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STABILITY PERFORMANCE OF SUNFLOWER CULTIVARS

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Abstract

This research evaluated the stability performance of sunflower cultivars in two groups of regional trials in the Northeast part of Greece. Genotype-environment interaction was measured by the linear response to environment effects and by the deviation from linear response. The data from the two groups of cultivars showed that only two hybrids were stable for seed yield across the examined environments. An open pollinated variety and a hybrid that was used as checks, displayed unstable performance. The majority of sunflower cultivars followed linear response to the environmental effects. However, the unpredictable component of the genotype-environment interaction variance i.e., the deviation from the linear response, had high variation and much more importance than the predictable component.

Introduction

Genotype-environment interaction is one of the main factors which affects negatively plant breeding. There is wide differentiation in response to environment. Some genotypes perform well at a given environment, but they may fail at another. This differential response is a genetic characteristic and reflects the stability performance of a genotype across the environments. Early generation selection in an array of sites, is one of the proposed efficient ways by Fasoulas (1988) to incorporate adaptability and stability performance. However, this can be done only by special field experimental techniques allowing the use of many replicates in evaluating locations.

In most breeding programmes, selection takes place in one location and follows multi-environmental screening to evaluate the stability performance. Subdivision of a heterogeneous area in smaller, more homogeneous regions and development of varieties into each of them is one approach, in order to overcome the problem of large genotype-environment interaction. Another approach is the development of varieties with high degree of stability over a wide range of environments.

Several methods have been proposed for measuring the stability performance of varieties. Finlay & Wilkinson (1963) proposed one useful technique for adaptation in barley. Linear regressions of the mean yield of individual varieties on mean yield of all varieties, for each site and season, were used as a measure of stability. Eberhart & Russel (1966) developed a statistical model for measuring stability parameters of a variety over a series of environments. Their model calculates an index for each of the environments. Regression coefficient and deviation from regression of a variety on the environmental indices, measure the response of varieties in various environments. Tai (1971) described another statistical approach for genotypic stability analysis. The genotype-environment interaction effect of a variety is partitioned into two components, the linear response to environmental effects (statistic $\hat{\alpha}$) and the deviation from the linear response (statistic $\hat{\lambda}$).

In this study the technique described by Tai (1971) was used to measure stability performance of sunflower hybrids and open pollinated varieties in the Northeast part of Greece.

Table 1. Sunflower hybrids and o.p. varieties tested for stability performance.

Group A (1986-1987)		Group B (1988-1989)	
Forsol	Hybrib	H-87	o.p.
Viki	Hybrib	Florasol	o.p.
Solarium-33	Hybrib	Sunbred-254	Hybrid
Olea	Hybrib	Isabel	Hybrid
Solarium-44	Hybrib	Mirasol	Hybrid
Isabel	Hybrib	Isis	Hybrid
Cavissos	o.p.	Cavissos	o.p.
Citosol	Hybrid	Cargisol	Hybrid

Materials and Methods

Two groups of sunflower hybrids and o.p. varieties were chosen to be the tested material. The first group (Table 1) that included seven hybrids and one o.p. variety had been tested in four locations over the period of two years (1985-1986). The second group, which included six hybrids and two o.p. varieties, had been tested during 1987-1988 in eight locations (Table 1). One o.p. variety (Cavissos), and one Hybrid (Isabel), were checks in two groups during experimentation. Each trial was grown in a randomized complete block design, with four replicates. A plot consisted of two rows, each 10 m long and 75 cm apart. Standard agronomic practices adopted by farmers in the area, including regular irrigation in some cases, were followed in the trials.

Combined analysis of variance was computed for the two group of trials. For each hybrid or o.p. variety stability statistics $\hat{\alpha}$ and $\hat{\lambda}$ were estimated, using the method described by Tai (1971). Statistic $\hat{\alpha}$ estimates the linear response of seed yield to environmental effects and it is computed from the formula $\hat{\alpha}$ = SI (GL),/(MSL-MSB)/mp where SI stands for the variance due to environmental effects, (GL), is the

Table 2. Combined anova table for seed yield (tn/ha) of two groups of sunflower regional trials.

Source variation	Group A (1986-1987) df	MS	Group B (1988-1989) df	MS
Locations	7	26.289**	15	21.54**
Repl. within Loc.	24	0.014	48	0.2
Varieties	7	0.159**	7	0.894**
Varieties x Loc.	49	0.127**	105	0.320**
Error	168	0.013	336	0.139

** P = 0.99

ariance associated with interaction effects among variety and environment. The terms MSL and MSB are the mean squares of the environmental effects and replicates within environments derived from combined analysis of variance. The letters m and p n the formula mentioned above, stand for the number of varieties and replicates espectively. Statistic $\hat{\lambda}$ estimates the deviation from linear response, using the for- nula $\hat{\lambda} = S^2 (GL), - aSI (GL),/(m-1) MSE/mp$ where MSE stands for mean square lue to the error also derived from combined analysis of variance.

The values $\hat{\alpha}$ and $\hat{\lambda}$ statistics for each cultivar were plotted in two orthogonal xes system. Two curves (hyperbolae) were made for each group, where 95% and 99% espectively of predicted a's are included if the true a was zero. Theoretical con- idence intervals for hypothetical $\hat{\alpha}$ values were also constructed. The first two verti- al lines in the figures were the limits of the 95% confidence interval for $\hat{\alpha} = 1$. These vertical lines separated the curves into different stability regions. The region nto curves included cultivars which do not differ significantly from average stability, $(\hat{\alpha}, \hat{\lambda} = (0.1)$. The region just below included cultivars with perfect stability perfor- mance $(\hat{\alpha}; \hat{\lambda} = (-1,1)$. Cultivars with statistics $\hat{\alpha}$ and $\hat{\lambda}$ out of these regions are described as unstable in yielding performance.

Results and Discussion

Table 2 provides the results of combined analysis of variance for seed yield. The environment, varieties and environment x varieities interaction mean squares were sig- nificant at 1% level of propability. Mean seed yield and estimation of $\hat{\alpha}$ and $\hat{\lambda}$ parameters are presented in Table 3.

In group A. hybrid Solarium 33 was the top yielder, with significantly higher dif- ference from the check o.p. varieity Cavissos. Also significant differences existed among the two checks. In group B the hybrid Florasol had the highest yielding ability. Isabel was the second in arrangement whereas the other check cultivar Cavissos yielded significantly lower.

Table 3. Mean seed yield (tn/ha) and estimates of $\hat{\alpha}$ and $\hat{h}$ parameters of two groups of sunflower regional trials.

	Group A (1986-1987)				Group B (1988-1989)		
Cultivar	$\bar{x}$	$\hat{\alpha}$	$\hat{h}$	Cultivar	$\bar{x}$	$\hat{\alpha}$	$\hat{h}$
Forsol	3.11	+0.02	3.28	H-87	2.84	-0.18	3.37
Viki	3.05	+0.02	1.30	Florasol	3.06	+0.09	3.40
Solarium 33	3.21	-0.17	16.27	Sunbred 254	2.96	+0.19	0.94
Olea	3.18	-0.07	10.48	Isabel	3.00	+0.20	1.60
Solarium 44	3.13	+0.13	5.06	Mirasol	2.81	-0.04	2.22
Isabel	3.17	+0.08	3.01	Isis	2.72	-0.14	1.46
Cavissos	3.10	+0.01	13.91	Cavissos	2.79	-0.11	2.94
Citosol	2.99	-0.03	7.00	Cargisol	2.95	-0.15	1.77
LSD_{05}	0.06			LSD_{05}	0.13		

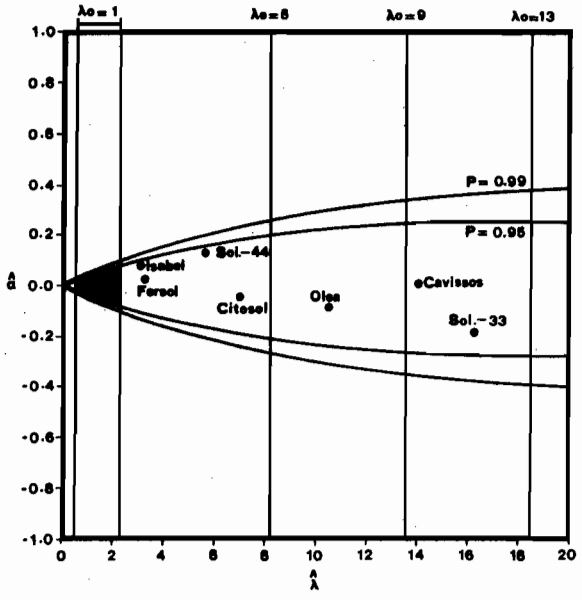

Fig.1. Stability statistics of seed yield in eight sunflower cultivars (group A).

Fig.1 illustrates the distributions of statistics $\hat{\alpha}$ and $\hat{\lambda}$ of sunflower cultivars in the 1986-1987 regional trials. The curve P=0.95 includes 95% of predicted a's if the true a is zero and the second P=0.99 the 99% of predicted $\hat{\alpha}$ s' if the true a is zero. All cultivars had $\hat{\alpha}$ values that are included in P=0.95 curve. So, there was linear response to the environmental effects. However, the $\hat{\lambda}$ statistic showed great variation in all cultivars. These results suggested that the unpredictable component of the genotype-environment interaction variance was much more important than the predictable one. Similar results had been reported by Baker & Leisle (1969) in wheat and Tai (1971) in potatoes. Only one hybrid, Viki, showed average stability (shaded area in Fig.1 are the limits). The values a=0 and λ=1 refer to average stability and correspond to values b=1 and $S=d^2$ in Eberhart & Russel (1966) model. However, hybrid Viki gave a low yield. Hybrid Solarium-33 had the higher seed yield but showed a very unstable performance. The check cultivar Cavissos was also unstable but the other check, Isabel, gave statistics $\hat{\alpha}$ and $\hat{\lambda}$ near to average stability region.

In Fig.2, the stability statistics $\hat{\alpha}$ and $\hat{\lambda}$ of the second series of trials (group B. 1988-1989) are plotted. Two hybrids. Sunbred- 254 and check Isabel, showed significantly different linear response to the environmental effects (P=0.95). The average stability region (shaded area in Fig.2) enclosed only the hybrid Isis. that had the lowest yielding ability. The hybrid Cargisol had a stability performance similar to the Isis, but was located out of the average stability region. The o.p. variety Cavissos showed again unstable performance. The hybrids Florasol and Mirasol that gave high yields, showed also unstable performance.

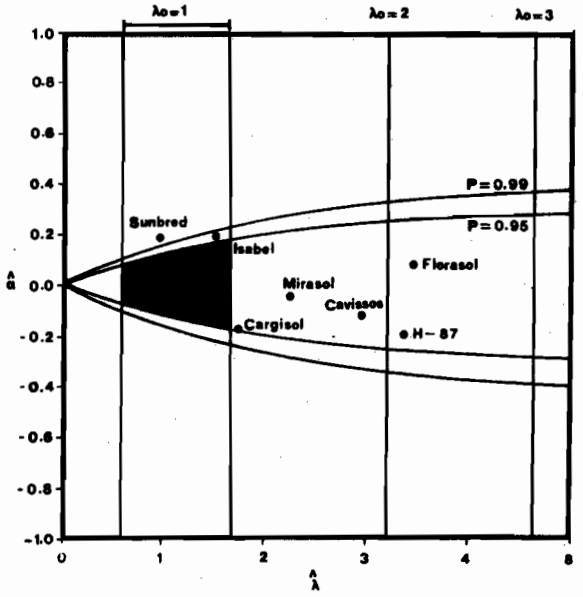

Fig.2. Stability statistics of seed yield in eight sunflower cultivars (group B).

From 14 cultivars that were examined, only two hybrids Viki and Isis, showed average stability performance. The high yielding hybrids and the checks were unstable. All trials took place in the Northeast part of Greece in a relatively small area. There, existed a diversity of environmental conditions, which was the reason of high genotype-environment interaction. Another important aspect in results was the unpredictable component of genotype-environment interaction variance.

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