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THE INITIAL MATERIAL FOR SUNFLOWER HETEROSIS BREEDING

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The N. I. Vavilov All-Union Scientific Research Institute of Plant Industry (VIR) Leningrad collects and investigates the world genefund of the majority of cultivated plants and their wild relatives, and in particular the sunflowers. At present the cultivated sunflower collection numbers about 1200 samples, collected on the Soviet Union's territory (about 60%) and from most countries of the world. It is a big reserve, that was unfortunately almost not used practically up to now.

The Soviet breeding school headed by academician V. S. Pustovoit, has developed the outstanding varieties according to oil content and other commercially valuable characters. These cultivars occupy 80% of the total world area under sunflower. But the efficiency of cultivar breeding was reduced due to the appearance of some limitations. There are two reasons. Firstly : the biological limit was practically reached both for kernel oil content (68—70%) and for huskness (20—22%). Secondly : the recent cultivars of the Soviet breeding started their pedigree from one and the same original population spread up to gigantic proportions, in which after 70 years of intensive selection the genotypic variation of the population disappeared and the process of its selfimprovement takes place with on abvious delay.

Under such circumstances the rapid productivity increase may be achieved only due to the heterosis breeding, on the basis of the inbred crosses.

What original material the inbred lines should be bred-from ? Naturally, the main attention should be directed towards the outstanding, high oil content varieties of the Soviet selection Mainly, they belong to the most cultivated and commercially valuable part of the world suflower genefund. But the heterosis effect is displayed by crossing the inbred lines of nonidentical origin, possessing a certain degree of genetic heterogeneity. When developing inbred lines all resources of the world sunflower genefund and in particular the VIR collection schould be utilized.

At present the main criterion of suitability for heterosis usage is the estimation of the general and specific combining ability (GCA and SCA). In previously conducted experiments we evaluated the inbred lines (from I_2 up to I_{12}) concerning the GCA inheritance in accordance with the general combining ability of the initial material. The heritability coefficient proved to be very high $h^2 = 0.60—0.86$.

The development of inbred lines requires a high volume of work and the most reasonable is to develop new inbred lines using mainly the varieties and samples of the world collection with high level of GCA. Therefore it became necessary to test the collection material for GCA.

General combining ability is estimated by topcross method with chemical emasculation of the female parent with gibberellin. During 7 year work we studied 17 testers, out of which 6 cultivar-populations of the Soviet selection, 4 hybrid testers and 7 lines and samples of the world collection. Investigations on hybrid testers confirmed good inheritance of the GCA character. When developing hybrid testers of the type : tester (cultivar with high GCA) — hybrid tester, the heritability coefficient is within the limits $h^2 = 0.4—0.7$.

For practical selection the following varieties are of great interest as testers: Sputnik (selection of the Armavir station of VNIIMK *) — for the medium ripening group of sunflower and Armaviretz (of the same origin) — for the early-ripening group. Good results were displayed by the variety Chernjanka 66.

During 2—3 years over 100 sample-varieties were evaluated by help of 3, more often 5—6 testers, for their general combining ability. It was revealed that about 8% of the collection samples possess good combining ability. Among the varieties of Soviet selection, the varieties of Armavir station of VNIIMK, show as a rule, the best GCA. Within the medium-ripening group, the varieties Armavirsky 3497, Sputnik and VNIIMK 8931 have good GCA, within the early ripening group — Armaviretz, Zarja, Voskhod. Some foreign samples are remarkable for their GCA, such as K-2153 (from Finland), K-1739 (Romania), K-2023 (Canada), K-2080 (Iraq), K-2084 (Israel), K-2140 (Australia), K-2146 (Argentina) and others.

By studying a great number of first generation hybrids it was found that the heterosis effect is often exhibited in seed yield, but as a rule, not in oil yield per hectare. The greatest heterosis effect was noticed as a result of crosses between foreign and soviet varieties or lines. However the best foreign samples both for their commercial characters and general combining ability have very high per cent of husk, 32-35 and even higher. Coarse husk dominates, and sometimes a negative economic heterosis is observed. For this reason, in order to develop hybrids with higher oil and protein yields per unit area, it is necessary that both parental forms have a low per cent of husk. The

*) VNIIMK — The All-Union Scientific Research Institute of Oil Crops „V. S. Pustovoit".

sufficient and perhaps the optimal level of husk is 22—23%. In order to reach this level one parent may have 19—21% of husk and the other not more than 24—23%. This is at present the main problem that practically hinders the utilization of heterosis in sunflower.

We have studied the inheritance of huskness utilizing the cultivar of prewar selection — Armavirsky 1813 (with high GCA). The original form had 38—40% of husk. The variation coefficient of this character was 36%. By inbreeding and selection, lines with 22—23% of husk were developed in three years. This year we obtained lines with 20—21% of husk. The method applied to the variety Armavirsky 1813 was also used for the collection samples with good GCA. In most cases this method was successful. For example, using the cultivar Klein a number of lines with 23—25% of husk was obtained during two years.

Our experience shows that the breeder should not avoid working with collection samples with high per cent of husk, as this character can be easily improved by selection.

The oil content is not a restricting factor in breeding for heterosis effect. The high oil content dominates, and sometimes the heterosis effect is observed with respect to this character. It should be underlined once more, that for developing valuable heterosis hybrids we recommend to take the high oil content cultivars (or lines) of Soviet selection at least as one of the parents.

The differences between hybrids of the same type resulted from crosses between cultivars (1) or between cultivar and line (2) are presented in table 1. The lines were selected two years for husk percentage reduction.

Table 1

Cuban experiment station of VIR, 1973

Hybrid combination	Yield in F_1	
	Seeds (% to standard)	Kernels (q/ha ± to standard)
K-2153 (from Finland) × cultivar Armavirsky 1813	131	0.0
Line 081 (from cultivar Armavirsky 1815) × × K-2153 (from Finland)	137	+3.2