A.A. Zali and
P. Vojdani, Iran

ADAPTATION OF SUNFLOWER VARIETIES CULTIVATED IN DIFFERENT ENVIRONMENTS

Stability performance of some varieties in very different environmental conditions is of interest both for agronomists and plant breeders. When varieties of a crop are compared over different environments their relative ranking is usually different, which makes it difficult to demonstrate the significant superiority of any variety. Genotype-environment interaction is caused by different reactions of genotypes to changes in the soil climatic and weather conditions.

Various procedures have been proposed to reduce genotype-environment interactions. Two of the more important procedures are: (a) stratification of the environments based on environmental differences such as rainfall distribution, soil types, temperature and altitude gradients, (b) selection of more stable genotypes that interact less with the environments in which they are to be grown, i.e. development of varieties possessing general adaptability.

Adaptability of different genotypes can be studied by:

1. Measurement of genotype-environmental interaction in a combined analysis of variance of the data obtained from varietal performance in several environments and years.

2. Estimation of the regression coefficient for average performance of each variety on the environmental index where the index for each environment is the average performance of all genotypes in that environment.

Although the first method has been used by various workers (G.F. Sprague and W.T. Federer, 1951; F. Yates and W.C. Cochran, 1938), it lacks precision and is difficult to use when large number of genotypes are being tested. To

overcome these difficulties, the regression method was proposed by Yates and Cochran in 1938 and was adopted by different investigators (B. Ehdai, 1975; K.W. Finlay and G.N. Wilkinson, 1963). In this method the adaptation of varieties are studied by the use of a two dimensional scatter diagramme with mean yield and regression coefficient as coordinates for each variety. The types of response for different varieties are as follows.

(a) Population mean has a slope, b = 1.

(b) b = 1.0 indicates average stability and when associates with low mean yield, the variety is poorly adapted to all environments.

(c) b > 1.0 describes varieties more sensitive to environmental changes and that are adapted to high yielding environments.

(d) b < 1.0 indicates relative insensitivity to environmental changes and such varieties that are specially adapted to low yielding environments.

Regression method was further developed by Eberhart and Russell in 1966. They defined a stable genotype as one with b = 1 and s^2d represents the mean squares of the deviation from regression.

The method proposed by Eberhart and Russell was applied in this study to learn about the adaptability of 15 different sunflower varieties grown in different parts of Iran.

Data obtained from sunflower yield trials conducted by the Institute of Seed and Plant Improvement were used in this study. Fifteen sunflower varieties. VNIIMK 8931, Mayak, NS-Peredovik, NSP-317, NSP-61, Chernyanka, Armavirsky, VNIIMK 6540. Record (Blit), Record (Certified), Orizent, Hybrid 52. Hybrid 53. Louch and Armavirets, were Compared in Karaj, Dashte Naz, Gorgan and Moghan for 3 years. Complete randomized block design with 5 replications was used for all trials. Each plot consisted of 6 rows, 6 meter long and 60 centimeters apart and only 4 middle rows were harvested. The

data obtained on grain yield/ha, oil percentage and total oil/ha were under consideration. The mean performance of all varieties at each site and for each season provides a numerical grading of sites and seasons and is used as an index for any environment.

For each variety a linear regression of individual performance on the mean performance of all varieties for each environment, as well as the deviation from regression, s^2d, was computed. A combined analysis of variance was performed for each character to learn about the differences between genotypes and environments, as well as deviation from regression for all varieties under study. Moreover, regression coefficients were also computed for each variety.

Mean squares from analysis of variance performed on seed yield, oil percentage and total oil yield of varieties grown in different environments are shown in Table 1. Significant differences were observed when varieties, environments and varieties in different environments were compared. Variety-environment interaction was significant for all characters and indicates differences in the performance of varieties under different environmental conditions.

The data obtained suggest the following conclusions:

1. Hybrids 52 and 53 as well as VNIIMK 6540 were higher in grain yield and total oil/ha whereas Armavirets and Chernyanka were lower as compared to other varieties. Majak and Armavirets with an average of 47.4 and 44.1% of oil produced the highest and lowest percentage of oil, respectively.

2. The average grain yield of NSP-317. Orizent, Mayak and NS-Peredovik was about the average of all varieties in each environment and their regression coefficient was about 1.0, indicating average stability and adaptability. Hybrid 52 with regression coefficient of 1.0, yielded more than the average of other varieties, show-

Table 1

Mean Squares from Analyses of Variance of 15 Sunflower Varieties Grown in 12 Environments

Source of variation	D.F.	Mean squares		
		Seed yield	Oil percentage	Oil yield
Genotype	14	573943**	9.80**	102317**
Environments	11	1225424**	100.10**	317890**
Genot. x Env.	154	250291**	1.49**	37065**
Within varieties	165	315300**	9.50**	55787**
Regression	15	1449837**	77.65**	331832**
Dev. from Reg.	150	201846**	2.69**	28182**
Reps. W/in env.	48	4901**	0.40**	65**
Residual	672	1280	0.18	16

Table 2

Stability Parameters and Performance for Different Entries

Entry	Seed yield			Oil percentage			Oil yield		
	$\bar{x}$	b	S^2_d	$\bar{x}$	b	S^2_d	$\bar{x}$	b	S^2_d
1	2	3	4	5	6	7	8	9	10
VNIIMK 8931	3106	1/58	0/243	47/07	1/19	0/750	1269	1/54	0/679
Mayak	3038	1/34	0/595	47/43	0/94	2/225	1269	1/18	0/830
NS. Peredovik	3045	1/34	0/501	47/38	1/37	0/785	1272	1/34	1/059
NSP 317	3165	1/07	1/143	45/53	1/32	3/263	1293	1/06	1/397
NSP 61	3037	1/41	0/543	47/28	1/21	1/059	1246	1/50	0/557
Chernyanka	2758	1/27	1/823	45/23	0/85	2/576	1125	0/43	6/342
Armavirsky	2125	1/87	1/375	45/98	0/98	1/201	1245	1/62	2/851
VNIIMK 654	3231	1/61	0/561	47/22	1/20	1/946	1332	1/49	1/592
Record (Blit)	3160	0/59	1/118	46/63	1/17	2/360	1275	0/58	2/345
Record (Cert.)	2964	1/06	1/389	45/87	0/85	3/801	1254	1/24	1/297

Table 2 (cont.)

1	2	3	4	5	6	7	8	9	10
Orizent	3174	0/95	1/342	45/99	0/78	2/886	1265	1/10	2/352
H-52	3510	0/86	1/560	46/84	1/02	0/792	1428	1/25	3/099
H-53	3378	1/66	0/881	46/20	0/86	1/84	1369	1/53	1/899
Louch	2818	-0/70	3/852	46/24	0/41	7/238	1299	0/25	8/343
Armavirets	2683	-0/91	4/681	44/15	0/84	7/637	1031	0/58	7/631

ing average stability and good general adaptability, whereas averagely stable Chernyanka produced lower mean yield and showed poor general adaptability.

VNIIMK 8931. Hybrid 53 and Armavirsky with a regression coefficient above 1.0 showed more sensitivity to changes of environment. They are expected to perform well in good environments and are recommended for areas with more favourable conditions. On the other hand, Louch and Armavirets with a regression coefficient less than 1.0 showed less sensitivity. These two varieties can be recommended for poor environmental conditions.

VNIIMK 8931, NSP-61, NS-Peredovik with b = 1.0 showed more sensitivity for their oil percentage. There were less fluctuations in oil percentage in other varieties with a regression coefficient of 1.0 and they showed average stability for this quantitative character.

NSP-317. Record (Blit. & Cert.) Mayak, Orizent and Chernyanka are considered to have average stability and general adaptability for their total oil yield, whereas Hybrid 52 showed average stability with good general adaptability. VNIIMK 6540, Hybrid 53, NS-Peredovik, VNIIMK 8931. NSP-61 and Armavirsky with a regression coefficient above 1.0 showed more sensitivity for their total oil yield and can be recommended for more suitable anvironments.

Louch variety for its grain and oil yield and oil percentage and Armavirets for its total grain and oil yield are considered to have poor general adaptability and are recommended for the area with less favourable conditions.

References

1. Eberhart, S.A. and Russell, W.A. 1966. Stability parameters for comparing varieties. Crop Sci., 6, 36-40.
2. Ehdai, B. 1975. Adaptation of safflower genotypes in different environments. 9th Oil-Seed Conference. University of Tehran, Iran.
3. Finlay, K.W., and Wilkinson, G.N. 1963. The analysis of adaptation in a plant-breeding programme. Aust. J. Agric. Res., 14, 742-754.
4. Sprague, G.F., and Federer, W.T. 1951. A comparison of variance components in corn yield trials. II. Error. year X variety, location X variety, and variety components. Agron. J., 43, 536-541.
5. Yates, F., and Cochran, W.G. 1938. The analysis of groups of experiments. J. agric. Sci., Camb., 28, 556-680.