

## SUNFLOWER HYBRIDS USING MALE STERILITY

By

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The goals of breeding for the sunflower crop.

From 1962 onwards, Russian varieties, rich in oil, such as VNIIMK 1646, VNIIMK 6540, ARMAVIR 9345, PEREDOVIK, arrived in France.

After a certain increase, the area devoted to sunflower cultivation has remained stationary at about 38,000 acres. To what can one attribute this lack of success?

First of all, to the differences between the oceanic climate of France and the continental climate of the regions of the U.S.S.R. where sunflowers are grown - Ukraine, Kouban, etc. These differences result in two difficulties in France which are almost unknown in the U.S.S.R.

- 1) Grey rot of the capitulum (head) due to Botrytis urerea, which occurs especially in the period just before maturity.
- 2) Lodging, which results most often from a breakage at the stem at least three feet above the soil. To obtain for the sunflower grower an increased and, most importantly, a regular income, it was essential to breed first for resistance to Botrytis urerea and lodging.
- 3) A third objective is an increase in grain yield with an oil content equal to that of the Russian varieties. An increase in grain yield seemed to us more important than an increase in oil content. If this was not the case, one would only consider the yield of oil per acre, which would be an error in the long term considered economically, since the meal is not without value. The experience with relative changes in the demand for soybean oil and soybean meal, whereby the percentage of gross return resulting from the oil fraction has declined, leads one to believe that an increase in the grain yield might be more desirable than an increase in the oil content.

Lately, two other breeding objectives have become important:

- 1) Resistance to Sclerotinia Sclerotium, cause of a white rot of the capitulum (head). This fungus has caused increasingly important losses in the regions where the sunflower crop has been successful and thus is repeated regularly every 3 or 4 years.
- 2) Resistance to Downy Mildew - Plasmopera helianthi. This parasite is known in France essentially in two southern regions, a) around Port St. Esport in the Rhane Valley since 1966, and b) around Tanloruse since 1968. In these two regions, some growers

never considered the imprudence of following a rotation of sunflowers every other year, which was bound to lead to the fatal and rapid extension of any source of mildew, even if infinitely small at the start.

In France, as the above remarks on Sclerotina and Mildew show, it appears difficult to make a success of sunflower growing with a rotation longer than four years. It would seem that today, the growers, in a given region, either give up sunflowers altogether or grow them every four years or less. This is why resistance to persistent soil born fungi is already important and will become more so if the area under sunflowers in France increases.

To obtain these different objectives, it appeared to us that single-cross hybrids were preferable to populations, since they insure homogeneity in the genetic progress obtained in different directions of breeding, and an easy control of this continued progress over the years.

In addition, the production of single-cross hybrids, responding to future needs at this moment unknown, should be faster than the production of population varieties with the same characteristics. The production of sunflower hybrids on a large scale is only possible using male sterility.

#### The Two Types of Male Sterility.

We have, at present, two types of sterility discovered at Clemont, Ferrand which are usable for large scale hybrid production.

1) Marked genetic male sterility - due to a recessive gene and linked to green coloring in the seedling (male fertility being linked to red coloring in the seedling). This chromosome linkage of two genes gives, by the removal of the red plants before flowering, female rows with more than 99% male sterile.

2) Cytoplasmic male sterility obtained from an interspecific cross (Helianthus petiolaris x H. annuus). This second type has the advantage over the first of not needing the manual labor of removing the red plants in the female rows in the seed production fields. However, it presents the inconvenience of limiting the male parents to fertility-restorers, while any male fertile line could be used as pollen parent with the first type at male sterility. Thus, the first type of male sterility is most useful for the breeder and the second type for the seed producer.

Marked genetic male sterility can be altered by modifying genes, and it is necessary to select among the female lines, genotypes having a complete male sterility. This presents no difficulties. At a later stage, it will be necessary to choose, among the available female parents, those which have the highest yield of hybrid seed per acre in order to reduce the cost of hybrid seed. We do not at the moment encourage 3-way hybrids (with the female parent a single-cross hybrid).

As to the cytoplasmic male sterility, it was demonstrated more recently and we are not yet sure of having lines with both characteristics altogether, 1) fertility restoring ability, and 2) capable of giving good hybrids. We found in 1969 that restoring ability depends on one dominant

gene and during the winter 1969-70, we became sure of having lines fixed for restoring ability.

#### Results Obtained to the End of 1969.

All the hybrids at present under trial have been produced with marked gene sterility.

INRA 6501, the first hybrid in France, has been put on the official list of varieties admitted to certification. It has received the name of INRA 6501 (INRA = National Institute of Agricultural Research). The number 6501 has the following meaning:

The first figure - 6, indicates the precosity (maturity rating); where 6 corresponds to that of Peredovik, 2 to that of Yenissie. The second figure - 5, indicates the height; 7 corresponds to the level of Peredovik, 3 to Yenissie. The last two figures - 01, constitute an order number.

After four years of trials in different regions of France, we can conclude that, on the average, this hybrid presents three times less lodging and three times less Botrytis than Peredovik. The grain yield is 12% greater than that of Peredovik. This increase can be more than 40% in growing conditions which make lodging likely. The oil content is a little below that of Peredovik (44% when Peredovik attains 47%), but the yield of oil per acre is more. The gross income per acre of the hybrid regularly tops Peredovik.

At the end of 1969, we got 1,500 kgs of hybrid seed and we hope to have between 20 and 30 metric tons in 1970.

#### New Hybrids at Present Under Trial.

The results of our trials allow a forecast that, in less than two years, hybrids will have an oil content equal to that of Peredovik with a 20% greater grain yield.

Certain hybrids are relatively tolerant to Sclerotinia Sclerotium showing regularly only half the attack of that of Peredovik.

For this parasite (as for Botrytis), we have never met any immunity or absolute resistance (no doubt because these two parasites have a wide host range and are not specific to sunflowers). We foresee an increase in relative resistance by selection so that the losses caused by these two parasites become economically insignificant.

The situation is entirely different for mildew. There exist, in this case, genes giving complete immunity. Some of these genes have been obtained in the U.S.S.R. and at Clermont-Ferrand from breeding of Jerusalem artichoke - sunflower hybrids, others have been found within the sunflower species in Romania, the United States and Argentina.

#### Conclusions and Forecasts.

In a future of more than five years, we consider that all the hybrids

destined for cultivation in France will be obtained with the help of cytoplasmic male sterility and will possess immunity to mildew with, in addition, a good tolerance to lodging, Botrytis and Sclerotinia.

Could it be hoped, could it be considered that the sunflower will become a "protein plant" with its oil producing role becoming of second importance? The question is worth putting since it would allow the plant breeder to better undertake his long term work.

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#### References

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