Asian Journal of Plant Sciences

ISSN 1682-3974

Asian Journal of Plant Sciences 3 (1): 36-38, 2004
ISSN 1682-3974

Stability Analysis of Upland Cotton Genotypes to the Aegean Region in Turkey

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Abstract: The breeding lines and standard varieties were evaluated for seed cotton yield in seven different environments. The mean squares of genotype x environment (linear) in stability variance analysis was found to be significant. The genotypes were tested by stability parameters such as regression coefficient (bi), deviations from regression (S^2d), equivalence value (W^2_i), stability variance parameter (σ^2_i), variance of yield value (S^2_i) and coefficient variation (CV_i). The results of different stability parameters were found to be similar to each other for selected genotypes. Kurak 2 and NAK 91-1, breeding lines for drought tolerant and Multi-Adversity Resistance, respectively, were the group of the best adaptation to all environments.

Key words: Cotton, genotype x environment interaction, stability analysis

INTRODUCTION

The seed cotton yield, as a combination of genetic potential and environment, is reduced by water deficiency and heat stress especially during boll development stage in Aegean Region of Turkey. The decreasing in yield depends on different micro environments and years. Improving stabile varieties has been suggested for the most potential solution to reach reasonable yield level at different growing conditions. For maximum progress, it has been reported that cotton breeders should make their selections in the region of interest[1]. The testing environments have been established through the region and breeders are concerned with yield stability along with yield[2]. On the other hand, performance tests of potential cultivars should be conducted in multiple years and locations. The extent of such performance testing depends on the magnitude of genotype x environment interaction, which occurs when genotypes differ in their relative performance across environments[3].

Genotype x environment interaction was found to be significant for seed cotton yield in many researches[4-8]. Following ANOVA analysis, stability analysis indicated that linearity had a considerable portion of genotype x environment interaction effects due to the high significance of the linear component of the interaction[6,9,10].

Yield stability has been analyzed in numerous ways. Bilbro and Ray[11] suggested that two parameters (regression coefficient and the deviation from regression) would be included along with mean yield in evaluation of breeder material. Geng *et al.*[12] reported that the high-yielding cultivars were less stable for seed cotton yield than earlier, lower yielding cultivars. Furthermore, Calhoun and Bowman[1] emphasized that the crux of determining stability is that it must be considered along with the mean yield.

The objective of this study was to analyze the yield stability of cotton varieties by using 6 different stability parameters in the Aegean Region of Turkey cotton variety yield trials between 2000 and 2001.

MATERIALS AND METHODS

Data was provided by Cotton Variety Yield Trials in Nazilli Cotton Research Institute for 2001-2002. From this study, reduced data sets were constructed using defined production regions (Nazilli, Söke, Sarayköy, Menemen in 2000; Nazilli, Sarayköy, Menemen in 2001). Thus, eleven genotypes were evaluated at combined (location x year) seven environments.

Cotton variety yield trials were MS 34-1 (Nazilli M 503 x Stoneville 825), NAK 91/1 (Nazilli 84 x Cabu'cs 2-1-83), Kurak 2 (Nazilli 84 x Delcerro BC_1 120-1), NAKBC_1 14/2 (Nazilli 84 x Cabu'cs 2-1-83), NGF 63 (Nazilli 84 x Gossypolsùz 86), Nazilli 143 (95-4) as new strains and Nazilli 84 S (standard variety for Aegean Region), Nazilli 143, Nazilli M 503, ST 250-2 and Bet Degan 11 as commercial varieties.

Entries were arranged in randomized complete-block designs, with four replicates in each environment. Four-row plots 10.0 m long were thinned to a within-row plant

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spacing of 20 cm and the density was 71.42 plant h^{-1}. The parcel area of harvest was 28 m^2. The sowing dates were varied between 20 April and 10 May depending on locations and years.

The genotype x environment interaction for seed cotton yield was analyzed by using the method of Eberhart and Russell[13]. Stability parameters such as regression coefficient (b_i) and deviations from regression (S^2d) were calculated according to Eberhart and Russell[13]. The other stability parameters were equivalence value, W^2_i,[14] stability variance parameter, σ^2_i,[18] the variance of yield value, S^2_i and the coefficient variation, CV_i, .[15] Variance analyses and stability parameters were performed by using the TarPopGen program[16].

The relationships between regression coefficients and the mean grain yields were figured according to Arshad[17]. The confidence limits of the regression coefficients and mean grain yields on figure were estimated follows formula;

Confidence limit = x (average) ± t value . $S_{\bar{x}}$

RESULTS AND DISCUSSION

The mean squares of the genotype, environments and genotype x environment interaction were significant (Table 1). Bernardo[3] reported that the extent of such performance testing depended on the magnitude of genotype x environment interaction, which occurs when genotypes differ in their relative performance across environments. Following the genotype x environment interaction, Eberhart and Russell's stability analysis were performed and the results were given in Table 2.

The mean squares of pooled error were used in testing the significances of the genotype by environment (linear) because of significant pooled error. This significance indicated that linearity was a considerable portion of genotype x environment interaction and the regression coefficients of genotypes were evaluated to select the stabile genotypes.

Mean seed cotton yield of genotypes varied between 4.94 t ha^{-1} (MS 34-1) and 4.38 t ha^{-1} (Nazilli 143 95-4) (Table 3). MS 34-1 and Kurak 2 genotypes had higher yield than standard varieties (Nazilli 84 S, Nazilli 143 and Nazilli M 503). Also, stability parameters of genotypes are given in Table 3. Eberhart and Russell[13] proposed that an ideal genotype is one, which has the highest yield over broad range of environments, a regression coefficient (b_i) value of one and deviation mean square (S^2d_i) of zero. The regression coefficients of Nazilli 143, Kurak 2, ST 250-2 and Nazilli 84s were magnitude due to close to 1. Nazilli M 503, MS 34-1, NAK 91-1, Nazilli 143 and ST 250-2 had small deviations from regression. On the other hand, deviations from regression of Bet Degan 11, Nazilli 143 (95-4) and Nazilli 84 S were very high.

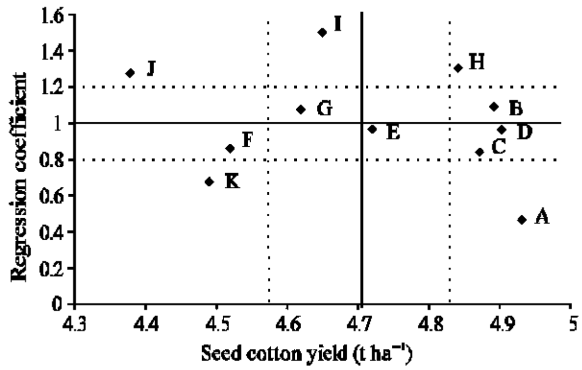
Table 1: Results of ANOVA variance analysis

Source	d.f.	Mean squares
Genotype	10	10266.13**
Environment	6	146802.86**
Genotype x Environment	60	3934.00**
Error	210	1680.70

Table 2: Results of stability variance analysis

Source	d.f.	Mean squares
Genotype	10	2566.53**
Env (Genotype x Env.)	66	4320.52**
Environment	1	220204.29
Genotype x Env. (linear)	10	1766.13**
Pooled Deviation	55	751.80
Pooled Error	210	420.17

**; significant at 0.01 probability level



Confidence limit for average grain yield; 4.71±0.1282
Confidence limit for regression coefficient; 1.000±0.1996

Fig. 1: Seed cotton yields and regression coefficients of 11 cotton genotypes

The low W_i, σ^2_i, S^2 and CV_i values are the characteristics for stable variety. When the lowest values were considered, equivalence value W^2_i of Wricke[14] and stability variance parameter σ^2_i of Shukla[18] showed similar values and trends. According to these two parameters, Nazilli 143, NAK 91-1, ST 250-2, NAKBC$_1$-14-2 and Kurak 2 would be considered as the most stable genotypes. The variance of yield value S^2_i and the coefficient variation CV_i of Francis and Kannenberg[15] indicated that MS 34-1 was first rank and other ranks were similar to other stability parameters. NGF 63, Nazilli 143 (95-4) and Bed Degan 11 lacked yield stability for Aegean Region when all calculated stability parameters were considered.

Relationship between the regression coefficients and mean seed cotton yields for 11 cotton genotypes are shown graphically in Fig 1. Kurak 2, Nazilli 84 S and NAK 91-1 had the highest yield at confidence limits for yield and their regression coefficients were close to 1 at confidence limits for regression. These three genotypes, therefore, were the group of the best adaptation to all

Table 3: Seed cotton yields (t ha^{-1}) and different stability parameters of genotypes

		Eberhart-Russel				Francis-Kannenberg	
Genotype	SCY (t ha^{-1})	bi	S^2d	Wricke Wi	Shukla σ^2_i	S^2	CV
MS 34-1	4.94	0.461	287.58	7252.33	1177.43	948.91	6.24
Nazilli 84 S	4.89	1.085	1395.35	7122.54	1154.40	5092.98	14.58
NAK 91-1	4.87	0.833	299.69	2057.49	255.76	2564.22	10.40
Kurak 2	4.90	0.964	562.60	2838.34	394.30	3572.11	12.19
Nazilli 143	4.73	0.973	363.90	1833.95	216.10	3462.80	12.45
NAKBC1 14-2	4.53	0.853	460.48	2732.51	375.52	2813.72	11.72
ST 250-2	4.62	1.071	435.18	2276.67	294.65	4189.28	14.00
Nazilli M 503	4.84	1.301	210.73	2866.39	399.28	5822.17	15.76
NGF 63	4.66	1.504	686.00	8519.18	1402.19	8120.78	19.35
Nazilli 143 (95-4)	4.38	1.279	1585.66	9483.02	1573.19	6776.54	18.79
Bed Degan 11	4.49	0.675	1932.58	12027.65	2024.66	3172.22	12.55
Average	4.71	1.000					

Confidence limit for average grain yield; 4.71±0.1282 Confidence limit for regression coefficient; 1.000±0.1996

environments. Also, the other stability parameters for Kurak 2 and NAK 91-1 were parallel to results of graphic. When the other genotypes were evaluated in Fig. 1, Nazilli 143 and ST 250-2 were defined as mid-adaptation to all environments while $NAKBC_1$ 14-2 had bad adaptation. Other genotypes were found to be outside of confidence limits.

Kurak 2, breeding line for drought tolerant and NAK 91-1, improved for Multi-Adversity Resistance, were found to be stable genotypes. Thus, these two genotypes would be recommended for stress conditions. Also, it was observed that the results of different stability parameters were similar to each other for selected genotypes.

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