

MORE IMPORTANT TRENDS AND ACHIEVEMENTS IN
OIL-YIELDING SUNFLOWER BREEDING IN POLAND

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The interest in oil-yielding sunflower growing and breeding was worked up in Poland in 1946. Later on, it was proved in trials that it was sunflower which gave the highest yield of seed and oil, and manifested the highest resistance to periodical droughts from amongst other spring oil-yielding plants tested. Sunflower oil of high edible value both for direct consumption and margarine production we have to import from abroad. The latter question takes a peculiar significance in Poland for more than 95 per cent of oil-yielding crops are rape and winter turnip-like rape and oil extracted of them is not the best one for food industry because of high content of erucic acid. In spite of this, oil-yielding sunflower has been a little known and propagated in Poland. In particular, it is necessary to investigate thoroughly some questions important from breeding standpoint solving of which will facilitate the sunflower breeding under soil and climatic conditions of our country. Poland is situated north 49°00' to 54°50' of the main region of sunflower cultivation in Europe which passes across the southern part of the Soviet Union, Roumania, Hungary and Bulgaria. Mean air temperatures and precipitations for individual months of long-term period as measured in the city of Poznan are following:

Month	I	II	III	IV	V	VI
Temperature in ° centigrades	-1.4	-0.5	3.0	8.0	13.8	17.1
Precipitation in mm	35	26	32	39	53	51
	VII	VIII	IX	X	XI	XII
	19.0	17.7	13.9	8.6	3.3	0.0
	77	55	47	35	35	37

The principal goals in sunflower breeding under climatic conditions prevailing in Poland are following:

1. Suitable length of the vegetation period from sowing to ripening.
2. High oil yield per hectare.

The vegetation period from sowing till ripening should not be longer than 100 to 120 days. The sunflower when sown at the optimum time - on the average at the beginning of the third decade of April - should ripen not later than 20th of August. The necessity of deseeding green heads and drying seed should be considered under climatic conditions prevailing in Poland.

Extremely early varieties proved to be low-fertile and having lower oil content but higher husk content of seed.

Oil yields per hectare are conditioned by the following factors: (a) seed yield per hectare; (b) oil content of seed; (c) husk content of seed.

It endeavoured to obtain seed of total weight as high as possible and a high kernel-husk percentage, as well as bearing possibly highest oil content. However, high oil output of seed is a very important factor, it is the yield of seed per hectare which conditions in most cases the oil output per hectare. Considering the above mentioned, it should be kept in mind that good oil bearers are more profitable from the technology standpoint. It is endeavoured to obtain varieties for the conditions of Poland of the husk-kernel percentage not exceeding 28 per cent, and oil content of seed some 40 per cent. Such varieties, when yielding 20 q seed per hectare, would bear some 8 q oil per hectare.

The breeding work on sunflower was started in Poland in 1946, and resulted in obtaining of two home-grown sunflower varieties, viz. Borowski, and Borowski Ulepszony (improved).

Borowski variety had been bred of unknown starting variety by Professor Moldenhawer and Mrs. Przyluska. It is a semi-dwarf variety (some 110 cm in height). Seed dark-gray with white stripes contain some 28 per cent oil and 40 per cent husk. Its favourable feature is short vegetation period lasting on the average 116 days long. The variety Borowski Ulepszony (improved) characterize with a higher cropping power and oil yielding, but its vegetation period lasts some longer and the plant is higher than that of Borowski variety.

A very important task, connected with the extension of the scope of breeding work on sunflower in Poland, was to evaluate various strains and varieties of foreign origin as starting material for breeding purposes. Thus, over the period 1961-1965, it was tested thoroughly some 25 most valuable varieties not counting observation of the material gathered in the collection. An average length of vegetation period of some varieties as well as mean oil yield obtained in strict experiments are presented in Table 1.

Soviet Union is the richest source of various sunflower types and forms. For the conditions prevailing in Poland, we are interested in the varieties of a short vegetation period and high oil yield per hectare. Such, for the most, are forms bred by the well-known Russian breeder Pustovoit of Krasnodar.

With reference to numerous works performed abroad, the Polish breeders took an interest in the possibilities of using heterosis breeding methods. For this purpose, the following number of hybrids were tested over the period 1961-1964:

99 intervarietal hybrids
115 lineal and varietal hybrids
20 lineal hybrids.

The collected findings allowed for obtaining of preliminary data concerning the rate and frequency of heterosis effect as well as of the methods for crossing and testing of various forms.

Table 1 The length of vegetation period and oil yield of some oil-yielding sunflower varieties.

Variety	Vegetation period in days	Oil yield in q per hectare
(a) 1961-1963		
Borowski - standard	116	3.4
Iennesei	117	5.7
Saratowski early	120	4.6
107	127	6.7
VNIIMK 8883	128	8.2
Armavirski 9345	130	8.8
Armavirski 9343	132	8.5
Smena	135	8.7
Peredovik	135	9.3
VNIIMK 8931	136	9.7
Zdanowski	136	7.1
Armavirski 3497	138	9.9
Jupiter	139	6.0
Iregi korai csikos	139	8.7
75	140	7.1
VNIIMK 1646	142	8.9
Ostsonne	144	7.0
(b) 1964-1965		
Karlik 68	116	3.8
Borowski - standard	120	3.7
Woroneski 64	121	5.7
Armavirec	122	5.8
Czernianka 66	128	6.8
Jugowastocznyj	130	8.3

The heterosis effect in hybrids of various types was observed for the most part in relation to the height of plants, yield of seed and oil and 1000 seed weight. The heterosis was found to occur rarely in relation to the head diameter, and in sporadic cases only in relation to the length of vegetation period as well as in oil and husk content of seed (Table 2).

The rate of heterosis effect, expressed in per cent of parental form of higher value of the investigated character, has manifested itself the most pronouncedly with regard to the yield of seed and oil, and the least with regard to the length of vegetation period. This concerned inter-varietal and lineal and varietal as well as lineal crossing.

Reciprocal intervarietal ($n = 7$) and lineal ($n = 5$) crossing allowed for evaluating of the total and individual combining abilities within the tested forms. In both cases the method given by Griffing (1956) was applied for testing n^2 combinations in lineal crossing, and $n(n - 1)$ combinations in intervarietal crossing.

Table 2 Rate ¹ and frequency ² of heterosis effect in sunflower hybrids of various type

Character	Heterosis for intervarietal hybrids		Heterosis for lineal and varietal hybrids		Heterosis for lineal hybrids	
	frequency	rate	frequency	rate	frequency	rate
	<u>in per cent</u>					
Length of vegetation period	3.7	2.5	2.8	7.3	0.0	0.0
Height of plants	10.8	18.0	16.2	26.4	70.0	23.5
Head diameter	12.5	13.3	4.9	16.4	35.0	18.7
Seed yield	9.7	41.1	16.2	109.9	80.0	173.5
Oil yield	7.6	44.2	15.2	142.3	80.0	171.5
1000 seed weight	18.7	22.5	11.2	16.7	60.0	47.4
Oil content	0.7	3.1	9.2	10.9	10.0	8.0
Husk content	2.5	17.4	2.1	6.7	10.0	10.7

- ¹ In relation to more fertile parental form.
² In relation to all combinations tested.

With regard to seed yield the tested varieties Saratowski and Borowski characterized with low combining ability, while the varieties Smena, Peredovik and 107 with intermediate one, and the varieties Ostsonne and Iregi with a high general combining ability. Two groups have distinguished themselves within the line, viz. of lower /1572/2, 1759/1, 1766/2/ and of a high 1585/4, 1767/1 general combining ability.

Table 3 General combining ability of variety (a) and lines (b) within reciprocal crosses with regard to seed yield (after Griffing)

(a)	
Variety	General combining ability
Ostsonne	+ 0.20
Iregi	+ 0.19
107	+ 0.06
Peredovik	+ 0.04
Smena	- 0.01
Borowski	- 0.22
Saratowski early	- 0.26
(b)	
Line	General combining ability
1585/4	+ 0.21
1767/1	+ 0.09
1572/2	- 0.05
1759/1	- 0.08
1766/2	- 0.17

A significant effect of crossing direction on the value of individual hybrids was stated in several cases.

An estimation of general combining ability within some lines was performed at the initial stage of inbreeding ($I_1 - I_2$) demonstrating the efficacy of using early testing method in breeding work on sunflower.

A high coincidence of results was obtained when crossing emasculated and non-emasculated lines with testing variety, this provides facilities for simplification of crossing method.

Fairly high coincidence of results was stated in testing the sunflower lines with population varieties Borowski and Iennesei, and this is too of a great practical importance for it allows for using only one testing variety.

Almost all from amongst the tested hybrids explicitly surpassed the standard variety Borowski with regard to oil yield per hectare. A great part of them characterized, unfortunately, with too long vegetation period. The most promising combinations are those characterizing with explicitly shorter vegetation period, only a little longer than that of Borowski variety, and cropping much better than the standard variety. Some of the hybrids are listed in Table 4. The hybrid Smena x Borowski is worth mentioning for it proved to be some 5 per cent earlier than variety Borowski, and to yield seed by 70 per cent and oil by 115 per cent higher than those of variety Borowski.

Table 4 F_1 of some sunflower hybrids outstanding with regard to breeding characters

Hybrid	Year	Length of vegetation period in days	Oil yield in q per hectare
Smena x Borowski	1961	131 (+ 7) ⁺	5.8 (+2.9) ⁺
9343 x Borowski	1961	128 (+ 4)	6.2 (+3.3)
1769/1 x Iennesei	1962	122 (+ 2)	6.7 (+3.6)
1768/2 x Borowski	1962	129 (+ 9)	7.2 (+4.1)
1787/2 x Iennesei	1963	114 (+ 9)	11.7 (+7.5)
1767/3 x Iennesei	1963	114 (+ 9)	11.1 (+6.9)
1759/1 x 1767/1	1964	123 (+13)	9.3 (+4.5)
1572/2 x 1767/1	1964	125 (+15)	9.1 (+4.3)

+ As compared with the standard variety Borowski.

The investigations performed proved the heterosis breeding method to be highly profitable first of all for the increase of seed and oil yields per hectare. The obtaining of forms of explicitly shorter vegetation period, suitable for the climatic conditions prevailing in Poland, which could be used for hybrid and synthetic varieties production calls for continuation of the investigations performed hitherto.

The breeding work on oil-yielding sunflower in Poland has been concentrated at the Department for Oil-yielding Plants, Plant Breeding and Acclimatization Institute, and was conducted at the Breeding Research Station at Borowo, Koscian county.

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