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RESULTS AND PROSPECTS OF SUNFLOWER HETEROSIS BREEDING IN THE VNIIMK

Soviet breeders of Academician Pustovoit's school have scored outstanding achievements in the breeding and production of sunflower varieties with high oil content, achievements that are unrivalled in the world practice of breeding. The best varieties produced in the Pustovoit All-Union Research Institute of Oil Crops contain 53-55% of oil in their seeds, while the oil yield is as high as 1700-1800 kg per hectare. The Pustovoit method, which consists in the selection from varietal and hybrid populations, individual assessment of the progeny and subsequent repollination of the best varieties, helped create heterosis and highly productive sunflower varieties. This method is actually the first try at using sunflower heterosis for broad economic purposes in the form of varieties-populations, since these include biotypes possessing a high general combining ability. This method has helped to produce and improve an abundant initial material for selecting highly productive variety-line and interlinear hybrids, synthetic varieties and hybrid populations. Soviet breeders have achieved such a high oil content that its further upgrading involves some difficulties. Further increases in oil yields per hectare necessitate the production of sunflower forms with the seeds' enhanced productivity. The solution to this problem is largely predicated on the use of the heterosis effect (it will be recalled that Academician V.S. Pustovoit attached great significance to the practical use of sunflower heterosis).

As early as the 1920s V.S. Pustovoit obtained interlinear hybrids the yields of whose seeds were 21-41% more than those of the then best varieties. Yet sunflower hybrids were

not used at that time because sunflower male sterility was not yet obtained. Nevertheless, searches were continued for a practical utilisation of sunflower heterosis.

In 1964 first synthetic hybrids were obtained on the basis of self-pollinated lines. When tested two of these hybrids, made up of 14 and 8 lines, surpassed the VNIIMK 8931 check variety by 8-10% in the case of the principal indicator, the oil yield. Synthetic hybrids had insufficiently stable seed yields and in some areas they were even considerably lower than those of normal varieties. Subsequently several interlinear and variety-line hybrids were obtained on the basis of lines with gene-conditioned sterility, the hybrids surpassing the VNIIMK 8931 check variety by 15-17% for oil yields.

The new interlinear hybrids, however, proved susceptible to broomrape and sunflower diseases. The task was then set to create highly productive hybrids with a high resistance to the sunflower's principal pathogenes common in this country.

Attempts to identify foreign-selected hybrids suitable for productive use bore no result because their productivity was not more than that of Soviet varieties.

G.V. Pustovoit, Doctor of Agricultural Sciences, produced the stock of interspecific hybrids incorporating high productivity and group immunity. This was a valuable basis for producing new varieties and obtaining self-pollinated lines possessing genes resistant to various diseases, such as downy mildew, rust, ashen rot, etc.

In 1975 more than 5,000 I_1-I_8 lines were studied at the VNIIMK, of which over 2000 were obtained from interspecific hybrids having varied resistance to downy mildew, verticilium, broomrape, rust, ashen rot and other diseases. High-oil varieties with good combining ability were identified and work is being completed on the production of sterile analogues of the best lines

and their fertility restorers.

Breeders and physiologists make strained efforts to assess and identify lines and hybrids resistant to various broomrape races (Orobanche cumana W.).

This resulted in the production of several lines having high resistance to that parasite.

Over the last three years the Institute has studied over 2,000 interlinear and variety-line hybrids, the most interesting of which are hybrids obtained on the basis of lines possessing male sterility. These hybrids have surpassed the check variety by 21-30% for the seeds' yield and by 20-31% for the oil yield (Table 1).

Hybrids obtained on the basis of mutant lines have recorded rather interesting results. The hybrid MML-42 surpassed the check variety by 11% for the seeds' yield over the three years on average, and yielded 13% more oil (Table 2).

The MML-42 hybrid is earmarked for broad field testing.

By using the method of chemical mutagenesis the Institute has obtained the initial material for getting self-pollinated lines with a heightened content of oleic acid in the oil. The proportion of oleic acid has been brought to 75% on average as against 30-35% in the normal zoned varieties, while individual plants have over 90% of this acid. It is planned to considerably broaden the range of work to produce highly oleic lines, since this makes it possible to obtain hybrids with varied fatty acid composition of oil, which in turn will help increase the range of vegetable fats.

On the basis of mutant lines the sunflower laboratory has produced and passed to state testing the sunflower mutant variety whose seeds contain 70-75% of oleic acid. This is in fact a new type of sunflower which has not so far existed in natural conditions and which yields oil with the proportion of oleic acid close to that in olive oil.

Table 1

Productivity of Sunflower Hybrids Obtained on the Basis of Ms-Lines

VNIIMK 1974

Hybrids	Vegetation period (days)	Yield		Seeds' oil content, %	Oil yield	
		c/ha	% of check		c/ha	% of check
Ms 125 x Armavirets	100	49.9	130.6	50.6	22.7	131.2
MS 353 x VNIIMK 8931	101	47.2	123.5	49.6	21.1	121.9
Ms 236 x 1524 VNIIMK 8931	93	43.4	121.4	48.9	20.8	120.8
(check)	96	38.2	100.0	51.8	17.3	100.0

Table 2

Productivity of Mutant Hybrids

VNIIMK 1973-75

Hybrids	Vegetation period (days)	Seeds' oil content, %	Seds yield		Oil yield	
			c/ha	% of check	c/ha	% of check
MML-42	96	52.1	33.4	111.0	15.7	112.8
MML-41	96	51.8	32.2	107.0	15.0	108.0
Peredovik	96	51.3	30.1	100	13.9	100

The Institute makes use of cytoplasmic male sterility and at the same time works on hybrids to be produced on the basis of fecundation selectivity.

Breeder K.I. Soldatov used the latter method to obtain the early ripening hybrid GS-I suitable for production utilisation (Table 3). The hybrid ripens at the same time as the quickly-ripening Salyut variety and yields 1-1.5 centners more seeds per hectare on average than the check variety.

Thus the VNIIMK has accumulated an extensive stock of self-pollinated lines with varied heritability and possessing valuable economic properties, such as high oil content, little huskness, quick ripening, low height and varied composition of individual fatty acids. Researchers have also produced lines whose genes are resistant to various sunflower pathogenes and obtained hybrids suitable for productive use. This gives grounds for hopes that sunflower hybrids will come to play a more important role in the farm production in the USSR.

Table 3

Productivity of the GS-1 Quickly-Ripening Sunflower Hybrid

VNIIMK, 1975

Hybrid, variety	Vegetation period, days	Seed yield, c/ha	Seeds' oil content, %	Oil yield	
				c/ha	% of check
GS-1	93	29.3	54.7	16.0	118.5
Salyut (check)	89	25.4	53.2	13.5	100

NSP 0.95 = 1.5
m% = 2.5