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## SUNFLOWER BREEDING IN YUGOSLAVIA

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The Institute for Agricultural Research in Novi Sad has been dealing with the sunflower breeding for many years. However, this work increased very much with the occurrence of the high-oil-yielding Soviet VNIIMK varieties which in 1962 occupied the whole area under sunflower in Yugoslavia.

In the first stage of work the greatest attention was devoted to adaptability and improving the Soviet varieties to our agro-ecological conditions. As the result of selecting the useful genotypes, the varieties VNIIMK 8931 and Peredovik were improved. At present these two varieties have been mainly grown on the whole area under sunflower in Yugoslavia, which ranged in the last ten years from 97 400 ha (1962) to 218 829 ha (1968). Ten-year average of sunflower yield in Yugoslavia amounts to 17.2 q/ha, whereas in Voivodina, which is our main sunflower growing region, this average in the same period amounts to 19.2 q/ha (table 1). Due to these sunflower yields Yugoslavia occupies one of the leading places in the world.

Simultaneously, in the earlier period the research on creating new local sunflower varieties was done after the method of the academician Pustavojt having as the main objects to increase seed and oil yield, as well as the resistance to diseases. After several year investigations, some prosperous lines were selected which proved to be more productive than the sunflower varieties widespread in our country. We present the research results obtained in last two years (table 2) with 10 prosperous lines compared to 4 Soviet varieties among which VNIIMK 8931 was taken for standard, as the most widespread variety with us. As regards the length of growing-season, only lines P-317 and P-14 are early-maturing, whereas the other investigated ones are on the level of the standard. Considering the seed yield, line P-20 stands out with the average yield of 38.35 q/ha which is higher in relation to the standard but is not significant. All lines investigated show higher oil percent compared with VNIIMK 8931 and the most outstanding are : P-77, V-5, P-12, P-14 and P-20. Oil content in absolutely dry seed of the line P-20 in two year average amounts to 52.29 % respectively 4.08 % more than the standard. As regards the oil yield which is the most important indicator of the value of sunflower variety, among the all lines investigated the following ones stand out : M-1, V-5, P-12, P-14 and P-20. Line P-20 with its oil yield of 17.52 q/ha is significantly better than the variety VNIIMK 8931 with the oil yield of 15.19 q/ha.

On the basis of two-year investigations concerning all analyzed properties, the line P-20 stands out in the group of middle-maturing varieties and the line P-14 in the group of early-maturing ones. As regards that the investigations were conducted in the years which were considerably different concerning the growing conditions (1970 was extremely unfavorable and 1971 was favorable), the results obtained should be proved in the forthcoming years.

Recently we have included in the breeding program the research on the occurrence of heterosis effect and its practical application. These investigations involved the following problems :

- Creation of self-fertilized lines from genetically divergent material resistant to Sclerotium bataticola and Alternaria sp.

- Finding out male sterile lines and investigations of male sterile types.

- Investigations of combining abilities and evaluation of heterosis effect for the most important characteristics and properties of sunflower.

At present in the breeding cycle there are about 1 000 inbred lines, beginning with  $S_3$  to  $S_{10}$  generations. Some of these lines represent a valuable material regarding the resistance to Sclerotium bataticola and Alternaria sp., which are considered to be the prevailing sunflower diseases in Yugoslavia. These lines possess simultaneously other useful characteristics such as high oil percentage in seed. From the whole material we have presented only several interesting inbred lines from  $S_{10}$ ,  $S_9$  and  $S_6$  generations, respectively the results which we obtained in 1971 (table 3). Breeding on resistance to diseases had positive effect through generations of self-fertilization. In this manner we obtained inbred lines which in field conditions (infected field) proved to be resistant to Sclerotium bataticola whereas to Alternaria sp. they were resistant or tolerable. Lines which stand out particularly are n° 2, N° 6 and N° 7 (table 3), which are simultaneously resistant to both diseases. The testing of combining abilities of these lines with male sterile ones is in progress.

In the existing breeding material we found more sources of male sterility. The most useful source was found within the lines from the variety Armavirski 9345, which represents genetic type of male sterility linked with the anthocyanic gene. The main characteristics of this line -MS 49- analyzed in 1971 are given in table 4. Moreover, we use in our work the source of cytoplasmatic male sterility from Clermont-Ferrand.

On the basis of the preliminary investigations (1971) of top-crosses among three sources of male sterility with Majak variety, which are presented in table 5, it can be concluded that there is a high heterosis effect for seed yield in two top-crosses MS 13 x Majak and MS 49 x Majak, which is extremely significant. However, the effect of heterosis in oil content was not expressed so that the high oil yields is the result of increased seed yield in these top-crosses.

In 1971 a great number of crossings of inbred lines with male sterile lines was performed whose combining abilities will show the real value of the existing breeding material.

Table 1 - Cultivation areas and yields of Sunflower  
in Yugoslavia and Voivodina\*

Years	Area (in ha)		Seed yield (in q/ha)	
	Yugoslavia	Voivodina	Yugoslavia	Voivodina
1960	73 700	36 600	13.3	15.9
1961	85 800	45 900	13.7	15.8
1962	97 400	52 000	16.5	20.0
1963	140 000	79 900	16.4	19.3
1964	146 000	88 200	17.8	20.6
1965	159 000	102 000	16.7	19.3
1966	154 000	107 000	18.2	20.2
1967	147 000	106 000	17.0	18.3
1968	161 000	118 000	19.2	21.1
1969	218 829	169 213	17.8	18.8
1970	194 452	144 612	13.6	13.9
1971	183 000	135 000	19.0	20.5
1962 - 1971	160 068	110 192	17.2	19.2

\*The main region for sunflower

Table 2 - Breeding characters of some Sunflower prosperous lines

N°	Variety-Line	Growing period in days			Seed yield, q/ha			% of oil in absol. dry seed			Oil yield q/ha		
		Year		Average	Year		Average	Year		Average	Year		Average
		1970	1971		1970	1971		1970	1971		1970	1971	
1	VNIIMK 8931	134	133	133,5	28,52	43,69	36,10	47,37	49,05	48,21	11,75	18,64	15,19
2	PEREDOVIK	132	132	132,0	30,07	45,87	37,93	47,71	49,84	48,77	12,48	19,89	16,18
3	SMENA	130	131	130,5	27,82	40,23	34,02	46,83	49,72	48,27	11,33	17,40	14,36
4	MAJAK	132	132	132,0	32,72	42,52	37,62	46,39	49,69	48,04	13,21	18,38	15,79
5	P - 61	131	130	130,5	31,49	42,22	36,85	46,74	50,68	48,71	12,80	18,61	15,70
6	P - 77	133	129	131,0	28,27	44,33	36,30	48,87	51,14	50,00	12,02	19,72	15,87
7	P - 301	128	132	130,0	28,08	40,63	34,35	47,77	50,53	49,15	11,67	17,86	14,76
8	P - 317	124	129	126,5	29,00	42,74	35,87	47,05	49,73	48,39	11,87	18,49	15,18
9	V - 31	132	132	132,0	28,69	42,53	35,61	47,03	50,53	48,78	11,74	18,69	15,21
10	M - 1	132	129	130,5	30,29	44,67	37,48	49,73	50,12	49,92	13,10	19,48	16,29
11	V - 5	131	132	131,5	27,09	48,71	37,90	49,36	50,91	50,13	11,63	21,57	16,60
12	P - 12	132	129	130,5	31,44	44,46	37,95	49,53	51,88	50,70	13,55	20,07	16,81
13	P - 14	124	131	127,5	31,48	44,41	37,94	50,42	51,52	50,97	13,81	19,90	16,85
14	P - 20	131	132	131,5	29,98	46,73	38,35	51,33	53,25	52,29	13,39	21,65	17,52

For seed yield : LSD 5% = ± 4,22 q/ha  
1% = ± 5,61 q/ha

For oil yield : LSD 5% = ± 1,80 q/ha  
1% = ± 2,39 q/ha

Table 3 - Value of several inbred lines

N <sup>o</sup>	Origin	Growing period in days	Height of plants cm	Head diameter cm	Seed yield in self pollination per plant/gr	Seed yield in open pollination per plant/gr	Weight of 1 000 seeds - gr	Husk % in absol. dry seed	% of oil in absol. dry seed	Sclerotium bataticola (0 - 5)	Alternaria sp. (0 - 5)
1	Peredovik - Check	132	203,5	19,8	-	112	73,3	22,3	49,84	2	2
2	S <sub>10</sub> generation NS 4 - 1	134	140	23,0	33,4	62	45,7	26,0	51,51	0	0
3	NS 4 - 2	134	145	24,0	21,1	70	43,0	21,6	52,51	0	1
4	MB - 3	130	163	28,0	5,2	175	74,5	20,0	50,71	0	1
5	SA 5 - 2	130	160	25,0	6,8	105	90,2	29,6	45,13	0	1
6	A 3497/2-5	134	161	22,0	3,6	128	67,6	24,2	47,15	0	0
7	S <sub>9</sub> generation A 9343/7-5	135	169	27,0	23,0	155	61,1	22,6	49,07	0	0
8	V 1646/1-5	130	149	23,0	9,9	95	67,0	22,0	47,09	0	1
9	CR 4-3	130	171	26,0	18,7	125	87,0	24,2	45,07	0	1
10	A 3497/1-2	134	202	29,0	11,4	169	88,0	28,0	42,23	0	1
11	A 3497/2-4	130	165	20,0	12,9	67	56,1	26,0	46,76	0	1
12	SM 3-6	134	196	25,0	3,9	49	70,0	27,0	47,75	0	1
13	S <sub>6</sub> generation M 7-4	117	176	26,0	20,3	66	67,0	28,0	48,24	0	1
14	V 8931/2-3	134	191	22,0	4,7	79	64,8	23,6	47,67	0	1
15	SM 6-1	130	156	22,0	18,5	113	65,1	20,0	49,90	0	1
16	H 4-3	134	185	22,0	18,1	62	51,7	27,0	46,55	0	1
17	V 6540/5-6	134	170	20,0	6,8	79	90,0	30,0	44,90	0	1
18	A 3497/3-11	134	137	24,0	23,0	79	58,0	26,2	46,95	0	1
19	A 3497/6-7	130	152	17,0	29,6	60	56,2	20,8	49,43	0	1
20	A 9343/3-3	130	121	19,0	16,0	64	71,6	24,6	45,72	0	1

Table 4 - Value of male-sterile line MS 49

(Origin Armavirski 9345)

N <sup>o</sup>	Growing period days	Height of plants cm	Head diameter cm	Seed yield gr/plant	Husk %	Kernel %	Weight of 1 000 seeds - gr	% of oil in absol. dry seed	Number of plants		Assumed ratio	P - %
									green male-sterile ttmsms	red male-fertile TtMsms		
MS 49	123	108-116	19-20	80-100	24-29	71-76	81	40-45	122	115	1 : 1	70-50

Table 5 - Value of top-crosses

N <sup>o</sup>	Origin	Growing period in days	Height of plants cm	Head diameter cm	Seed yield q/ha	Prevalence of F <sub>1</sub> over Majak		% of oil in absol. dry seed	Oil yield q/ha	Husk %	Weight of 1 000 seeds - gr
						q/ha	%				
1	VNIIMK 8931	130	186	20	41,54	-	-	46,38	16,76	24,0	80,0
2	PEREDOVIK	130	167	20	41,87	-	-	47,10	17,15	23,4	87,7
3	MS <sub>13</sub> x MAJAK	132	158	30	59,36	18,97	46,9	44,23	22,84	25,0	111,3
4	MS <sub>49</sub> x MAJAK	132	151	24	52,74	12,35	30,5	42,73	19,60	27,0	85,6
5	MS <sub>7</sub> x MAJAK	131	168	22	44,54	4,15	10,2	43,65	16,91	29,0	85,8
6	MAJAK	132	192	19	40,39	-	-	48,33	16,97	24,5	77,2

For seed yield : LSD 5% = ± 7,86 q/ha  
 1% = ± 10,84 q/ha