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GENOTYPE × ENVIRONMENT (PREDICTABLE) INTERACTION IN COTTON

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ABSTRACT

Genetically diverse ten genotypes were tested under three different spacing which were S1 (90 cm x 45 cm), S2 (90 cm x 50 cm) and S3 (90 cm x 60 cm) at Cotton Research, Training and Seed Multiplication Farm, Sadarpur, Dinajpur during the growing season, 2006-2007. Analysis of variance revealed significant effect of the spacing over the characters studied. Phenotypic index, regression coefficient and deviation from regression coefficient were the fundamental clues of G x E interaction. After furnishing the results, the genotype D-1 found to be the suitable and the spacing 90 cm x 60 cm was the most favorable for the characters and the seed cotton yield along with yield of lint was high in D-1 (2.19 kg/plot) over three spacing.

***Keywords**: Spacing, Genotype, Interaction, Cotton*

INTRODUCTION

Cotton is a multipurpose crop and has a great agro-industrial usage in the world. Fibers obtained from cotton are used in different purposes, especially in the manufacturing of a large portion of clothing for mankind (Fryxell, 1979). Raw cotton is used for medical and surgical purposes. The lints are used for stuffing, cushions, pillows, mattresses etc (Hake *et al*., 1996). It is also used for the production high grade paper rayon, films and explosive (Bonde, 1992). The stalk is used as fuel and for cultivating mushrooms etc. The byproduct such as the gossypol free refined oil is used for human consumption and making cake or meal for the livestock (Hearn, 1981).

The cotton crop behaves differently under different environmental conditions; therefore, stability in performance is one of the most desirable characteristics of any genotype to be released for commercial cultivation. The climatic factors such as temperature, moisture, soil fertility, day length and sowing time very across the years and locations (Bull *et al*., 1992; Sial *et al*., 2001). Specific adaptations and high yield, G x E interaction for seed cotton yield was found to be significant in many researches (Mepherson and Gwathmey, 1996; Tuteja *et al*., 1999).

The ultimate goal of every plant breeder is to operate a selection among the germplasm at his disposal and to utilize them to obtain new cultivars superior to the existing ones. To identify such genotypes, G x E interaction is the major concern to a breeder, because such interaction promotes the selection of superior cultivars by altering their relative productiveness in different environments. Varietal stability in yield with respect to different micro environments is one of the most desired properties of a genotype to fit the crop under available cropping pattern. So, wider adaptability and stability are prime consideration in formulating efficient breeding program. Genotype-environment interaction is an intrusive factor that plant breeders deal with the developing a high potential variety for wider cultivation. To ascertain phenotypic stability, multiplication trials over a number of years are needed. Sometimes, the unilocation trials can also serve the purpose to provide different environments which can be created by planting the experimental materials on different dates of sowing, allowing various

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spacing and differential doses of fertilizers and irrigation levels, etc (Luthran *et al.*, 1974; Tehlan, 1973). Therefore the present investigation was undertaken to study the genotype – environment interaction in cotton using different morpho – agronomic characters.

MATERIALS AND METHODS

The study was carried out at the cotton Research, Training & Seed Multiplication Farm, Sadarpur, Dinajpur during the growing season of 2006-07. Ten cotton genotypes taken from the Gene Bank of Cotton Research station, Mahigonj, Rangpur are used in the present study. The experimental design for the present study was a randomized complete block with three replications. Each experimental plot consists of two rows of 4.5 meter, 5.0 meter and 6.0 meter in length respectively. The row to row distance was 90 cm plant to plant distance were 45 cm, 50 cm and 60 cm respectively.

Green manure and decomposed organic matter are used @ of 6.0 ton/hectare before final land preparation. The chemical fertilizers such as Urea, T.S.P, MOP, Gypsum, Borax and Zinc sulphate were applied in the rows at the rate of 50-175-100-100-10-10 and 10 kg/ha, respectively as basal doze. The rest 150 kg Urea was applied in three equal splits (i. e. 50 kg/ split) at 25,42 and 55 days after planting as side dressing, 3-5 cm away from the plant and the furrows of the fertilizer are hilled up immediately. At the time of third side dressing of Urea, 75 kg of MOP (rest) was also used. Other intercultural operations such as weeding, mulching, irrigation and drainage were performed timely as per need. After 50 days of sowing, first spray of chloropyriphose was done against sucking pest such as jassid and aphids. Other seven sprays were done timely. To control chewing pest (i.e. boll worm) pyrethroid was used 6 (six) times. In all cases scouting base pesticide application was followed. Hand pickings, light trap and Zollaghier trap were also used to control insects and to sustain friendly agro-ecosystems. Fungicides (Bavistin, Endophil etc) were also used for seedling disease and boll-rot. Irrigation was done one time at moisture stress condition.

The crops ware harvested in the month of December, January and February dated on 16, 24 and 22 respectively. Ten plants were selected randomly from each plot to record data on yield and yield contributing characters. All data were subjected to statistical analysis. Analysis of variance was done for all the characters (Singh and Chaudhary, 1985). Eberhart and Russell's (1966) model and "Genotype Grouping Technique" Proposed by Francis and Kannenberg (1978) were employed for genotype and environment (spacing) interaction and stability analysis.

RESULTS AND DISCUSSION

The mean performance of 10 cotton genotypes evaluated for different plant characters over three spacing are presented in Table 1. From the tabular results it was observed that the genotype G_{10} (BC-0165) needed minimum number of days (35.89days) while the genotype G_8 (VN-35) required maximum days to 50% flowering (45.44days). It was found that in general the genotypes which required minimum days to 50% flowering required less number of days for days to 50% boll splitting and vice – versa.

The genotype G_1 (BC-025) had the lowest value for node number of 1st fruiting branches/plant (7.58) and the genotype G_9 (D-1) had the highest value for node number of first fruiting branches/plant (8.58). Among the 10 genotypes, G_6 (BC-0405) possessed the lowest value for number of bolls/plant (23.93), where the genotype G_{10} (BC-0165) had the highest value for number of bolls/plant (29.71). The genotype G_3 (BC-044) produced lowest weight of seed cotton yield (2.007kg) and the genotypes G_9 (D-1) produced highest weight of seed cotton yield (2.53 kg) followed by G_1 (BC-025) (2.40kg) and were most suitable for cultivation across all the predicted environments (spacing) under study while other genotypes varied in performance.

The average spacing effects, summarized over genotypes (Table 2) showed that all the characters studied, vegetative branches/plant secondary fruiting branches/plant, node number of 1st fruiting

Table 1: Mean of different plant characters in 10 genotypes of cotton averaged over three spacing

Genotypes	Number of vegetative branches / plant	Number of primary fruiting branches/ plant	Number of secondary fruiting branches /plant	Node number of 1st fruiting branches /plant	Days to 50% flowering	Days to 50% boll splitting	10 Bolls weight (g)	Number of bolls/plant	Plant height at harvest (cm)	Weight of seed cotton yield (kg)
G_1 (BC-025)	4.33c	18.12ab	27.32cd	7.54d	38.00e	106.22a	61.11bcd	26.16bc	96.99cd	2.407ab
G_2 (BC-040)	3.93d	18.19a	21.50g	6.96e	37.33ef	100.89b	62.78bc	28.01ab	102.37bc	2.351b
G_3 (BC-044)	4.20cd	16.36ef	22.24fg	7.59cd	42.00c	102.89b	57.22de	24.26cd	107.44ab	2.007c
G_4 (BC-088)	4.23cd	17.22cd	22.91fg	7.97bc	36.44fg	96.56c	64.44b	24.39cd	108.49a	2.134c
G_5 (BC-0294)	4.27cd	16.43def	25.21e	8.08b	40.33d	101.00b	59.44cde	25.12cd	98.24cd	2.018c
G_6 (BC-0405)	4.38c	15.94fg	24.11ef	7.43d	43.89b	102.78b	63.89b	23.93d	98.90cd	2.141c
G_7 (BC-0406)	4.10cd	17.21cd	25.99de	7.44d	43.67b	101.78b	57.56de	26.31bc	93.04d	2.139c
G_8 (UN-35)	5.34a	16.78cde	30.77b	7.84bcd	45.44a	107.89a	63.89b	26.42bc	99.27cd	2.113c
G_9 (D-1)	5.58a	15.56g	34.68a	8.58a	43.67b	108.78a	73.33a	27.38b	95.89d	2.538a
G_{10} (BC-0165)	4.71b	17.38bc	29.16bc	7.80bcd	35.89g	101.00b	56.67e	29.71a	109.54a	2.026c
SE(±)	0.172	0.275	1.318	0.139	1.116	1.170	1.565	0.581	1.804	0.057
Level of significance	**	**	**	**	**	**	**	**	**	**
CV (%)	7.63	4.71	7.89	5.95	3.53	3.03	6.47	7.92	5.91	8.52

Table 2. Mean of spacing of different characters in 10 genotypes of cotton.

Spacing	Number of vegetative branches/ plant	Number of primary fruiting branches/ plant	Number of secondary fruiting branches/ plant	Node number of 1st fruiting branches /plant	Days to 50% flowering	Days to 50% boll splitting	10 Bolls weight (g)	Number of bolls/plant	Plant height at harvest (cm)	Weight of seed cotton yield (kg)
S_1 (90cm× 45cm)	4.39b	16.74b	24.09c	7.72a	40.89a	102.93ab	62.67a	22.39c	100.27a	1.92b
S_2 (90cm× 50cm)	4.53ab	17.19a	26.88b	7.66a	40.87a	104.47a	60.17b	26.63b	102.63a	2.01b
S_3 (90cm× 60cm)	4.60a	16.83ab	28.19a	7.79a	40.27b	101.53b	63.27a	29.49a	100.15a	2.64a
SE(±)	0.0033	0.026	0.195	0.038	0.104	0.522	0.449	0.372	0.318	0.011
Level of significance	*	NS	**	NS	*	**	**	**	NS	**
CV (%)	7.63	4.71	7.89	5.95	3.53	3.03	6.47	7.92	5.91	8.52

Table 3. Average seed cotton yield (kg/plot),, coefficient of variation (CV%), response and stability parameters of 10 genotypes of cotton evaluated under three spacing using Eberhart and Russell's model

Genotypes	Mean under different spacing			Mean	CV (%)	Phenotypic index (Pi)	Regression coefficient (bi)	Deviation from regression (S^2di)
	S_1 (90cm× 45cm)	S_2 (90cm× 50cm)	S_3 (90cm× 60cm)					
G_1 (BC-025)	2.15	2.14	2.94	2.41	22.09	0.22	1.161	-1.427**
G_2 (BC-040)	1.90	2.29	2.86	2.35	17.88	0.16	1.178	-1.395*
G_3 (BC-044)	1.76	1.97	2.29	2.01	18.11	-0.18	0.654	-1.423**
G_4 (BC-088)	2.06	1.94	2.40	2.13	18.58	-0.05	0.567	-1.419**
G_5 (BC-0294)	1.74	1.86	2.45	2.02	27.64	-0.17	0.969	-1.434**
G_6 (BC-0405)	1.95	1.79	2.68	2.14	10.85	-0.05	1.160	-1.398*
G_7 (BC-0406)	1.87	1.92	2.63	2.14	14.43	-0.05	1.082	-1.433**
G_8 (UN-35)	1.90	1.85	2.59	2.11	15.79	-0.07	1.038	-1.424**
G_9 (D-1)	2.32	2.24	3.06	2.54	16.10	0.35	1.128	-1.417**
G_{10} (BC-0165)	1.51	2.10	2.47	2.03	38.31	-0.16	1.063	-1.313*
Spacing mean	1.92	2.01	2.64	2.19				
Spacing index	-0.27	-0.18	0.45					

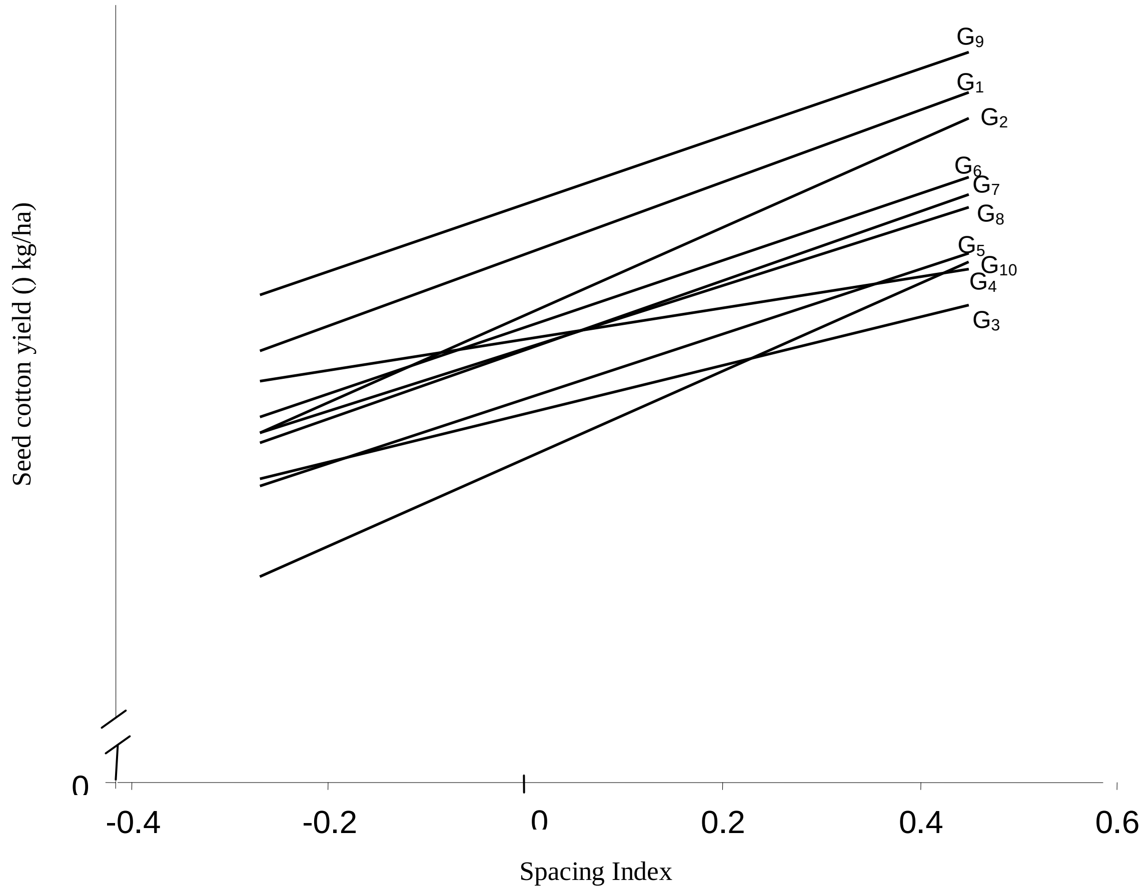

Figure 1. Linear regression of seed cotton yield of 10 cotton genotypes

branches/plant, 10 bolls weight, Number of bolls/plant and weight of seed cotton yield had the highest value in the third spacing (90 cm×60 cm). The characters, primary fruiting branches/plant, days to 50% boll splitting and plant height at harvest were increased in second spacing (90 cm×50 cm). Only the character days to 50% flowering performed the best noticeable in 1^{st} spacing (90 cm × 45 cm). The third spacing was more appropriate in attaining higher yield. A drastic decreasing trend of yield and other characters studied was observed in 1^{st} spacing. Each plant spacing – sowing date – year combination may be considered as one environment after comparing varieties (Gomez and Gomez, 1984).

Analysis of variance showed significant differences among the genotypes in respect of seed cotton yield (kg/plot) (Table 7). Mean of seed cotton yield under three spacing are presented in Table 18. From the spacing mean, it was observed that the genotypes produced on an average highest seed cotton yield in 3^{rd} spacing (90 cm × 60 cm) followed by 2^{nd} (90 cm × 50 cm) and 1^{st} spacing (90 cm × 45 cm). This indicated that 3rd spacing was the most favorable one for this trait and the majority of the genotypes had the capacity to exploit that spacing benefit to produce highest seed cotton yield. Varieties would able to adjust their life process in ways such as to maintain productivity at a level despite unpredictable fluctuations of the environment (Allard and Bradshaw, 1964). Overall the spacing, the genotype G_9 (D-1) gave the highest seed cotton yield

(2.54 kg) whereas; the genotype G_3 (BC-044) gave the lowest seed cotton yield (2.01kg). On an average of all spacing the genotype G_9 (D-1) gave the highest phenotypic index (Pi = 0.35) and G_3 the lowest (Pi= -0.18). The proportion of environment and G x E interaction variation for seed cotton yield was much larger than that due to genotypes main effects (Naveed *et. al.*, 2007). Besides, stability in yield of cotton over wide range of environment has long been desired by plant breeders (Laghari *et al*., 2003).

Analysis of the stability parameters of the individual genotype indicated that all the genotypes showed individual nonlinear sensitivity. However, none of the genotypes showed combined bi and S^2di sensitivity. Genotypes G_3 (BC-044) and G_4 (BC-088) had low bi values which indicated that these genotypes were least responsive to spacing changes. The efficiency of stability analysis to identify genotypes stable for various traits in cotton and other crops have also been demonstrated by Rahman *et al*. (2001). The slopes of individual cultivars are depicted in Fig 1. Regression lines of the genotypes had different slopes due to different magnitudes of b and resulted different interactions.

Considering all the three stability parameters it was observed that G_5 (BC-0294) showed bi value nearly unity (0.969) with significant S^2di and negative phenotypic index and the genotype G_3 (BC-044) had the higher negative phenotypic index with significant S^2si values indicated that this genotype was fairly responsive but unstable.

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