V.F. Pimakhin, USSR

CMS UTILIZATION IN HETEROSIS BREEDING OF THE SUNFLOWER

Studies of male sterile forms in order to utilize them in sunflower heterosis breeding were started in Agricultural Research Institute of the South-East in 1967. At first from the home-bred varieties inbreds were obtained possessing genic male sterility (GMS) and inheriting the absence of pollen formation as a single recessive trait. However, these lines were not included into the programme of hybrid development. The recently developed sources of cytoplasmic male sterility (CMS) and fertility restoration are more promising in this respect. The main research has therefore been conducted since 1979 with CMS source on the cytoplasm of H. petiolaris and in a lesser degree on the cytoplasm of H. lenticularis. We study the nature and stability of CMS and its influence on biological and agricultural properties of the crop, the reaction of varieties and lines to the sterile cytoplasm. We also produce counterparts of fertility restorers and sterility maintainers, and develop and study new inbreds and first single crosses. The essence of the results obtained is as follows.

We have conducted 5 series of experiments aimed at CMS transfer through grafting. The sterile counterpart of the variety Chernyanka-66 was taken as a grafted plant (on cytoplasm H. petiolaris). The fertile early maturing variety Karlik-68, the maintainer of this CMS type, was taken as a graft. The normal fertile variety Chernyanka-66 served as a grafted plant in the check, and the fertile variety Karlik-68 - as a graft. Grafts were effected into splits, 5-10 plants per each variant. Fertile progenies of the grafts were maintained as inbreds, and sterile progenies were maintained by crossing with fertile grafts. In

total 150 graftings were effected and 800 plants were studied.

In all 5 series of graftings CMS was transferred from the sterile grafted plant to the fertile graft. The percentage of successful graftings showing CMS transfer in the progeny was about 10% of the total number of graftings. Sterile progeny in the first (after grafting) generation of the selfed grafts showed stable maintenance of sterility during six generations.

In phenotype (except CMS) all plants of these families were identical to the fertile variety Karlik-68 and possessed no marker traits of the selfed plants. The progeny of fertile grafts did not segregate and maintained full fertility.

In the check where the same variety was grafted to the fertile grafted variety Chernyanka-66 no sterile plants in grafted generations were observed. The CMS transfer through grafting is influenced by genotypic features of both grafts, environmental conditions of season of grafting and conditions of the first year of growing the seed generation of the graft, as well as the vegetation phases of graft components.

The best results were obtained when grafting was effected in the winter-spring period in the greenhouse and when the first seed generation was grown in the field.

The highest yield of sterile plants is observed when the grafted plant was used in the phase of 5-7 developed leaves and the graft was in an early stage of development before setting of the sporogenic tissue (the phase of cotyledon leaves - one pair of developed leaves).

The nature and mechanisms of CMS transfer through grafting are still not known exactly. Supposedly, CMS is transferred from the sterile grafted plant to a fertile graft by extrachromosomal "determinants" of sterility.

In the last series of experiments CMS was transferred through grafting to another fertile very early variety of our selection, Saratovsky-2115. Similarly, CMS was transferred to the fertile variety Karlik-68 from the sterile variety Donskoy-47 utilized as grafted plant.

In all experiments CMS was successfully transferred from medium maturing sterile grafted plants to ultra early ripening varieties. When developing methods of CMS transfer through grafting to midseason varieties and inbreds, a basically new method of fast development of sterile counterparts will be obtained.

Three-year studies (1973-1975) with different weather conditions showed a high stability of CMS expression in the field conditions in the Middle Volga Region. Hybrids of sterility sources and sterility maintainers had some 0.7% fertile segregates, ranging, from 0 to 3.5%. for different samples.

During the breeding work with sterile material it was found that sterile cytoplasm does not adversely affect 17 studied biological and agricultural traits, including the length of vegetation period, yield, oil and husk percentage of seeds and kernels, number of seeds per head, the mass of 1000 seeds, plant height, the head and stalk diameter, field and laboratory germination rate of the seed, etc. We have observed a somewhat early (by 1-2 days) flowering of sterile counterparts, and increased bud setting and seed formation in the head in comparison with fertile counterparts.

Our studies of the reaction of some 50 home-bred varieties and some inbreds of our own to the sterile cytoplasm have shown that all of them are good sterility maintainers. The development of sterile counterparts seems therefore to be a rather simple problem. At present 19 commercialized and prospective highly productive home-bred varieties are transferred on the sterile base, including Peredovik, VNIIMK 6540,

VNIIMK 8883, Saliut, Sputnik, Armavirsky 3497, Voskhod, Vostok, Chernyanka 66, Saratovsky 2, and Volgar. They all are utilized to obtain variety-line hybrids and as testers in evaluating inbreds for combining ability. Sterile counterparts are being developed from the most prospective inbreds.

Fertility restorers are developed on the basis of sterile cytoplasm utilizing Rf genes obtained from home-bred varieties and collection entries. Synthetics, which are combined from restoring sources of different genetic origins are used for the same purpose. The programmes of obtaining fertility restorers are now close to completion (4-5 backcrosses).

Breeding sources for hybrids are developed with vegetation period similar to that of the commercialized variety VNIIMK 8883 or 5-15 days shorter. At present 100 inbreds developed by us are included into our working collection. Most of them show oil content of about 43-46% (the best lines have 48-51%) and 18-22% huskness.

The first set of simple hybrids on the basis of CMS (with unrestored fertility) has been obtained; in 1976 they were included into different nursery trials, including 3 hybrids into the main variety trial and 37 hybrids in the preliminary trials. According to tentative estimates during preceding seasons the best of them (on the fertility basis) outyield the standard VNIIMK 8883 variety by 10-15%.

The development of hybrids is going along with the breeding of varieties. Our laboratory has developed and prepared for State Varietal Trials a new early variety Saratovsky 38; for 4 years of trials it outyielded the variety VNIIMK 8883 Improved by 4.1% of oil in seeds and by 76 kg of oil yield per hectare.

We believe that the future breeding work should combine development of hybrids and breeding varieties (at least to the point of biological upper limit of oil content of the seed),

using method developed by Academician V.S. Pustovoit, as modern high oil varieties, well adapted to local conditions of growing, represent a valuable gene fund allowing a highly effective utilization of heterosis to increase the productivity of this valuable oil crop.