Tropical and Subtropical Agroecosystems, 17 (2014): 477 - 482

Short note [Nota corta]

GENOTYPE × ENVIRONMENT INTERACTION AND YIELD STABILITY ANALYSIS IN MULTIENVIRONMENT

[INTERACCIÓN GENOTIPO X MEDIO AMBIENTE Y ANÁLISIS DE LA ESTABILIDAD DE LA PRODUCCION EN MÚLTIPLES AMBIENTES]

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SUMMARY

The present study was carried out in 8 genotypes with their 56 F1s hybrids over three locations to study stability in the performance of different environmental conditions for various economic traits. The mean squares due to genotype were significant for oil content, seed cotton yield, micronaire and fiber strength. The genotype × environment mean square was significant for seed cotton yield and fiber strength indicating different response of the genotypes in different environments. Three crosses, namely 23 ES × B 58-1290, B 58-1290 × 23ES and B 58-1290 x 23 K were found more stable for oil content (%) over the years as indicated by their non-significant deviation from regression. For boll weight and seed cotton yield, among the crosses VCH (F) x RS 810 and RS 810 x 23 ES had high mean and was stable and responsive to favorable environments as indicated by the regression coefficient more than unity.

Key words: Cotton, environments; Stability; Eberhart and Russell method.

RESUMEN

El presente estudio se realizó con 8 genotipos y sus 56 híbridos F1, en tres localidades, para evaluar la estabilidad de varios caracteres económicos en condiciones ambientales diferentes. Se encontró significancia para los efectos de genotipo en los caracteres de contenido de aceite, producción de semilla de algodón, grosor y resistencia de la fibra. La interacción genotipo x ambiente fue significativa para producción de semilla de algodón y resistencia de la fibra indicando la respuesta diferencial en cada ambientes. Tres cruzamientos (23 ES × B 58-1290, B 58-1290 × 23ES y B 58-1290 x 23 K) fueron más estables para el contenido de aceite durante los años, indicado por el análisis de regresión. El peso de la fibra del capullo de algodón y producción de semilla de los híbridos VCH (F) x RS 810 y RS 810 x 23 ES fue más alto, estable y respondió a condiciones ambientales favorables, indicado por el coeficiente de regresión mayor a la unidad.

Palabras clave: Algodón; ambiente; estabilidad; método de Eberhart y Russell.

INTRODUCTION

Cotton, *G. hirsutum* is grown in India under a wide range of climatic conditions. Cotton a sensitive crop to weather fluctuations, it shows higher magnitude of genotype x environment interaction (Campbell and Jones, 2005). Climatic, soil, insect, disease and cultural conditions also differ from one state of the country to another and frequently from year to year at any one location. The agro ecological diversity of environments complicates breeding and testing of improved genotypes with adequate adaptation, but it also permits identification of extreme environmental conditions that guarantee selection pressure from important stresses. Estimation of phenotypic stability has proven to be a valuable tool in the assessment of varietals adaptability. It is generally agreed that, the more stable genotypes can somehow adjust their phenotypic responses to provide some measures of uniformity in spite of environmental fluctuations**.** More knowledge about causes of G x E interaction is needed and would be useful for establishing breeding objectives, identifying the best test condition and finding areas of optimal cultivar adaptation. This information can be obtained by description of individual genotype performance in various environments because it allows identification of genotypic traits involved in G x E interaction.

Genotype x Environment interaction (G x E) usually present whether the varieties are pure lines, single cross or double cross hybrids, top crosses or any other material with which the breeder may be working. The major concern of a breeder is to develop stable genotypes that give maximum economic yield/unit area and consistent performance for productivity across environments. In stability analysis, Finley and Wilkinson (1963) considered linear regression as a measure of stability, whereas Eberhart and Russell (1966) emphasized that with linear (bi) and non-linear (S^2di) components of genotype – environment interaction be considered while judging the phenotypic stability of a genotype. The present study was carried out to determine the effect, of G x E interaction on the oil content, yields and yield components and fibre quality traits.

MATERIAL AND METHODS

The experimental material for the present investigation comprised of 8 upland cotton genotypes 23K, B58-1290, CSH7106, F 1861, 3HS, RS 810, 23 ES and VCH (F) . These genotypes were crossed in diallel mating design with reciprocals to obtain 64 crosses. Eight genotypes and 64 crosses were grown in randomized block design with three replications over three years, 2005 to 2007 at three locations namely, IARI New Delhi (North zone), UAS Dharwad farm (South zone) and CICR, Nagpur (Central zone). Each locations was specifically chosen to represent one of the major environments under which cotton is growing in India. Each cross and parent was grown in a 2 row plot of 4.5 m length at a spacing of 60 x 60 cm. The data on seed cotton yield, yield components and fibre quality traits was analyzed for stability analysis according to Eberhart and Russell (1966) model.

Fiber samples from each plot were ginned and fiber was taken to the Ginning Training Centre, Nagpur for fiber quality characters using high volume instrument (HVI).

RESULT AND DISCUSSION

The analysis of variance for genotype x environment interaction were presented in Table 1. Mean squares for genotypes were significant for oil content, seed cotton yield, micronaire and strength. The mean squares for G x E interactions were non-significant for all the characters except seed cotton yield and strength (Reddy *et al*., 2003). High and significant mean squares due to environment (linear) indicated considerable differences among environments and their considerable differences among environments and their predominant effects on almost all the traits. High and significant mean squares due to environment (linear) indicated considerable differences among environment and their predominant effects on almost all the traits. Significant pooled deviations from the mean for number of bolls, boll weight, 2.5% span length, micronaire, strength. Singh *et al.* (2004) noticed similar results. Environment (linear) was highly significant for all the characters except, boll weight and strength. Both linear and non-linear components of G x E interactions were significant for 2.5 % span length. It indicates that different genotypes for respective characters fluctuated considerably for stability. Components contribute significantly to differences in stability among the genotypes. Similar results reported by Singh *et al.* (2005) Genotype having high mean, unit regression and least deviation from regression is considered to be superior (2). The stability and responsiveness appeared to be specific for specific characters within single genotypes out of 64 hybrids some stable hybrids are presented in Table-2. The pooled analysis of variance showed that varieties and environment mean squares more significant for seed oil content (%), seed cotton yield (g/plant) and fiber bundle strength (g/tex) indicating substantial variability among genotypes and environment. However, mean squares more non-significant for boll weight, 2.5% span length and micronaire suggesting that testing over environments is of some value for determining relative performance among varieties and crosses across different climatic zones. Similar results were reported by Reddy and Satyanarayan (2003) in upland cotton. The significant mean squares due to genotype x environment (linear) for all the characters studied except boll number and 2.5% span length indicated that considerable differences among environments and their predominant effects. Significant pooled deviation from the mean for boll number, boll weight, 2.5% span length, micronaire and fiber bundle strength revealed the importance of non-linear component in the manipulation of G x E interactions. Similar results are noticed by Singh *et al.* (2004) in Asiatic cotton.

The mean (x), regression coefficient (S^2di) are presented in Table 2. Mean yield of crosses over environmental index ranged from 110.18 g (VCH (F) x F 1861) to 65.20 g (VCH (F) x RS 810). The cross VCH(F) x RS 810 recorded the highest oil content 24.50 % and highest fibre bundle strength 23.49 but had poor seed cotton yield (65.20 g/plant). Cross 23 ES x B 58-1290 had recorded highest fiber bundle strength (25.00 g/tex) followed by B58-1290 x VCH (F) (23.80%). A genotype having high mean, unit regression and least deviation from regression is considered to be stable (Eberhart and Russell, 1966).

The genotypes by environment interaction mean squares were significant for seed cotton yield and fiber bundle strength but non-significant for oil content, number of bolls, boll weight, 2.5% span length and micronaire indicated that all the genotypes interacted strongly with the environments. Similar results were reported by Verma *et al.* (2008) in Asiatic cotton and Laghari *et al.* (2003) in Upland cotton.

Crosses 23 ES x B58-1290, B58-1290 x 23 ES and B 58-1290 x 23 K had non-significant regression coefficient approaching unity and non-significant deviation from linearity were stable responsive to favourable environment for oil content (%). For boll weight, crosses 3 HS x VCH (F) and RS 810 x 23 ES had high mean, non-significant regression coefficient more than unity and also non – significant deviation from regression were stable and responsive to favourable environment. Similar results were reported in Asiatic cotton by Verma *et al*. (2008). For fiber strength traits, crosses VCH (F) x F1861 and F1861x 23 ES had the higher regression coefficient and higher deviation from regression suggests that the cross had below average stability and specially adapted to favourable environments. Similar results were reported in Upland Cotton by Laghari *et al. (*2003).

CONCLUSION

The present study has reported an evaluation of the genotype of the genotypic and environmental performance of crosses over different environments. Stability analysis indicated that the crosses 23 ES × B 58-1290, B 58-1290 × 23ES and B 58-1290 x 23 K were found more stable for oil content (%) and for boll weight and seed cotton yield crosses VCH (F) x RS 810 and RS 810 x 23 ES were stable responsive to favorable environment. Hence, there crosses may be exploited in future breeding programmes in order to improve productivity of upland cotton over environment.

Table 1. Analysis of variance for stability for various traits by Eberhart & Russell model

	Oil content			Seed Cotton yield			Boll Number			Boll weight		
	Mean	βi	S^2di	Mean	Bi	S^2di	Mean	βi	S^2di	Mean	βi	S^2di
23 K	19.50	0.95	0.01	85.34	1.23	0.95	19.21	1.10	0.30	3.63	1.14	0.53
B 58-1290	19.00	0.80	0.02	112.50	0.94	0.24	36.50	0.98	0.25	3.80	0.80	0.01
CSH 7106	20.44	0.31	0.33	88.67	1.15	0.21	27.54	1.61	0.50	3.61	1.10	0.08
F 1861	20.45	0.25	0.70	78.64	0.82	0.15	24.62	3.93	0.60	3.03	0.91	0.06
3 HS	22.50	0.73	0.30	85.34	1.23	0.52	29.25	- 1.41	0.65	3.29	0.83	0.09
RS 810	22.50	0.95	0.03	80.50	1.02	0.21	24.50	1.02	0.14	3.50	1.02	0.02
23 ES	24.40	0.80	0.02	62.24	1.30	0.35	25.50	1.20	0.12	3.80	1.20	0.12
VCH (F)	23.30	0.90	0.16	71.22	0.32	0.02	26.40	4.00	0.01	3.50	0.64	0.02
23 ES x B 58-1290	22.56	0.84	0.02	100.99	1.06	0.15	24.50	1.00	0.12	4.08	0.30	0.02
3 HS x VCH (F)	23.11	1.05	0.05	100.67	0.70	0.25	35.26	0.85	0.80	4.50	2.20	0.30
B 58-1290 x 23 ES	24.00	0.90	0.01	79.55	1.56	0.75	32.40	1.50	0.05	3.77	2.40	0.45
B 58-1290 x 23 K	23.20	0.70	0.02	107.61	1..25	0.80	32.89	1.65	0.02	3.00	1.20	0.50
B 58-1290 x VCH (F)	23.00	0.80	0.03	74.07	1.85	0.02	30.54	3.40	0.10	3.70	0.94	0.80
RS 810 x 23 ES	23.26	0.95	1.35	81.61	1.03	0.30	27.54	4.40	0.20	3.85	1.02	0.12
VCH (F) x F 1861	20.51	1.06	0.01	110.18	1.02	0.20	31.65	2.30	0.25	3.42	1.67	0.46
VCH (F) x RS 810	24.50	1.26	0.02	65.20	1.20	0.02	33.00	1.20	0.35	3.82	1.08	0.09

Table 2. Gene X Environment interaction and stability analysis for cotton hybrids

Source of variation	Oil content (%)	Seed Cotton Yield (g/pt)	No. of Bolls (p/pt)	Boll weight (g)	2.5% Span Length (mm)	Micronaire ($10^{-6)}$)	Strength (3.2 mm)
Replicate within environment	1.75	148.27	75.32	0.13	2.80	0.90	0.71
Varieties	2.51*	479.96*	56.46	0.20	3.31	2.23*	3.64*
Environment +(Variety *Environment)	6.37	1562.18	205.11	0.25	2.32	2.41	5.65
Environment	5.16*	2438.75*	100.61*	0.07	1.77	1.82	8.62*
Variety * Environment	6.40	1548.26*	206.76	0.25	2.33	2.42	5.60*
Environment	10.31*	4877.57	201.21*	0.33	3.53	3.65	17.25*
Variety*Environment (L)	7.03*	1660.59*	198.23	0.31*	2.04	1.23*	3.49*
Pooled deviation	5.65	1413.57	211.93**	0.19**	2.60**	3.55**	7.29**
Pooled error	1.00	104.52	16.23	0.09	0.50	0.70	1.17

Table 3. Gene x Environment interaction and stability analysis for cotton hybrids

	MICRONAIRE			STRENGTH			2.5% SPAN LENGTH		
Entry	Mean	βi	S^2di	Mean	βi	S^2di	Mean	βi	S^2di
23 K	3.80	-1.55	0.70	24.50	1.03	0.30	23.76	2.99	0.46
B 58-1290	3.66	-0.64	0.53	23.50	1.60	1.20	24.80	3.50	0.48
CSH 7106	3.66	4.76	0.71	22.50	0.60	1.60	25.37	2.50	0.20
F 1861	3.66	-0.64	0.53	24.60	2.50	1.80	24.80	3.50	0.48
3 HS	4.56	0.50	0.14	22.50	3.40	1.30	25.82	3.30	0.15
RS 810	3.93	0.88	0.05	26.50	1.30	0.30	26.67	1.50	0.93
23 ES	3.70	1.60	0.25	22.50	3.50	1.30	23.73	2.23	1.54
VCH (F)	4.26	0.63	0.20	23.50	2.20	1.30	25.90	0.81	1.05
23 ES x 3 HS	4.10	0.30	0.43	22.50	1.40	0.45	26.42	3.35	0.07
23 ES x B 58-1290	3.93	0.88	0.05	25.50	1.05	0.50	26.67	1.50	0.93
3 HS x VCH (F)	4.56	0.50	0.13	22.50	1.45	2.30	26.44	0.66	2.03
B 58-1290 x 23 ES	3.70	-1.92	0.70	23.50	1.04	0.45	26.86	-1.30	0.44
B 58-1290 x 23 K	4.01	0.33	0.69	22.50	1.02	0.65	24.60	-0.20	3.40
B 58-1290 x VCH (F)	4.12	1.66	0.30	21.50	1.64	0.80	25.54	1.70	0.02
RS 810 x 23 ES	4.36	0.21	0.70	23.50	1.20	0.90	27.03	1.05	0.48
VCH (F) x F 1861	4.26	1.50	0.55	22.50	1.80	0.98	25.51	0.62	1.20
VCH (F) x RS 810	3.70	1.60	0.25	22.60	2.25	0.75	23.73	2.23	1.54

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Submitted August 18, 2014 – Accepted September 08, 2014