Dr. Dragan Škorić,
Yugoslavia

MODE OF INHERITANCE OF OIL CONTENT IN SUNFLOWER SEED OF F_1 GENERATION AND COMPONENTS OF GENETIC VARIABILITY

Introduction

Oil yield per area unit is the basic objective of sunflower growing. It is the sum of seed yield and oil content in seed. The contribution of oil content to oil yield is large. Zdanov (1966) maintains that an increase of oil content by only 1% significantly increases the oil yield per area unit. This is why the breeding for a high percentage of oil in seed is one of the basic objectives in the development of sunflower hybrids based on male sterility.

A thorough knowledge of the mode lf inheritance and the variability of this character offers the possibility to achieve the desired goal faster. Schuster (1964) states that the heritability of oil content in sunflower seed is low. According to Pustovoit (1963), the heritability of oil content in sunflower seed in F-1 generation is intermediary. The variability of oil content in seed, which is a quantitative character, is large both within the same varietal population and among different varietal populations (Morozov, 1974). The variability of this character is influenced by genetic as well as environmental factors.

A number of authors dealt with the combining ability of different sunflower inbred lines as regards their oil content in seed (Schuster, 1964; Putt, 1966; Gundaev, 1966 and 1968; Stoianova et al., 1971; etc.). The majority of them concluded that the heterosis (in relation to a better parent) for the oil content in seed is not manifested frequently while its intensity is weak.

The results obtained by Putt (1966) show that the component of general combining ability (GCA) is considerably higher than that of specific combining ability (SCA). This is the basis for the conclusion that the additive effect of genes is more important for the expression of oil content in sunflower seed than the non-additive effect.

The objective of this research was the evaluation of combining ability of different inbred lines, determination of the mode of inheritance of oil content in sunflower seed in F-1 generation, and the determination of the components of genetic variability.

Material and Method

Ten inbred lines from different varietal populations in S_9 generation were assayed in the research. The following lines were included: A-9343-2, Sm-3, A-3497-2, CR-2, SR-1, Pr-1, NS-7, AŠ-6, V-1640-2, and CM-1. Diallel crossings, excluding the reciprocal ones, were performed in 1973. The plants used as maternal components were artificially male sterilized with a solution of ghiberellic acid (3 cm^3 H_2O + 0.5 mg of ghiberellic acid per plant at the beginning of budding.) All hybrid combinations in F-1 generation were comparatively tested with the parental lines in 1974.

The tests were conducted in three replications, at random design. The basic plots included 30 plants at harvest. The oil content in seed was determined in the average samples of the basic plot after the method NMR (NMR analyser, IJS-2-71). In order to obtain a complete insight into the components of genetic variance and the effect of genes on the oil content in seed, the analysis of diallel crossings was used for their combining ability. The analysis was performed according to Griffing (1956), method 2, model I.

The analysis of the components of genetic variance and the regression analysis were performed according to the methods of Jinks (1954), Hayman (1954), and Mather and Jinks (1971)

Research Results

The oil content in sunflower seed showed a continual variability with the frequency distribution within the normal curve. It was characteristic for the majority of the quantitative characters. The oil content in seed of the examined inbred lines ranged from 27.50% (SR-1) to 43.75% (A-3497-2) (Table 1). Their hybrid combinations in F-1 generation differed this character. The lowest oil content in seed was found in the combination CR-2xNS-7 (30.40%), the highest in A-9343-2xA-3497-2 (47.08%).

The inheritance of oil content in seed in F-1 generation showed partial dominance, full dominance, superdominance, and intermediarity. According to the obtained results, the majority of the examined hybrid combinations in F-1 generation showed partial dominance (F-1 similar to one of the parents) and full dominance (F-1 the same as one of the parents), while superdominance, i.e., heterosis (F-1 significantly better than the better parent) was found in nine hybrid combinations. A small number of hybrid combinations showed intermediarity (F-1 the same as the parents' average).

Superdominance was found in three hybrid combinations, the parents of which differed regarding the oil content in seed (A-3497-2xCR-2, A-3497-2xSR-1, and CR-2xSR-1). The occurrence of superdominance in other hybrid combinations, the parents of which did not vary significantly regarding the oil content in seed, was due to the parental divergence in other characters and the interaction among these characters (A-9343-2xA-3497-2, Sm-3xCM-1, etc.).

The analysis of variance of the combining abilities showed that the additive and non-additive components of genetic variance were important for the inheritance of oil content in sunflower seed in F-1 generation. The ratio GCA/SCA showed the additive component to be 11.2 times higher than the non-additive one. These results indicate that the additive effect of genes regarding the inheritance of oil content in seed is more important than the non-additive effect. These results agree with the results of Putt (1966).

Among the examined inbred lines, the lines A-3497-2, Sm-3, A-9343-2, AŠ-6, and Pr-1 had high values of GCA. The crosses between the lines A-9343-2, Sm-3, A-3497-2 on one side and the lines CR-2 and SR-1 on the other had the highest values of SCA. The cross CR-2xSR-1 had a high value of SCA. These results show that the crosses with a high value of SCA usually include a parent with a high value of GCA and another parent with a low value of GCA (Table 2). It means that the combining ability of certain line is valid only for a certain combination and that in a combination with another line the first line does not have to be a poor combiner for the examined character.

A further analysis of the components of genetic variability showed that the value of the additive component (D = 33.1844) was considerably higher than the value of the dominant component (H_1 = 2.0669, H_2 = 0.6520). Therefore, the main portion of the genetic variance comes from the additive component in the inheritance of oil content in seed (Table 3). Regarding the expression of oil content in seed, the dominant alleles were superior to the recessive ones since the obtained value F (interaction additive x dominant effect) was positive. It was also confirmed by the calculation of allele frequency. The frequency of dominant alleles (u = 0.913) was much higher than the frequency of recessive ones (v = 0.087). Dominant and recessive alleles were not uniformly distributed among the examined inbred lines ($H_2/4H_1$ = 0.0787). More-

Analysis of Results of Diallel

N°	N°	1	2	3	4
	Line	A9343-2	Sm-3	A3497-2	CR-2
1.	A-9343-2	42.55	42.05	47.08**	44.09
2.	Sm-3		42.56	43.68	43.83
3.	A-3497-2			43.75	45.61*
4.	CR-2				30.77
5.	SR-1				
6.	Pr-1				
7.	NS-7				
8.	AŠ-6				
9.	V-1640-2				
10.	CM-1				

LSD 5% = 1.74%
1% = 2.30%

Table 1

Crossing (Oil content in seed - %)

5	6	7	8	9	10
CR-1	Pr-1	NS-7	AŠ-6	V1640-2	CM-1
41.48	41.77	41.28	44.04	43.36	42.97
42.89	43.85	41.72	44.89*	45.11*	45.70**
47.03**	43.66	41.21	45.27	43.05	42.68
39.96**	32.73	30.40	35.01	33.52	34.25
27.50	41.40	34.46	41.44	31.33	31.25
	42.55	37.82	44.79*	43.35	45.22**
		37.53	40.45	39.41	42.97
			42.90	43.29	41.56
				43.09	43.96
					42.26

N°	N°	2	3	4	5
	Line	Sm-3	A3497-2	CR-2	SR-1
1.	A-9343-2	-3.16	1.21	5.37**	2.32**
2.	Sm-3		-2.66	4.64**	3.26**
3.	A-3497-2			5.76**	6.74**
4.	CR-2				6.82**
5.	SR-1				
6.	Pr-1				
7.	NS-7				
8.	AŠ-6				
9.	V-1640-2				

LSD 5% = 1.60
1% = 2.31

Table 2

Values

6	7	8	9	10
Pr-1	NS-7	AŠ-6	V-1640-2	CM-1
-1.85	0.57	-0.15	0.34	-0.26
-0.24	0.54	0.23	1.62*	2.00*
-1.09	-0.63	-0.05	-1.10	-1.68
-4.86	-4.29	-3.16	-3.48	-2.98
3.36**	-0.67	2.83**	-6.11	-6.40
	-1.76	1.73*	1.45	3.11**
		0.32	0.42	3.77**
			0.82	-1.12
				2.45**

Table 3

Variance Components of Oil Content in Seed

Component	Value
D	33.1844
H_1	2.0669
H_2	0.6520
F	1.0326
E	0.39
$\frac{H_2}{4H_1}$	0.0787
u	0.913
v	0.087
$\sqrt{\frac{H_1}{D}}$	0.280
$\frac{K_D}{K_R}$	1.1329

over, the ratio between the total number of dominant alleles and recessive alleles in all parents (K_D/Kr = 1.13) showed that the dominant alleles were superior to the recessive ones regarding the expression of oil content in seed.

The average degree of dominance ($\sqrt{H_1/D}$= 0.280) regarding the inheritance of oil content in seed of all combinations was smaller than 1 and indicated the presence of partial dominance. The regression analysis confirmed the superior importance of the additive reaction of genes over the non-additive regarding the mode of inheritance of oil content in seed (Graph 1). The dispersion of points along the expected line of regression shows the genetic divergence of the examined inbred lines. The obtained results indicate that the lines Sm-3, A-9343-2, and A-3497-2 had more dominant genes, while the lines CR-2 and SR-1 had more recessive genes. The other examined inbred lines contained equal portions of dominant and recessive genes for the oil content in seed.

Conclusions

The following conclusions can be drawn on the basis of the analyses of the crosses of 10 examined inbred lines:

The majority of the hybrid combinations in F-1 generation showed partial or full dominance regarding the oil content in seed. Superdominance or intermediarity was found in a small number of the hybrid combinations.

The variance analysis of the combining ability showed that the additive and non-additive components of genetic variance were important for the inheritance of oil content in sunflower seed. The participation of the additive component, however, was much higher.

The lines A-3497-2, Sm-3, A-9343-2, AŠ-6, and Pr-1 had high values of GCA.

The crosses between the lines A-9343-2, Sm-3, and A-3497-2 on one side and the lines CR-2 and SR-1 on the other had high

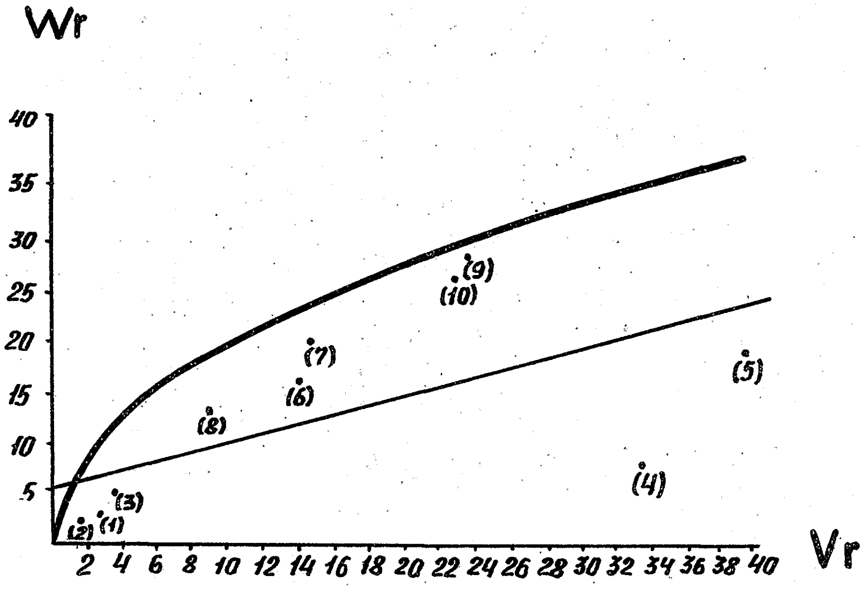

Fig. 1. Regression analysis Vr, Wr

values of SCA. Usually, the crosses with a high SCA value include one parent with a high GCA value.

Regarding the expression of oil content in seed of the F-1 generation, the dominant alleles were superior to the recessive ones. The regression analysis confirmed the fact that the dominant and recessive alleles were not uniformly distributed among the examined inbred lines.

Taking into consideration all examined combinations, it can be concluded that partial dominance is important in the inheritance of oil content in seed of F-1 generation.

References

Griffing, B., A generalised treatment of the use of diallel crosses in quantitative inheritance. Heredity, 10, 31-50, 1956.

Griffing, B., Concept of general and specific combining ability in relation to diallel crossing systems. Aust. J. Bio. Sci., 9, 463-493, 1956.

Gundaev, A.I., Ispoljzovanie priznaka mužskoj steriljnosti pri mežlinejnoj gibridizacii podsolnečnika. Selekcija rastenij s ispoljzovaniem citoplasmatičeskoj mužskoj steriljnosti. 433-441, 1966, Kiev.

Gundaev, A.I., Ispoljzovanie geterozisa u podsolnečnika i polučenie gibridnih semjen na osnove mužskoj steriljnosti. Geterozis v rastenievodstve: 358-367, 1968, Lenjingrad.

Hayman, B.J., The theory and analysis of diallel crosses. Genetics, 39, 787-809, 1954.

Hayman, B.J., Interaction, heterosis and diallel crosses. Genetics, 42, 336-355, 1957.

Jinks, J.L., The analysis of continuous variation in a diallel cross of Nicotiana rustica varieties. Genetics, 34, 767-789, 1954.

Mather, K., and Jinks, J.L., Biometrical genetics. Second Ed., Chapman and Hall, London, 241-271, 1971.

Morozov, V.K., Selekcija podsolnečnika v

SSSR. Piscepromizdat, 1947, Moskva.
Pustovoit, V.S., Itogi rabot po selekcii i semenovodstvu podsolnečnika. Masličnie i efiromasličnie kuljturi, 1963, Moskva.
Putt, E.D., Heterosis, combining ability, and predicted synthetics from a diallel cross in sunflowers (Helianthus annuus L.). Can. J. Plant Sci., Vol. 46, 59-67, 1966.
Stoianova J., Ivanov P., Nasledjavane na njakoj priznaci v F_1 pri slncŏgleda.
Georgiev, I., Genetika i selekcija, God. 4, No. 1, 3-13, 1971, Sofia.
Schuster, W., Inzucht und Heterosis bei der Sonnenblume. Giessen, 1964.
Zdanov, L.A., Selekcija podsolnečnika na visokuju masličnost. Dokladi VASHNIL imeni V.I. Lenina, No. 5, 1966.