STABILITY PARAMETERS OF OIL AND PROTEIN CONTENT IN PROTEIN SUNFLOWER LINES

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Abstract

Oil and protein content phenotypic stability in seeds of three sunflower lines (*Helianthus annuus* L.) in their third, fourth and fifth years of self-fertilization was analyzed over a period of two years and in three different agroecological localities. Stability parameters were processed using a model proposed by Eberhart and Russell (1966). Regression coefficient showed the tested lines to have satisfactory stability for both traits. Regarding oil content, somewhat higher stability was found in Kolos, a cultivar used in this experiment as the standard, while the most unstable was line D 4441 in its fourth year of self-fertilization. The highest stability of protein content in seeds was found in line D 4441 in the third year of self-fertilization. The lowest stability of that trait, as well as oil content, was found in line D 4441 in the fourth year of self-fertilization.

Introduction

Developing a protein type of hybrid sunflower with desirable traits requires inbred lines with high protein content and low oil content in the seeds. Each phenotype is the result of an interaction between genotype and the environment, i.e., of a total of genetic and various environmental factors, a system of genotype/environment interactions, and random causes (Mather, 1949; Falconer, 1960; Mather and Jinks, 1971). The breeder's main concern, however, is not the statistical interaction of G x E itself, but changes in the order of genotypes under different conditions of the environment (Fox and Rosielle, 1982).

There is a series of models enabling analysis of the genotype adaptability to environmental conditions. The biological concept considers as stable the genotypes that retain constant yield or value of some other quantitative trait, regardless of the changeable ecological factors (Becker, 1981). Under the biological concept, stability is not always desirable as advancement of agricultural practices and improvement of conditions of cultivation in general are not followed by changes in genotype reaction. The agronomic concept of stability is therefore much more acceptible to breeders. A certain measure of phenotypic stability is represented by the genotype's slight contribution to the existing genotype/environment interaction (Mihaljčević, 1989).

This investigation aimed to determine the variability of the investigated phenotypic traits of inbred sunflower lines, the genotype/environment interaction and the degree of stability depending on the degree of homozygosity (year of self-fertilization) and environmental conditions.

Materials and Methods

Three promising inbred sunflower lines in their third, fourth and fifth years of self-fertilization were used in the investigation. The chosen lines originate from the protein cultivar Kolos, selected at the Agricultural and Technological Research Centre in Zajecar. Kolos was used as the standard. The selected lines of S3, S4 and S5 generations were sown in 1997 and 1998 applying a randomized block design with three replications in the experimental fields of the Agricultural and Technological Research Centre in Zajecar, the School of Agriculture in Leskovo, and the Stig Agricultural Institute in Pozarevac. Sowing was done on a well-prepared soil at optimal time for each locality.

The acquired experimental data were processed by a three factorial analysis of variance, while stability parameters were processed by regression analysis according to Eberhart and Russell (1966). The stability parameters of this model are the mean values (x), linear regression coefficient (b) and deviation from regression (S2d). T-test was used to examine the significance of the regression coefficient using the standard error of the average coefficient Se(b). According to Eberhart and Russell (1966), a stable genotype has the regression coefficient of around 1.0 ($b \cong 1$) and a minimal deviation from regression ($S^2d \cong 0$).

Results and Discussion

Oil and protein contents in seeds of three sunflower lines in their respective S3, S4 and S5 generations showed significant mean variations. The highest oil content mean for the two years and all localities was found in line Rs 4 I 10 in its third year of self-fertilization (32.49%), the standard deviation being 3.0, while the lowest (18.32%) was recorded for line D 4441 in its fifth year, with a high standard deviation (4.3). Line Rs 4 I 10 in the third year of self-fertilization had the highest mean protein content (22.05%) calculated for both years of investigation and for all localities, while line D 4441 in the fifth year had the lowest mean (19.16%), Table 1.

Table 1. Means (%) of oil and protein contents in different sunflower lines in their S3, S4 and S5 generations of self-fertilization (year and locality average).

INBRED LINE		**Average ± δ**	**Average ± δ**
1.	**Rs 4 I 10-S_3**	32.49 ± 3.0	22.05 ± 2.2
2.	**Rs 4 I 10- S_4**	30.86 ± 3.0	21.79 ± 2.2
3.	**Rs 4 I 10-S_5**	29.12 ± 3.1	21.26 ± 2.3
4.	**D 4441- S_3**	28.23 ±2.7	21.39 ± 2.6
5.	**D 4441- S_4**	21.45 ± 5.6	19.99 ± 2.1
6.	**D 4441- S_5**	18.32 ± 4.3	19.16 ± 2.5
7.	**Ko 7 - S_3**	29.87 ± 2.5	21.66 ± 2.7
8.	**Ko 7 - S_4**	26.11 ± 3.2	21.06 ± 3.0
9.	**Ko 7 - S_5**	23.90 ± 1.7	20.61 ± 3.1
10.	**Kolos-standard**	31.04 ± 4.2	21.43 ± 2.9

Genotype x Year x Locality LSD 0.05 =3.604 LSD 0.05 =1.740
0.01 = 4.763 0.01 = 2.300

Oil Content in Seeds. The data acquired using the analysis of variance indicate highly significant differences in seed oil contents between lines, localities and years, and the same applies to all interactions except genotype x locality, in which differences were significant. Of the total variance, genotype accounts for 64.69%, interaction of the second order (genotype x year x locality) for 11.06%, and the genotype x year interaction for 7.90%, with a comparatively high experimental error (16.35%), Table 2.

Table 2. ANOVA for oil contents in seeds of different sunflower lines in S3, S4 and S5 generations of self-fertilization.

Source of variation	Degree of freedom (DF)	Mean squares (MS)	F-relation	Variance components σ2	%
Years –G	1	206.60	41.60***		
Localities – L	2	74.17	14.94***		
G x L	2	179.94	36.23***		
Genotype – S	9	384.05	77.33***	19.66	64.69
S x G	9	36.69	7.39***	2.40	7.90
S x L	18	8.48	1.71*	0.00	0.00
S x G x L	18	15.05	3.03***	3.36	11.06
Error	118	4.97		4.97	16.35
				30.39	100.00

Parameters of stability indicate the genotypes' different reactions to changed environmental conditions regarding oil content in seeds. The stability of genotypes is evaluated by ranking the regression coefficient (b) deviations from 1, and ranking values of deviation from regression (S2d). According to those parameters, the standard cultivar Kolos was the most stable regarding that trait (second ranking for b=0.88, and first ranking for S2d=0.09), while Rs 4 I 10 in the fifth year of self-fertilization, having a regression coefficient of 1.06 and deviation from regression of -0.87, was the most stable line. The lowest stability over the period of investigation was recorded for line D 4441 in the fourth year of self-fertilization (b=0.31 and S2d=8.39), which ranked tenth for both parameters, Table 3 and Fig. 1.

Table 3. Stability parameters for oil contents in different sunflower lines of S3, S4 and S5 generations.

Inbred line	b	Rank	S2d	Rank
Rs 4 I 10-S3	0.47	5	-0.87	8
Rs 4 I 10- S4	1.49	6	-0.24	3
Rs 4 I 10-S5	1.06	1	-0.87	7
D 4441- S3	1.43	4	-0.84	5
D 4441- S4	-0.31	10	8.39	10
D 4441- S5	-0.17	9	-0.14	2
Ko 7 - S3	1.76	7	-0.54	4
Ko 7 - S4	2.05	8	1.27	9
Ko 7 - S5	1.34	3	-0.87	6
Kolos-standard	0.88	2	0.09	1

Standard error for the average regression coefficient Sb 0.886

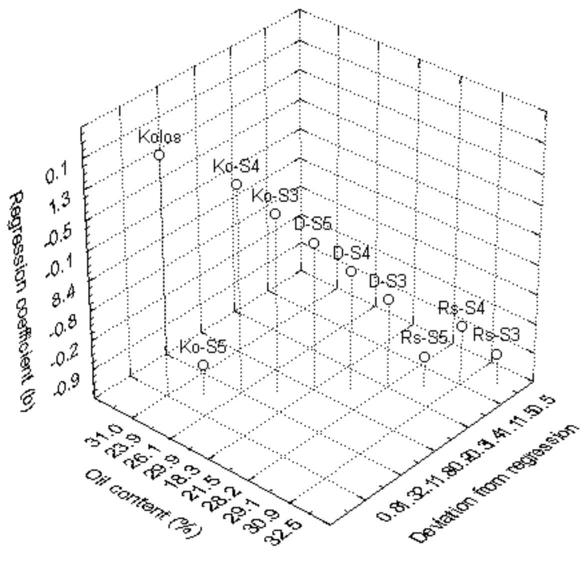

Figure 1. Relation between oil content and stability parameters of sunflower inbred lines.

Protein Content in Seed. The analysis of variance applied to the material investigated at three localities over the period of two years showed that differences between genotypes, localities and years of investigation, as well as the first order interactions (locality x year), were highly significant for the protein content in seeds. Very significant differences were recorded for the first and second order interactions, i.e., genotype x year and genotype x locality x year, respectively. No significant differences were recorded for the genotype x locality interaction. Genetic differences between the investigated inbred lines accounted for 26.42% of total variance, with exceptionally high participation of random variance (47.15%), Table 4.

Table 4. ANOVA for protein contents in different sunflower lines of S3, S4 and S5 generations of self-fertilization.

Source of variation	Degree of freedom (DF)	Mean squares (MS)	F-relation	Variance components σ2	%
Years – G	1	755.22	670.12***		
Localities – L	2	19.03	16.45***		
G x L	2	43.17	37.32***		
Genotype – S	9	14.25	12.32***	0.65	26.42
S x G	9	3.99	3.45***	0.15	6.10
S x L	18	1.23	1.06 ns	0.00	0.00
S x G x L	18	2.65	2.29**	0.50	20.32
Error	118	1.16		1.16	47.15
Total				2.46	100.00

Considering the values acquired for both stability parameters, the most stable line for this trait was D 4441 in the third year of self-fertilization (b=1.27 and S2d=0.11). Lines Rs 4 I 10 and Ko7 were nearest to the average stable genotype in their fourth generations of self-fertilization. Line D 4441 in S4 generation (b=0.20 and S2d=-0.17) was the most unstable genotype for protein content, Table 5 and Figure 2.

Table 5. Stability parameters for protein content in different sunflower lines of S3, S4 and S5 generations.

Inbred line	b	**Rank**	S2d	**Rank**
Rs 4 I 10-S_3	0.46	6	-0.17	7
Rs 4 I 10- S_4	0.90	2	-0.16	6
Rs 4 I 10-S_5	1.84	8	-0.17	8
D 4441- S_3	1.27	1	-0.11	2
D 4441- S_4	-0.20	9	-0.17	9
D 4441- S_5	0.48	5	-0.15	5
Ko 7 - S_3	0.65	4	-0.17	10
Ko 7 - S_4	0.71	3	-0,12	3
Ko 7 - S_5	1.61	7	-0.12	4
Kolos-standard	2.28	10	0.05	1

Standard error for the average regression coefficient Sb 0.285

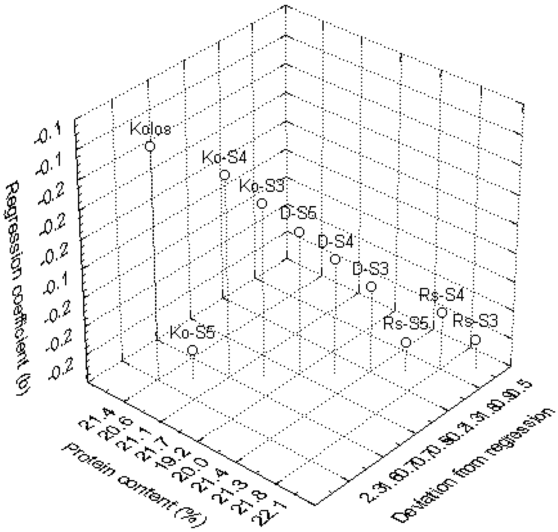

Figure 2. Relation between protein content and stability parameters of sunflower inbred lines.

No statistical significance was found in the regression coefficient for oil and protein contents in seeds, which indicates that regression (b) was not significant, i.e., no significant reaction of the genotype to different localities and years was expressed in this particular investigation.

Conclusions

The data acquired from investigating the ecological stability of 10 sunflower genotypes, using the Eberhart and Russell (1966) method, at three localities over a period of two experimental years suggest the following conclusions. ANOVA results show a satisfactory stability of oil and protein contents in the overall seed samples, but differences were found when individual reactions of genotypes in their different generations of self-fertilization were tested to altered environmental conditions.

Regarding oil content, a somewhat higher stability was found for the cultivar Kolos, which was used as the standard in this investigation (b=0.88 and S2d=0.09), while line D 4441 in the fourth year of self-fertilization was the most unstable (b=0.31 and S2d=8.39).

Line D 4441 in the third year of self-fertilization was found to be the most stable for protein content in seeds (b=1.27 and S2d=0.11). The lowest stability for that trait was again, as for the oil content, recorded in line D 4441 in its fourth year of self-fertilization (b=0.20 and S2d=0.17).

The analysis of sunflower genotypes in different years of self-fertilization, grown in three different agroecological localities over a period of two years, contributes to our better understanding of the behavior of those genotypes in different conditions, which facilitates proper choice of parent plants in sunflower breeding programs.

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References

Becker, H.C. 1981. Correlation among some statistical measures of phenotypic stability. Euphytica. 30:835-840.

Eberhart, S.A. and Russell, W.A. 1966. Stability parameters for comparing varieties. Crop Sci. 6:36-40.

Fox, P.N., and Rosielle, A.A. 1982. Reducing the influence of environmental main-effect on pattern analysis of plant breeding environments. Euphytica. 31:654-656.

Frankel, R., and Galun, E. 1977. Pollination Mechanisms, Reproduction and Plant Breeding. Springer-Verlag, New York.

Mather, K. 1949. Biometrical Genetics. Mathuen Co. London, 162 pp.

Mather, K. and Jinks, J.L. 1971. Biometrical Genetics. Second Edition. Chapman and Hall, London. p. 241-271.

Mihaljčević, M. 1989. Fenotipska stabilnost inbred linija i hibrida suncokreta tolerantnih prema *Sclerotium bataticola Taub.* Doktorska disertacija, Poljoprivredni fakultet, Univerzitet u Novom Sadu.