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# SUNFLOWER BREEDING IN SOUTH AFRICA

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Sunflower is grown only under natural rainfall conditions and only in those areas with a summer rainfall.

The production areas are :

1. An area with relatively cool climate and high rainfall.
2. A transitional area.
3. A hot area with lower rainfall.

The interest in sunflower production has increased considerably as has also the proportion planted to high-oil varieties such as Peredovik, Smena and similar types. The table below gives an indication of the developments.

| Season | Total production (x 1000 metric tons) | % high-oil types |
|---|---|---|
| 1966/67 | 100 | 7.5 |
| 1967/68 | 80 | 12.1 |
| 1968/69 | 89 | 31.4 |
| 1969/70 | 95 | 53.8 |
| 1970/71 | 133 | 60.8 |
| 1971/72 | 151 | 73.7 |
| 1972/73 | 233 | ? |
| 1973/74 | 267 (estimate | ? |

The reason for the very rapid increase is mainly economic as the increased price for sunflower changed the relationships in crash yield per unit area in favour of sunflower. Unfortunately the increase in production is not the result of an increased yield per unit area — however, we hope to do something about this very soon.

We classify sunflowerseed into two groups, high-oil (FH) and low-oil (F) classes with a corresponding difference in price. Fortunately the high-oil varieties are all anthocyanin-less and the low oil type (known

locally as Short Russian) contains anthocyanin. This makes identification of class easy.

The high-oil types flower at approximately 65 days and are mature at 100 days, while Short Russian flowers at 75 days and ripens at 120—130 days. The Short Russian (contrary to the name) is a very tall, large-leafed plant with a comparatively high water requirement and yields very well indeed under favourable conditions. As a resultf of its long growth season Short Russian competes directly with maize (our main summer crop) as far as planting date is concerned.

In area 1 the main crops are maize, sorghum and sunflower, maize on the lighter soils and the other two on the heavier soils because of their higher drought resistance. In this area Short Russian outyields the high-oil types to a sufficient extent to make up for the lower price and can actually compete economically with maize. Area 1 produces about 50% of our sunflower crop and nearly all the Short Russian. Both sorghum and high-oil sunflower can be planted up to a month later than maize and Short Russian sunflower, and in this area farmers use these short-season crops to extend their activity over a longer period.

Area 2 is a transitional area between 1 and 3.

Area 3 is much hotter and drier than 1 and because of the higher water requirement of Short Russian it cannot outyield the high-oil types sufficiently to make up the price difference. In this area (3) high-oil sunflower was usually planted when early maize plantings were impossible because of spring drought, but many farmers are now accumulating early-season moisture for the express purpose of planting sunflower. This area is more subject to periodic droughts and the drought resistance and short growth period of sunflower reduces the risk factor. Most of the soils which are used for crop production in area 3 are light sandy soils.

This is a very brief and superficial outline of our local situation but I hope it is sufficient to give you some idea of the background. We think that developing good hybrids will not only increase the yield per unit area but also the total area under sunflower as the increased yield makes sunflower more competitive against other crops.

## RESEARCH

*Agronomic.* The agronomic research programme has been intensified considerably and is aimed at determining the best utilization of our available resources. This programme includes variety trials, spacing, planting dates, weed control etc. in the different areas and on the dominant soil types within each area.

*Breeding.* This programme only started in 1970 when we acquired cytoplasmic male sterile and restorer material from France. We are doing work on both hybrids and open-pollinated varieties, the latter

because of their better adaptability in marginal areas and lower seed cost.

Introduced varieties are very variable, most probably because of variable genotype x environment interactions within the variety when it is moved to a new environment. This is a serious problem with mechanized harvesting.

## OBJECTIVES

1. Our major varietal vacuum is a high-oil type with a growth period and yield similar to Short Russian. The oil content of Short Russian is 30—33% while the minimum requirements for class FH is 40%.

2. We intend to release only hybrids with an oil content of 43% and higher. While qualification for the FH class is essential we do not intend breeding for an excessively high oil content at the expense of overall yield and protein content.

3. Disease resistance is of prime importance. Resistance to *Puccinia, Verticillium, Phoma* and *Alternaria* are of immediate importance and resistance to *Plasmopara* has to be considered. We do not yet have *Plasmopara* but I think we must be prepared beforehand.

4. We hope to produce a full range of hybrids from very latematuring to early dwarfs like the Romanian HS 18 and HS 20.

5. Under our conditions of high temperature and intense sunlight I believe that a smaller leaf area and therefore a smaller plant should be just as efficient physiologically as a large leaf area under European conditions. In other words we are slecting for short plants independantly of earliness.

## SOURCES OF LINES

We use everything we can get hold of to increase the variability and broaden the genetic base of our material. Cytoplasmic hybrids are used to develop restorer lines and genic m.s. hybrids and open-pollinated varieties for maintainer and eventually cms lines. These various sources are also used in building up open-pollinated composites from which lines can be drawn.

Most of the INRA material has been found to be too earlymaturing and ill-adapted to our conditions, but a promising restorer was selected from the original variable material supplied by Dr. Leclercq. The most useful American line has been HA 61 as a source of resistance to some diseases and we have back-crossed this line to Rf. RHA 265 is inclined to lodge and is very susceptible to *Cystopus candidus*. The lines HA 89, HA 99 and HA 234 hold more promise. Amongst our locally-developed lines the best have been derived from the Romanian hybrids HS 52, HS 55, HS 33 and HS 34. The other Romanian hybrid HS 301 has proved disappointing. The VNIIMK varieties have yielded some fairly

good material but losses of lines through self-incompatability have been extremely high. A very valuable source of selection has been progeny from a cross between Short Russian and Saratovski, but the oil content of many of these lines is not very good.

We are rather worried about the fact that all our cms lines contain the same cytoplasm. The danger of this situation is clearly demonstrated by the instance of T-cytoplasm and T-race of *Helminthosporium maydis* in maize. Consequently we have also started a programme aimed at developing new sources of male sterility and restorer. Both *H. petiolaris* and *H. tuberosus* are also being used to introduce disease resistance.

## METHODS

Selected plants from the various sources are selfed and rigourously selected for self-fertility. We have found that sunflower stabilises very rapidly phenotypically and that lines are very homogeneous in the S3. In future we will test for general combining ability at this early stage and the best lines will then be simultaneously inbred and back-crossed to cms. In six generations the maintainer lines will then be S6 and the cms back-crossed three times.

We have found that lines vary greatly in their extent of inbreeding depression. Some lines weeken so much that they just disappear and others show no depression at all. This is of course a very important factor in the economics of hybrid seed production.

When we started the programme we started back-crossing from the S1 to speed up the process on a limited number of lines, but so many of these lines were eliminated at a later stage for some or other reason that this method cannot be used on a large scale.

Restorer lines are developed by similar methods using the Rf gene in a sterile cytoplasm to keep a check on whether the Rf gene is being retained or not.

Trial hybrids are made up when the lines are in at least the S6 generation and planted in a limited (but representative of the major areas) number of trials. The best few from these trials are then planted on a wider scale for one year before the lines are multiplied and released.

We intend developing both single-cross and 3-way hybrids. Although double crosses are theoretically possible by using a combination of two types of sterility, I do not think this will ever be worthwhile if we can develop vigorous Rf lines.

## PRESENT STATUS OF PROGRAMME

At present we have approximately 70 lines which have reached the S6 generation of inbreeding with their cms equivalent. Of these lines 42 were derived from Romanian hybrids showing the adaptability of

this material to our conditions. Many more lines are in earlier stages of inbreeding.

The oil content of many of these lines was determined and a number of them had an oil content of nearly 50%, which is extremely good under our conditions (Peredovik is usually 43—45%). During the 1974/75 season we will be planting our first 100 trial hybrids. These are all single-crosses from 5 male parents (1 local selection, HA 61 and 3 INRA lines) and 22 female lines (13 local selection, 5 INRA lines and 4 American lines).

*Organization of breeding work* All abovementioned breeding work is done by the oil and protein crop breeding team. This group consists of only three professional officers (university graduates) and one technician with occasional assistance from the labourer team. Nearly all the pollinations have to be done by this group of four and when one considers that they are also responsible for the breeding work on groundnuts and dry beans it is obvious why the scale of our programme is relatively small.

During the summer season we can plant two generations of all the material with a growth season similiar to and shorter than Peredovik. We find some problems in the seed dormancy of sunflower but this is not excessive. A rest period of four weeks under fairly warm conditions seems to be enough to break dormancy.