improvement of these both traits by selection and breeding provided most part of genetic variance is heritable.

REFERENCES

Ahmad, N., M. Abid and F. Ahmad, 2008. Boron toxicity in irrigated cotton (*Gossypium hirsutum* L.). *Pakistan J. Bot.*, 40: 2443–2452

Anonymous, 2007-2008. *Economic Survey of Pakistan*, p: 20. Finance Div. Economic advisory wing Islamabad, Pakistan

Asad, M.A., F.M. Azhar and Z. Iqbal, 2002. Association of yield with various economic traits in *Gossypium hirsutum* L. *Int. J. Agric. Biol.*, 4: 105–106

Azhar, F.M., A.R. Abid and M.A. Khan, I984. Association of yield with various economic characters in *Gossypium hirsutum* L. *Pakistan Cottons*, 28: 127–134

Azhar, F.M., M. Naveed and A. Ali, 2004. Correlation of cotton seed yield with fibre characteristics in *Gossypium hirsutum* L. *Int. J. Agric. Biol.*, 6: 656–658

Bahadar, S., I.A. Khan and S.S. Mehdi, 1993. The estimate of heritability and genetic advance for various plant traits in segregating population of *Gossypium hirsutum* L. 1. Yield and related characters. *Pakistan J. Agric. Sci.*, 30: 280–284

Banumathy, S., P. Shanti and S. Patil, 2000. Genetic analysis of fuzzlessness and other attributes in *Gossypium hirsutum* L. *Crop Res. Hisar*, 20: 102–104

Bertini, C.H.C. De. M., F.P. Da Silva, R. De. P. Nunes and J.H.R. Dos Santos, 2001. Gene action, heterosis and inbreeding depression of yield characters in mutant lines of upland cotton. *Pcsq. Agropec. Brasilaria*., 36: 941–948

Dewey, O.R. and K.H. Lu, 1959. A correlation and path co-efficient analysis of components of crested wheat grass and seed production. *Agron. J.*, 51: 515–517

Falconer, D.S., 1981. *Introduction to Quantitative Genetics*, p: 127. Longman Press, New York, USA

Fonseca, S. and F.L. Patterson, 1968. Yield components, heritabilities and interrelationships in winter wheat (*Triticum aestivum* L.). *Crop Sci.*, 8: 614–617

Iqbal, M., M.A. Chang, M.Z. Iqbal, M. Hassan, A. Nasir and N. Islam, 2003 Correlation and path co-efficient analysis of Earliness and Agronomic Characters of Upland Cotton in Multan. *Pakistan J. Agron.*, 2: 160–168

Joshi, H.J., P.K. Chovatia and D.R. Mehta, 2006. Genetic variability, character association and component analysis in upland cotton. *Indian J. Agric. Res.*, 40: 302–305

May, O.L. and C.C. Green, 1994. Genetic variation for fibre properties in elite Pee Dee cotton populations. *Crop Sci.*, 34: 684–690

Miller, P.A. and J.O. Rawlings, 1967. Breakup of initial linkage blocks through intermating in a cotton breeding population. *Crop Sci.*, 7: 199–204

Naveed, M., F.M. Azhar and A. Ali, 2004. estimates of heritabilities and correlations among seed cotton yield and its components in *Gossypium hirsutum* L. *Int. J. Agric. Biol*., 6: 712–714

Rauf, S., T.M. Khan., H.A. Sadaqat and A.I. Khan, 2004. Correlation and path co-efficient analysis of yield components in cotton (*Gossypium hirsutum* L.). *Int. J. Agric. Biol*., 6: 686–688

Singh, S., 1982. Genetics of yield, its components and quality characters in upland cotton (*G. hirsutum* L.). *Indian J. Agric. Sci*., 58: 401–402

Steel, R.G.D., J.H. Torrie and D.A. Dickey, 1997. *Principles and Procedures of Statistics, A Biometrical Approach*, pp: 204–251. McGraw Hill Book Co., New York, USA

Tyagi, A.P., 1986. Association analysis for yield in upland cotton (*G. hirsutum* L.). *E.A. Agric. For. J*., 52: 37–70

Tyagi, A.P., R. Mor and D.P. Singh, 1988. Path analysis in Upland Cotton (*G. hirsutum* L.). *Indian J. Agric. Res.*, 22: 137

Zhou, Y.Y., 1986. Yield components in upland cotton. *Acta Agric. Univ. Pekinensis*, 12: 269–274

(Received 22 December 2008; Accepted 02 April 2009)