

## EARLY SELECTION ON SUNFLOWER SEEDLINGS FOR BROOMRAPE (*OROBANCHE CUMANA* WALLR.) RESISTANCE

Z. Horváth

Bácsalmás Sunflower Producing System, Zrinyi 8, 6430  
Bácsalmás, Hungary.

### SUMMARY

Broomrape (*Orobancha cumana* Wallr.) has been of more importance in the production of sunflower in Hungary. Consequently, it requires a permanent and effective control to be developed. For eliminating this dangerous parasitic plant, two means of control appear to be reliable: (1) the use of phytophagous insects or hyperparasitic microorganisms and (2) the selection of resistant sunflower lines and the production of resistant hybrids.

Both of these control measures have been the subject of investigations for years at the Bácsalmás Sunflower Producing System (BNR.) For the early diagnosis of broomrape infection of sunflower, a new testing method has been developed using potted sunflower seedlings for the inoculation by broomrape seed. The evaluation of plant response to *O. cumana*, in other words, the frequency of infection within a sunflower line has been made on the basis of histological changes at the host-parasite interface, the resistant plants showing secondary lignin accumulation near penetration site. The induction of lignin seems to prevent the establishment of parasitic contact between vessels of the two organisms. As lignin accumulation is associated with brown necrotic lesions of the host tissue accompanied with dead broomrape plants in a number of cases, the response of sunflower to infection can be easily assessed by means of a dissecting microscope. As a result, sunflower populations (lines) can be divided into four phenotypic groups as follows:

- a./ plants showing broomrape nots yellow-opal in colour and detectable with the naked eye,
- b./ plants with very small, undeveloped nots,
- c./ plants showing necrotic lesions, and
- d./ plants with neither necrosis nor parasite.

The latter two groups of sunflowers are considered resistant to broomrape.

### INTRODUCTION

In order to produce sunflower varieties and hybrids which are resistant to sunflower broomrape (*Orobancha cumana* Wallr.), good-quality genetic material, an efficient selection method, and a reliable and highly productive examination method aiming at the evaluation of resistance to infestation are required.

The possibilities and advantages of early evaluation of sunflower resistance became conspicuous especially after it had been established that the resistance to sunflower broomrape was controlled by an Or dominant gene (Burlov - Kostiuk, 1976). This circumstance has led to the study of the immunity ultrastructure and to the definition of the physiological and biochemical differences of the immune and sensitive sunflower forms (Antonova, 1978).

The possibility that on the basis of sensitive reactions, the resistant plants can be selected from a given population long before flowering, made it possible to elaborate and apply an efficient immune selection method (Panchenko, 1973, Panchenko - Antonova, 1974 ; 1976, Dyakov - Antonova, 1978).

The efficient soviet examination methods have been adapted to circumstances in Hungary, taking the local ecological conditions into account, by the Sunflower Cultivation System of Bácsalmás. The flower-pot, broomrape provocation method applied by the System can guarantee that the broomrape infection is securely diagnosed at an early stage, and the sensitive sunflower plants are separated from the resistant ones (Horváth 1986a ; 1986b ; 1986c ; 1987a ; 1987b).

With this the System has ensured an efficient examination method for the base institutes interested in sunflower cultivation in Hungary (Research institute of Herbage Cultivation, Iregszemcse, Research Institute of Corn Cultivation, Szeged) to establish their system of improving sunflower broomrape resistance in practice.

## MATERIALS AND METHODS

My examination method is based on the realization that during the resistance examinations of sunflower forms considerable physiological and biochemical differences can be discovered between sunflower forms which are immune against the parasites and those which proved to be sensitive to the during the pathological process. During examinations by foreign authors it has been shown that the sunflower broomrape can penetrate not only into the roots of sensitive sunflower forms but into those of immune ones as well (Panchenko - Antonova, 1974). However, most of the haustoria of the sunflower broomrape dies in the different stages of infection, both in the root parenchyma and in the tissues of the stele, because in the immune forms a secondary layer of lignin is formed in the zone of contact with the parasite, and this precludes the possibility that the fascicular tissue system of the parasite is inoculated with that of the sunflower in the roots. This can be seen well by a binocular microscope as brown, necrotic spots in areas where the broomrape has died.

A prerequisite of artificial broomrape provocation tests is to make sure that the conditions of cultivation and the circumstances of infestation are uniform. To this end I have carried out the artificial provocation in plastic flower-pots of 19 cm diameter. I filled the pots with the mixture of lime sand of high Ca CO<sub>3</sub> (at least 6 %) content and medium-hard clayey soil in the ration of 6:4. I used 250 mg of cleaned broomrape seed for 1 kg of the soil mixture, uniformly scattered on the surface of the soil and thoroughly mixed with the soil.

As I used this mixture of sand and soil for several instances of provocation, I attached great importance to mineral nutrition. In each phase of the experiment, which lasted about 1 month, I applied 0.025 g of phosphorus, 0.015 g of nitrogen and the same amount of potassium as active ingredients for 1 kg of soil mixture. I put 4 sunflower achenes in each pot, then I covered the soil surface with 2 cm thick turf to keep the soil moist. I sowed the seeds in green-houses of 20 °C in the first decade of March, under natural illumination. I washed out the sunflower roots on the 23rd-25th day from the sprouting of the plant. Before washing the roots out, I had not watered the plants for 2 days, so it was easy to take the roots out of the pots by gently tapping them, without injuring the plant.

## RESULTS

These examinations have revealed that it takes 7 or 8 days for the haustoria of the broomrape to penetrate into the sunflower host-plant roots (in the case of the immune forms too, but in these forms the haustoria die later on). Taking into consideration the time necessary for the broomrape seeds to sprout (4 or 5 days), the necroses can be seen as early as on the 12th or 13th day, even in the immune forms. In the case of high infection loading (a lot of broomrape seeds), the immune forms can be detected and are distinctly visible by a reading-glass

on the 15th - 18th days. This method, however, can only be recommended for small populations, because the microscopic examination of the root system of plants representing a great number of selection samples is extraordinarily laboursome. Therefore, in the case of a lot of specimens (resistance improvement), it seemed expedient to wash out the sunflower root system on the 23rd - 25th day from the springing of the sunflower plants, then to weed out the specimens on the root of which distinctly visible, full-grown broomrape fundaments had appeared. After that the symptomless plants, which had been separated from the infected ones as described above, can be divided into two groups by the above microscopic examination, on the basis of the necrotic spots, into immune and sensitive specimens.

On the basis of this positive, and at the same time negative selection, the studied populations can be divided not only into two groups (sensitive and immune), but into four phenotypical groups in accordance with the

- a./ broomrape roots visible to the naked eye,
- b./ tiny, undeveloped roots,
- c./ necroses,
- d./ necrosis- and broomrape- free root system

Groups c/ and d/ in the above list can be regarded as practically resistant to broomrape infection.

At the same time it has to be remarked that the differences between the examined sunflower forms cannot be determined unambiguously by selection on the basis of necrosis alone, if conditions are unchanged, because the broomrape populations applied for infestation consist of genes of different virulence.

In this case the necroses on the roots are due to an immune reaction to the less virulent varieties, this is why the necrosis in itself cannot guarantee resistance to the most aggressive varieties. Consequently, in a certain case, the various forms of immune reaction are not influenced by the different degrees of resistance of the host-plant, because the immune reaction is frequently determined by the virulence of the broomrape population.

## DISCUSSION

The early diagnosis method of detecting broomrape infestation is often applied by the base institutes for sunflower seed supply in Hungary (Research Institute of Herbage Cultivation, Iregszemcse, Research Institute of Corn Cultivation, Szeged), under the expert guidance of the Sunflower Cultivation System of Bácsalmás. In addition to broomrape resistance improvement, this method can be applied as a safe means of checking the resistance features of consignments of seed to be exported, and of examining imported sunflower lines or hybrids to a similar effect. The method has been tested by several institutes abroad (Nürtingen - Fachhochschule, Federal Republic of Germany, Aleppo - The International Center for Agricultural Research in the Dry Area, Syria). Its efficiency is reinforced by Petzoldt-Sneyd's examinations (1986) as well.

## CONCLUSIONS

Plant breeders are permanently confronted with the task of searching for new, broomrape-resistant sunflower forms, because each resistant variety or hybrid becomes infected with broomrape after several years. It is a generally accepted view among plant breeders that with the development of resistant forms, much more aggressive broomrape varieties come into being. The number of these varieties increases simultaneously with the spreading of resistant sunflower forms, whereas the old varieties disappear as the varieties feeding them withdraw.

Therefore, research in broomrape resistance has to follow this new development consistently and intensively, and to ensure the conditions of progress in the field. I wanted to contribute to this work by means of the achievements of the Sunflower Cultivation System of Bácsalmás.

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