PROSPECTS OF HYBRID SUNFLOWER SEED PRODUCTION BASED ON GIBBERELLIN INDUCED MALE STERILITY

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Studies conducted by VNIIMK, VIR and other research institutions have shown that heterosis utilization by transition from variety cultivation to hybrid cultivation results in an increase of seed yields of this crop by 15-20% and over.

To utilize sunflower hybrids it is necessary to develop simple and reliable methods of hybrid seed production on production scale. The classical approach to produce hybrid seed consists in cytoplasmic male sterility (CMS) utilization. However, CMS utilization becomes possible only after female lines are transferred to the sterile base and pollinators are chosen. The latter should well restore fertility. This method is used in practice but it does not preclude the cultivation of heterotic hybrids which do not possess CMS and respectively require other methods of seed production. That is why we attempted to develop a practically accessible method of seed production based on chemically induced male sterility. Gibberellin was used as gametocide.

Chemical castration as the means to obtain sunflower hybrid seed had long ago attracted the attention of research workers. Thus, in 1959 the German scientist Schuster had obtained data showing that aqueous gibberellin solution treatment of sunflower plants resulted in male sterility. Similar results were later obtained by Putt (Canada), Popov (Bulgaria), Vrenceanu (Romania). In our country A. Anashtchenko (VIR), A. Zdrilko (the Ukrainian institute of breeding, genetics and plant production) were engaged in such studies.

A.V. Anashtchenko (1967-1971) developed optimal concentrations of the aqueous gibberellin solution and determined stages for plant treatment for the greatest effect. It should be noted that chemical castration results in some negative effects, first of all in some considerable reduction of seed production. Plants treated with gibberellin

in the experiments conducted by A. Anashtchenko reduced seed yields by 25-30%.

The reduction of the seed yields, the difficulties related to ehe necessity of treating the plants strictly at a definite stage and the dependency of chemical castration on weather conditions has lead to a certain scepticism of some scientists concerning this method. For the same reasons chemical castration was not widely used in hybrid sunflower seed production abroad.

A. Anashtchenko recommended hand sprayers to be utilized for castration. This method was utilized under conditions of the Kuban VIR Experiment station and in other scientific research institutions in their breeding programs with comparatively limited treated areas. The attained sterility percentage of the plants was rather high (90-100%). However, treatments of hybridization plots with hand sprayers cannot meet the requirements of the hybrid seed mass production due to low production level. That is why we attempted to study the possibility to mechanize the process of chemical castration and to develop a more productive method of hybrid sunflower seed production.

We have developed a special experimental tractor mounted device to the sprayer PU-°5 with the possibility to treat 4 rows of sunflower in different combinations: four at a time, every second row, every third and fourth rows a time.

Hybridization plots were planted in the following way: four female rows and two rows of male plants. The variety Peredovik was used as female parent and variety Salyut was used as male parent. The well prepared field was planted by a six-row planter SPC-6 to obtain uniform stands. This latter condition is extremely essential to obtain the uniform stage of head formation in all plants of female rows. The depth of planting was also of considerable importance.

Planting was effected at the rate of 40-50 thousands of plants per hectare. Plants were treated with gibberellin with the help of the experimental device mounted on the Belaruss tractor at the stage of the start of head formation (fig. IO). The concentration of the aqueous solution was optimal —0.005%. About 550-600 l of solution were used per hectare at the tractor speed about 6 km/h.

Following the treatment, at the start of flowering the first screening was effected to eliminate fertile plants in female rows. Five days later the second screening was effected to eliminate late flowering plants.

Two combine harvesters were used simultaneously during the

harvest: one of them harvested female plants, the other one harvested the male plants.

Fertile and sterile plants were counted before the first variety screening. In spite of the imperfect design of the experimental device a high sterility percentage had been attained (Table 1).

TABLE 1

The effect of the aqueous gibberellin solution on pollen formation in sunflower plants.

Plant type	Plants, %		Mean for 2 years
	1974	1975	
Without pollen (sterile)	38.0	39.2	38.6
Underdeveloped pollen (Semisterile)	57.1	46.5	51.8
Normal pollen (fertile)	4.9	14.3	9.6

The data of the Table 1 show that in two seasons of the experiment the percentage of fertile plants was insignificant and could not play an important role in plant pollination. It should be reminded that all fertile plants were eliminated at the start of flowering during the variety screening.

The semi-sterile plants formed a limited amount of pollen with a low viability level.

It was also necessary to determine whether the plant treatment with gibberellin had any effect on germination rate, germination energy, on the size and other properties of hybrid seed. The experimental results have shown that gibberellin treatment practically had not reduced the planting properties of the hybrid seed (Table 2).

The seed yield per hectare in hybridization plots is of considerable importance in hybrid seed production. In 1975 the area of the hybridization plot was 1.8 Hectare. This plot yielded 1600 kg of quality seed, that is, 8.9 q/ha. Hence, one hectare hybridization plot presents the possibility to plant 150-180 ha of production fields.

Some studies were also dedicated to determine the effect of chemical castration on seed yield in the progeny. In 1975, 1977 and 1978 a special experiment was conducted to test hybrid seed obtained by

chemical and hand castration. The experiment included the same variety Peredovik and Salyut according to the scheme of preliminary trials (plot area 38.2 sq.m, 3 replications). The results showed that chemical castration had not reduced the hybrid seed productivity compared with those obtained by hand castration.

TABLE 2

The effect of chemical castration on planting properties of sunflower seeds.

Properties	1974		1975		Mean for 2 years	
	hybrid seed	Check	hybrid seed	Check	hybrid seed	Check
Germination energy, %	92.0	94.0	94.0	96.0	93.0	95.0
Germination rate, %	94.0	95.5	95.0	96.0	94.5	95.7
Weight of 1000 seeds, g	81.2	82.7	78.9	79.3	80.0	81.0
Specific gravity weight g/l	403.6	—	435.6	415.6	419.6	

The experimental device allows to treat 8-10 ha per shift instead of 0.5-0.8 ha by hand spraying. This indicates a higher economical importance of the recommended method. It should be noted that gibberellin production has been organized in our country and it is easily available in the market.

At present the experimental device is utilized to obtain hybrid seed of the variety-line hybrid VK-119 x Vostol which at present is under ecological and production trials.

Thus, the data obtained in VNIIMK show that the mechanized chemical castration with gibberellin opens the prospects for the development of a new method of hybrid sunflower seed production.

TABLE 3

Sunflower seed yield (Peredovik x Salyut) in the progeny depending on the method of production (VNIIMK; 1975)

Method of seed production	Weight of 1000 seeds g	Husk, %	Oil in kernels %	Seed yield, q/ha
Chemical castration (mechanized)	64.3	20.7	53.4	36.9
Manual castration	66.3	22.0	53.6	36.5
Peredovik — check	66.2	20.5	55.8	33.8
$NSR_{0.05}$	2.6 q/ha			

TABLE 4

Properties of the hybrid Peredovik x Salyut obtained by different means of castration (VNIIMK, 1977-1978).

Method of hybrid seed production	Vegetation period, days	Weight of 1.000 seeds, in g	Oil cont. %	Husk, %	Seed yield, q/ha
Manual castration	95	61.1	51.7	19.6	30.9
Mechanized chemical castration	96	62.1	51.1	20.3	30.1
$NSR_{0.95}$		3.6	1.3	1.3	3.3