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GENOTYPE-ENVIRONMENT INTERACTION IN YIELD OF HILL COTTON GENOTYPES

K. M. Dewan[1], M. S. R. Bhuiyan[2], M. G. Robbani[3] and M. Sonom[4]

Department of Genetics and Plant Breeding
Sher-e-Bangla Agricultural University
Dhaka-1207, Bangladesh

ABSTRACT

Stability analysis helps in understanding the adaptability of genotypes over different environmental conditions and the identification of adaptable genotypes. The experiment was conducted at the Chittagong Hill Tracts (CHT) areas of Bangladesh i.e. Bandarban, Rangamati and Khagrachari during May to September 2014 to study the genotype environment interaction effect on yield of some selected hill cotton genotypes. The experiment consisted of two factors: Factor A: Location (3 locations) - L_1: Bandarban; L_2: Rangamati and L_3: Khagrachari; Factor B: Different cotton genotypes G_1: HCG-4; G_2: HCG-13, G_3: HCG-15, G_4: HCG-21, G_5: HCG-26, G_6: HCG-42, G_7: HCG-51 and V_8: HC-1 (Check). In case of location environment, the maximum boll per plant was recorded from Bandarban (19.13). The highest single boll weight was recorded from Bandarban (4.65 g). The highest seed cotton yield per hectare was recorded from Bandarban (1825 kg). The highest lint yield per hectare was recorded from Khagrachari (809 kg). For genotypes, maximum boll per plant (24.61), single boll weight (5.18 g), seed cotton yield per hectare (2170 kg) and lint yield per hectare (927 kg) was observed in HCG-13. In case of interaction of environments and genotypes, highest boll per plant (27.03), single ball weight (5.29 g), seed cotton yield per hectare (2170 kg), lint yield per hectare (981 kg) was observed in HCG-13 at Bandarban than the Rangamati and Khagrachari. Based on performance of eight genotypes HCG-13 followed by HCG-21 and HCG -42 was found to be highest yielder.Genotype HCG-13 was found highest yielder than the other genotypes and showed better performance at Bandarban than the Rangamati and Khagrachari.

Keywords: Cotton cultivar; genotype-environment interaction; yield; adaptability.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is an important fibre yielding crop of global importance and important industrial raw materials belonging to the family Malvaceae. It is grown in tropical and subtropical regions of more than 80 countries of the world. Among these countries, China, USA, Russia, India, Brazil, Pakistan, Turkey, Egypt, Mexico and Sudan are accounted for 85-90% of the total cotton production (Zeng *et al*., 2014). Cotton (*Gossypium arboreum*) is an important crop for hill farming. It has been cultivated since the prehistoric time in hill districts of Bangladesh. Cotton is important to tribal people not only for their source of income but also in their religious rites. The hill people make their clothing with the hill cotton. Blankets are also produced with this hill cotton. The hill cotton is exported to different countries. Hill cotton is a long duration crop and generally hilly farmers grow cotton in Jhum system i.e. they cultivate cotton with other crops like rice, maize, chilies, sesame, okra, marpha, pigeon pea etc. in the same pit at a time in hill slope. As a result every crop has to compete to each other for nutrient, moisture, sunshine, air and other growth factors. For intra and inter species competition the yield of cotton, rice and other component crops is low and unstable. On the other hand, in Jhum cultivation environmental pollution and soil erosion is very high. Some indigenous varieties of cotton are being cultivated for a long time in Jhum cultivation.

The bolls of the varieties are of different shape and size: big, medium or small. Fibre colour is white or khaki. Two released varieties are now being cultivated named HC-1(white) and HC-2(khaki).Cotton yield is a polygenic complex character, depends on several contributing characters coupled with varying environmental condition (Larik *et al*., 1997; Khan, 2003, Khan *et al*., 2009). It also has been stagnant for the last two decades and very low as compared to other cotton growing countries of the World (Khan and Hassan, 2011). In the hill tracts wide range of cotton genotypes were existed but the suitable genotypes for hilly areas are not defined. As a result cultivation of hill cotton is decreasing day by day due to the lack of high yielding variety.This study was conducted to evaluate the influence of G×E on lint yield and (ginning out turn) GOT of selected hill cotton genotypes , to identify the genotypes suitable for specific locations of hill tracts andto identify the stable genotype(s) suitable for the three hill tracts.

MATERIALS AND METHODS

The experiment was conducted at the Chittagong Hill Tracts (CHT) areas of Bangladesh i.e. Bandarban, Rangamati and Khagrachari. Seven genotypes of cotton and one cheek variety were used as experimental materials (Table 1).The size of the each plot was 3 m × 2 m. The distance maintained between two blocks and two plots were 1.0 m and 0.5 m, respectively. The two factors experiment was laid out in split-plot design with three replications where location factor was assigned in main plot (Bandarban, Rangamati and Khagrachari) and cotton genotypes in sub-plot. The plot was fertilized with 10ton, 200 kg, 200 kg , 175 kg, 100 kg, 20 kg, 20 kg and 20 kg Urea, TSP, MP, Gypsum, Magnesium Sulphate and Borax respectively. The seeds of cotton were defuzzed and treated with Gaucho @ 5 g per kg seed and were sown 2-3 seeds per hill[1] on 12th May 2014 at Bandarban, 14th May 2014 at Khagrachari and 16th May 2014 at Rangamati in furrows maintaining the row to row spacing of 90 cm and plant to plant spacing 45 cm. All recommended agronomic package of practices were followed to grow a healthy crop. The data was recorded from Days to 1st flowering , Days to 1st ball split, Plant height (cm), Vegetative branches per plant , Fruiting branches per plant, Boll per plant, Single boll weight (g), Seed cotton yield per hectare, Lint yield per hectare, Ginning out turn (GOT), Seed index and Lint index.

The significance of the difference among the treatment combinations of means was estimated by Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984). Moreover, recorded parameters were also subjected to stability analysis using Eberhart and Russell (1966) model. The stability of genotypes under different environments measured Eberhart and Russell (1966). Genotypic and phenotypic variances were estimated with the help of the following formula suggested by Johnson *et al*. (1955). Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated following formula as suggested by Burton (1952). The following formula was used to estimate the expected genetic advance for different characters under selection as suggested by Allard (1960). Genetic advance in percentage of mean was calculated by the following formula given by Comstock and Robinson (1952).

Table 1.List of cotton genotype

Sl. no	Genotypes	Sl. no	Genotypes
01.	HCG-4	05	HCG-26
02.	HCG-13	06.	HCG-42
03.	HCG-15	07.	HCG-51
04.	HCG-21	08.	HC-1 (Cheek)

RESULTS AND DISCUSSION

From the pooled analysis of variance, it was observed that genotypic effects were significant for all characters under the present study indicating the presence of variation among the genotypes for these characters. The environments (location of Bandarban, Rangamati and Khagrachari) were also significantly influenced all the characters. The genotype × environment interaction showed significant variation significant for all the characters (Table 2).

Table 2. Pooled analysis of variance (ANOVA) for different traits of cotton genotypes in a genotype-environment interaction study

Characters	Rep (df:2)	Env. (df:2)	Genotypes (df:7)	G × E (df:14)	Error (df:42)
Days to 1st flowering	0.269	172.226**	62.04**	23.14*	11.55
Days to1st boll split	0.154	293.002**	74.19**	20.18*	10.50
Plant height (cm)	22.976	582.891*	2528.30**	137.60**	44.86
Vegetative branches per plant (no.)	0.046	2.831**	4.22**	0.57**	0.04
Fruiting branches per plant (no.)	0.034	39.171**	46.73**	1.74**	0.54
Boll per plant (no.)	0.968	50.669**	150.453**	7.104**	1.951
Single boll weight (g)	0.027	3.368**	6.357**	0.274*	0.154
Seed cotton yield per hectare (kg)	2382.69	120476.07*	786022.39**	56166.15**	9563.05
Lint yield per hectare (kg)	9.347	105740.60**	184774.60**	4139.19**	779.478
Ginning out turn-GOT (%)	0.793	98.998*	25.282**	12.922**	5.186
Seed index (g)	0.014	0.566**	0.153*	0.132*	0.063
Lint index (g)	0.024	5.825*	1.455**	0.751**	0.241

It was observed that high mean performances of different studied characters is not fixed for any particular genotype that means a genotype showing high mean for a character may or may not show high means for the other characters that were studied under the present study. Genotype-environments interactions were also found significant for all the traits (Table 1) which suggested that the genotypes interacted significantly with the changes of environments and prediction for most of the genotypes appeared to be feasible for all the associated characters. Such interaction helps to select superior genotypes by changing their relative productiveness in different environmental condition. Significant G×E interaction suggested the linear function of the additive environment effects (Mather and Jinks,1982) and was reflected by the change in the ranking order of genotypes under varying environments. However, overall performance of genotypes depends upon the magnitude of genotype×environment interaction. Mean yield of genotypes over environmental index ranged from 1107 Kg/ha in Rangamati to 2170 Kg/ha in Bandorban. Genotype HCG-13 produced 2037/ha the highest seed cotton yield over environments viz., 2037 Kg at Rangamati, 2007 Kg at Khagrachari (Table 2).The commercial cheek variety HC-1(Cheek) yield was obtained in 1238 Kg/ha , 1107 Kg/ha, 1168 Kg/ha was found Banderban, Rangamati and Khagrachari respectively. The highest site mean yield was recorded in Banderban (1238 Kg/ha) and the lowest at Rangamati (1691Kg/ha) and the different was was significant.

Table 2. Overall mean seed cotton yield (Kg/ha) of cotton genotypes

Name of genotypes	Environments (Location)			Mean	CV(%)
	Env-1 (Bandarban)	Env-2 (Rangamati)	Env-3 (Khagrachari)		
HCG-4	1587	1232	1739	1519	6.78
HCG-13	2170	2037	2007	2071	5.52
HCG-15	2035	1890	1972	1965	4.56
HCG-21	1930	1907	1877	1905	3.78
HCG-26	1755	2009	1764	1843	5.78
HCG-42	2022	1896	1965	1961	6.09
HCG-51	1863	1451	1891	1735	3.78
HC-1 (Check)	1238	1107	1168	1171	4.89
Env. mean	1825	1691	1798		
Env. index	20.65	-23.78	4.89		

Regression coefficient (bi) is considered as parameter of response and S^2d as the parameters of stability. For a given value of independent variable, the value for dependent variable may be estimated using the regression equation, provided S^2d is not significantly different from zero. Assuming $S^2d = 0$, a high value of bi will mean more change in y for a unit change in (bi) In other words, the variety is more responsive. Such variety may, therefore, be recommended only for highly favourable environments, say under high fertility conditions. A relatively lower value of bi, say around 1, will mean less responsive to the environmental change and therefore, more adaptive. If, however bi is negative the variety may be grown only in poor environment. S^2d, if significant from zero, will invalidate the linear prediction. If S^2d is non significant, the performance of a genotype for a given environment may be predicted. Accordingly, a variety whose performance can be predicted (i.e. $S^2d = 0$) is said to be stable. Here stability means predictability.

Table 3.Stability parameter for seed cotton yield

Name of genotypes	Average mean yield	Regression coefficient (bi)	Deviation from regression (S^2d)
HCG-4	1519	17.781**	1.891
HCG-13	2071	39.087**	3.897
HCG-15	1965	14.891**	4.673
HCG-21	1905	7.903**	-5.902
HCG-26	1843	5.897**	7.091
HCG-42	1961	8.904**	-5.902
HCG-51	1735	6.893**	-2.561
HC-1 (Check)	1171	5.903**	1.981

The wide variation for regression coefficient (b) values for seed cotton yield among genotypes was observed , ranging from 5.897 in HCG-26 to 39.087 in HCG-13.Three genotypes HCG-13 (2071 Kg/ha), HCG-15(1965 Kg/ha) , HCG-42 (1961 Kg/ha) had the highest mean seed cotton yield and high value of regression coefficient of these genotypes 39.087 ,14.891 and 8.904 respectively which means those genotypes are recommended only for highly favourable environments, say under high fertility conditions. These genotypes have low stability and adaptation over environment according to stability definitions proposed by Finly and Wilkinson (1963), Eberhart and Russel (1966). Lin and Binns (1985) suggested that the genotypes will the lowest regression coefficient (b) values (<0.70) were considered unresponsive to different environments or had above average stability i.e between 0.70 and 1.30 (b value) had average stability and with more than (>1.30) regression coefficient were considered responsive to favorable (high yielding) environments or had below average stability. The commercial cheek HC-1 had lowest yield among all genotype and proved to be the less stability as its regression coefficient (b) is 5.903 and deviation from regression(S_2d) is 1.981. Geng *et al. (*1987) suggested that the cultivars with exceptionally small regression coefficients (b=0.01 and 0.20) would be highly stable over different environments. According to stability analysis HCG-13 was highest yielding genotype (2071 Kg/ha) but lowest stability as its regression coefficient (b) is 39.087 and deviation from regression (S^2d) is 3.897.

REFERENCES

Allard, R. W. 1960. Principles of Plant Breeding. John Willey and Sons, Inc, New York. p 36.

Burton, G. W. 1952. Quantitative inheritance in grass pea. Proceedings of the 6th Internl. Grassland Congr. 1: 277-283.

Comstock, K. and P. R. Robinson. 1952. Estimation of genetic advance. Indian J. Hill. 6(2): 171-174.

Eberhart, S. A. and W. A. Russell. 1966. Stability parameters for comparing varieties. Crop Sci. **6**: 36–40.

Finlay, F. W. and G. N. Wilkinson. 1963. The analysis of adaption in plant breeding programme. Aust. J. Res.14: 742-754.
Gomez, K. A. and A. A. Gomez. 1984. Statistical Procedure for Agricultural Research (2nd edn.). Int. Rice Res. Inst., A Willey Int. Sci., pp. 28-192.
Johnson, H. W., H. F. Robinson and R. E. Comstock. 1955. Estimation of genetic and environmental variability in soybeans. Agron. J. 47: 314-318.
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*). Ph.D. Dissertation, Sindh Agric. Univ. Tandojam, Pakistan.
Khan, N. U. and G. Hassan. 2011. Genetic effects on morphological and yield traits in cotton (*G. hirsutum* L.). Span. J. Agrl. Res. 9(2): 460-472.
Khan, N. U., G. Hassan, K. B. Marwat, S. Batool, K. Makhdoom, I. Khan, I. A. Khan and W. Ahmad. 2009. Genetic variability and heritability in upland cotton. Pakistan J. Bot. 41: 1695-1705.
Larik, A. S., S. R. Ansari and M. B. Kumbhar. 1997. Heritability analysis of yield and quality components in *G. hirsutum*. Paistan J. Bot. 29: 97-101.
Lin, C. S., M. R. Binns, L. P. Lefkovitch. 1986. Stability analysis: where do we stand. Crop Sci. 26:26894-26900.
Mather, K. and J. L. Jinks, 1982. Biometrical Genetics. Chapman Hall Ltd. London.
Zeng, L. H., W. R. J. Meredith, B. T. Campbell, J. K. Dever, J. F. Zhang, K. M. Glass, A. S. Jones, G. O. Myers and F. M. Bourland. 2014. Genotype-by-environment interaction effects on lint yield of cotton cultivars across major regions in the U.S. cotton belt. J. Cotton Sci. 18(1): 75-84.

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