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Variety×Environment Interaction in Cotton Yield Trials

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Abstract: Aegean Region standard cotton varieties and some commercial varieties were evaluated at four environments. Variety×environment interactions was found significant for lint yield and lint percentage. The stability parameters, regression coefficient and mean squares of deviation from regression coefficient were computed and the relations between regression coefficients and lint yield and lint percentage were figured. The standard variety, Nazilli 84 S was the most stabile variety for lint yield, while Carmen, Ozbek 142 S and Sahin 2000 were group of the mid-adaptation to all environments. Ozbek 142 S also was a group of the best adaptation to all environments because of its regression coefficient and the highest lint percentage.

Key words: Genotype×environment, stability, regression, adaptation, lint yield, lint percentage

Introduction

Cotton is grown an area of about 698.000 hectares in Turkey, among which Aegean Region shares 176.000 hectares according to 2004/2005 data (Ozudogru and Cakaryildirim, 2005). The lint yield is much higher than the major cotton growing countries. However, Miller *et al*. (1959) also revealed that cotton is grown in an array of edaphic, climatic, disease and insect conditions. These factors vary from one location to another and from year to year in the same location and their effects are reflected in yields of cotton cultivars. In the result of cotton breeding, adaptation of improved cultivars is an important factor for increasing the productivity of cotton. But inconsistent yield performance of the cultivars under diverse environmental conditions due to high genotype-environment interaction is a major contributing factor to reduction in productivity (Misra and Panda, 1990).

The expression of complex characters, particularly yield, is heavily influenced by environmental conditions. Furthermore, because all of the traits that contribute to yield may not be positively correlated among themselves, material selected for high yield in one environment may perform relatively poorly in another. Genotype×environment interaction can be result of genotype rank changes from one environment to another, difference in scale among environments, or a combination of these phenomena (Cornelius *et al*., 1993). In the continuing debate on whether or not modern high-yielding varieties of cotton have contributed to the observed increased variation in yield, there is often some misconception about the aims of plant breeders, the methods they use and what they can achieve. To solve the genotype-environment interaction has been made many attempts. Regression techniques have often been used to estimate the stability of individual cotton genotypes (Abebe *et al*., 1984a, b). The mean of genotypes in each environment has been used as an index of that environment. The mean yield of each genotype in each environment has also been linearly regressed

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on the mean yield off all genotypes in each environment as suggested by Finlay and Wilkinson (1963). Eberhart and Russel (1966) proposed that a stable genotype is considered to have the highest yield over a broad range of environment, a regression coefficient value of one and deviation mean square of zero.

The genotype×environment interaction was found to be significant for seed cotton and lint yield in many researches (Opondo and Ombakho, 1997; Palomo *et al*., 1998; Mert *et al*., 1999; Yuksekkaya and Unay, 2002; Unay *et al*., 2004). The stability analysis shown that genotype x environment interaction resulted from linear relationships (Sarma *et al*., 1994; Baloch *et al*., 1994; Opondo and Ombakho, 1997).

The high yielding and stable cotton varieties for Aegean Region of Turkey were aimed to determine via regression techniques in this study.

Materials and Methods

Six cotton varieties, Carmen, Eksi 911, Gurelbey, Nazilli 84 S, Ozbek 142 S and Sahin 2000 (*Gossypium hirsutum* L.), were evaluated at four locations. These locations were Nazilli-Aydin, Soke-Aydin, Saraykoy-Denizli and Menemen-Izmir in 2005. The experiment design was a Randomized Complete Block with four replications. The plots were 12 m length and consisted of six each row. The plant density for each experiment was 71420 plant ha^{-1}. The harvested area was 28 m^2.

The sowing dates of locations were between May 1 and May 15. The first and second pickings were realized at September and December, respectively. As pre-planting fertilizer, 500 kg ha^{-1} of 20-20-0 was used. Then 130 kg ha^{-1} of urea (46-0-0) as pre-flowering fertilizer was used before first irrigation. All cultural practices (irrigation and plant protection) were conducted on commercial cotton farming operations across the region. The lint yield (kg ha^{-1}) was determined by first and second picking the four center rows of each plot. Seed cotton was ginned at laboratory roller gin for lint percentage (%) in the Fiber Quality Laboratory at Nazilli Cotton Research Institute.

In order to study the stability of lint yield and lint percentage performance of cotton varieties, the parameters viz. mean lint yield and lint percentage over all sites (mean), linear regression coefficient (b) and mean squares of deviation from regression coefficient (S^2d) were computed according to regression techniques proposed by Finlay and Wilkinson (1963) and Eberhart and Russell (1966).

The relations between regression coefficients and lint yield and lint percentage were figure According to Arshad (1992). The confidence limits of the regression coefficients and lint yield and lint percentage on figure were estimated follows formula;

Confidence limit = x (average)±t-value. S_x

Results and Discussion

The results of variance analysis for lint yield and lint percentage are given in Table 1. There were significant differences between cotton varieties for both observed characteristics. The differences between environments (locations) were found significant for all characters. The significant genotype×environment interactions for all characters showed that the extent of such performance testing depended on the magnitude of genotype×environment interaction, which occurs when genotypes differ in their relative performance across environments (Bernardo, 2002). The genotype×environment interaction was also significant for seed cotton and lint yield in many studies (Opondo and Ombakho, 1997; Palomo *et al*., 1998; Mert *et al*., 1999; Yuksekkaya and Unay, 2002; Unay *et al*., 2004). These interactions must be significant to performing the stability analysis (Pederson, 1974).

Table 1: ANOVA analysis for observed characters

Source	df	Mean of squares	
		Lint yield	Lint (%)
Block (Environment)	8	1.58*	0.40
Genotype	5	1144.39**	34.25**
Environment	3	11124.96**	7.08**
Genotype×Environment	15	462.35**	9.86**
Error	40	0.69	0.36
Total	71		

*, **; significant at probability level 0.05 and 0.01, respectively

Table 2: Mean squares of deviation from regression (S^2d_i) and regression coefficients (b_i) for observed characters

Variety	Lint yield			Lint percentage		
	Mean (kg ha^{-1})	b_i	S^2d_i	Mean (%)	b_i	S^2d_i
Carmen	1848	1.484	17.33**	41.78	1.724	0.08
Eksi 911	1961	0.580	14.89**	44.43	0.944	0.18
Gurelbey	1768	0.783	229.73**	42.03	1.104	14.36**
Nazilli 84 S	2039	0.772	153.71**	43.19	0.281	4.53**
Ozbek 142 S	1979	1.425	41.36**	45.82	1.143	1.19**
Sahin 2000	1905	0.956	57.26**	41.61	1.366	2.94***.

**; significant at probability level 0.05 and 0.01. respectively.

The regression coefficient (bi) and deviation from regression (S^2d_i) as stability parameters and mean values for each variety are presented in Table 2. The lint yield was between 1768 kg ha^{-1} (Gurelbey) and 2039 kg ha^{-1} (Nazilli 84 S). For lint yield, bi values ranged between 0.580 (Eksi 911) and 1.484 (Carmen) and S^2d_i values ranged between 14.89 (Eksi 911) and 229.73 (Gurelbey). When both stability parameters were evaluated together, it was showed that the most stabile variety was Sahin 2000 because of its regression coefficient of one and deviation mean square of zero.

In the mean of the lint percentage values, Ozbek 142 S had the highest values with 45.82%, while the lowest value was found for Sahin 2000 variety. The regression coefficient varied from 0.281 (Nazilli 84 S) to 1.724 (Carmen) for lint percentage. Deviation from regression were between 0.08 (Carmen) and 14.36 (Gurelbey). It was said that Eksi 911 was the stabile variety for lint percentage.

Eberhart and Russell (1966) evaluated that an ideal variety is one which has the highest yield and a regression coefficient of one. Therefore, relationships between regression and mean lint yield and lint percentage for six varieties were evaluated. These results figured in Fig. 1 and 2.

Aegean Region standard variety and widely grown, Nazilli 84 S shown the best adaptation to all environments, while second commercial variety, Carmen and Ozbek 142 S and Sahin 2000 were group of the mid-adaptation to all environments. In study of Unay *et al*. (2004), Kurak 2, NAK 91-1 and Nazilli 84 S were found stabile genotypes. For Nazilli 84 S cultivar, this parallel result proved that Nazilli 84 S was the most stabile cultivar of Aegean Region. Gurelbey and Eksi 911 were outside of confidence limits for both lint yield and regression coefficient.

When the varieties were evaluated for lint percentage, Ozbek 142 S was considered as the group of the best adaptation to all environments because of its 1.19 regression coefficient and the highest lint percentage (45.82%). Eksi 911 variety followed Ozbek 142 S with 0.944 regression coefficient and 44.43% mean value. This variety also considered with the lowest deviation from regression (0.18). Unfortunately, Aegean Region standard and commercial varieties, Carmen and Nazilli 84 S were put outside of this type classification as being outside the confidence limits.

In conclusion, genotype×environment interaction and stability analysis demonstrated that there were significant differences among cultivars and environments. Therefore, new cotton genotypes should evaluated for stability in yield and fiber properties performance across the environments. Profitability of cotton production depends more on lint percentage than other fiber properties in

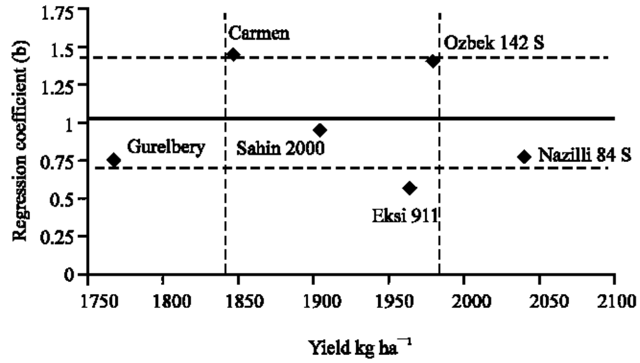

Fig. 1: Lint yields and regression coefficients of six cotton varieties

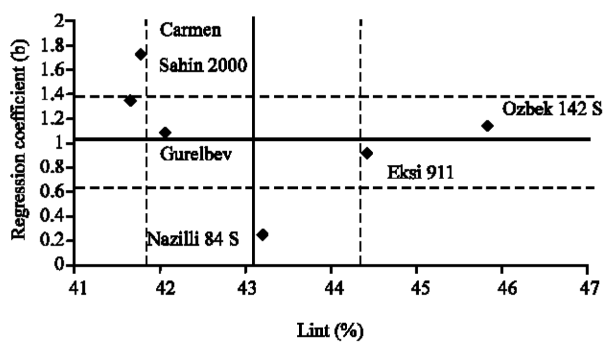

Fig. 2: Lint percentages and regression coefficients of six cotton varieties

Turkey. Therefore, Ozbek 142 S should be taken into consideration as suitable variety for Aegean Region. Moreover, this variety can be easily used as a parent in cotton breeding program.

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