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BREEDING SUNFLOWER FOR RESISTANCE TO SCLEROTINIA LIBERTIANA FUCK.

The phytopathogenic fungus Sclerotinia libertiana Fuck. causes white rot which does serious damage to sunflower crops even under crop rotation conditions.

In the seasons favourable for the development of the pathogene the rate of infection is over 70%. In the stalks of the plants the fungus forms about 10 g of sclerotiae making up over 400 kg/ha under severe infection; most of them are left in the soil. Such intensive soil infection may prevent further sunflower cultivation in some regions.

At present there are no effective control measures against this disease which could considerably reduce its damage; thus, breeding sunflower for resistance to white rot is the only effective path to solve this problem.

New sunflower genotypes that have been recently developed have totally changed the views upon the possibility of breeding sunflower for resistance to white rot. Considerable differences in resistance of the breeding material under natural infection in the field make it possible to select tolerant genotypes.

Materials and Methods

Successful choice of resistant material depends upon the reliability of trials. Evaluation based upon natural infection is impossible in some seasons because of unfavourable conditions for disease expression. Evaluation of the breeding material by reliable methods of artificial inoculation allows a rapid and effective sunflower breeding for resistance to white rot.

Difficulties of developing the respective methods of artificial inoculation are conditioned by the presence of independent forms of the disease (roots and the above-root part of the stalk, the stalk and leaves, the heads). Infection being ef-

fected by micelium and ascospores in different stages of sunflower development necessitates utilization of different methods of evaluation.

The method of V.F. Kukin (1968) was used for three years (1973-1975) to evaluate a large number of varieties, hybrid combinations and inbreds of different genetic origins.

Resistant plants were grown under self-fertilization and their progeny was again tested. In 1975 this material was tested under different methods of artificial inoculation. Along with the method of Kukin the following methods were also tested:

A. "Tooth pick". Following the heat treatment in the boiling water the tooth pick was immersed into the nutritive solution (100 g of carrot, 10 g of glucose, 20 g of agar per 1 litre of water), then later it was covered with the fungus from the diseased stalk of sunflower. In five days, when fungus micelium was developed the tooth picks were sticked into the stalks of sunflower.

B. Particles of infected leaf petioles were introduced into the cuts on the stalks. Inoculation was effected following 24 hours of petioles being in a humid chamber to form the micelium of the fungus.

C. A piece of pith with an active fungal micelium was taken from the stalks of plants naturally infected in the field and was applied to the stalks of tested plants without injuring the tissues of the plants.

D. Sclerotiae were introduced into the soil along with the planting.

Inoculations were made on the stalks 60 cm above the soil level at the phase of head formation before flowering. The spot of inoculation was covered with moist cotton wool and aluminium foil, except the Tooth-Pick method where moistening was not utilized.

The resistance of the tested material was evaluated as percent of diseased plants in the basis of the typical symptoms.

Experimental Results

The 3 year trials by the Kukin method showed that most resistant were the lines RHA 265, RHA 266 and the hybrids including these lines, and also the progeny of resistant plants of some hybrids and varieties. The variety VNIIMK 8931 and the line CMS HA 60 were most susceptible to white rot.

The progeny of resistant plants from hybrid combinations and varieties had a considerably higher resistance than the initial material. The progeny of the resistant plant from the VNIIMK 8931 had only 10% of diseased plants as compared with 64% of diseased plants in the intial variety. We have obtained the progeny of one plant from the Romanian hybrid H-52 following two years of selection for resistance the progeny having 11% of diseased plants. The hybrid H-52 in the 1973 trials had 97% of diseased plants (L. Ćuk, 1974). Nevertheless, the selection results by the Kukin method cannot be considered reliable. For example, under field conditions the line RHA 265 (stalk damage) showed the highest percentage of diseased plants, while in laboratory trials it was one of the most resistant ones.

Trials by methods A and B give a higher percentage of diseased plants but the obtained material is not sufficiently differentiated in resistance. The high percentage of diseased plants means that there are no significant differences in the tested material, which reduces the possibilities of selection.

When the C method is used the material is not differentiated at all as the inoculated plants were diseased 100%.

When the fungus sclerotiae were introduced into the soil along with the planting a high differentiation of the tested material was obtained. The most resistant was the line RHA 265 with 10% of diseased plants, and the most susceptible was the line RHA 266 showing 90% diseased

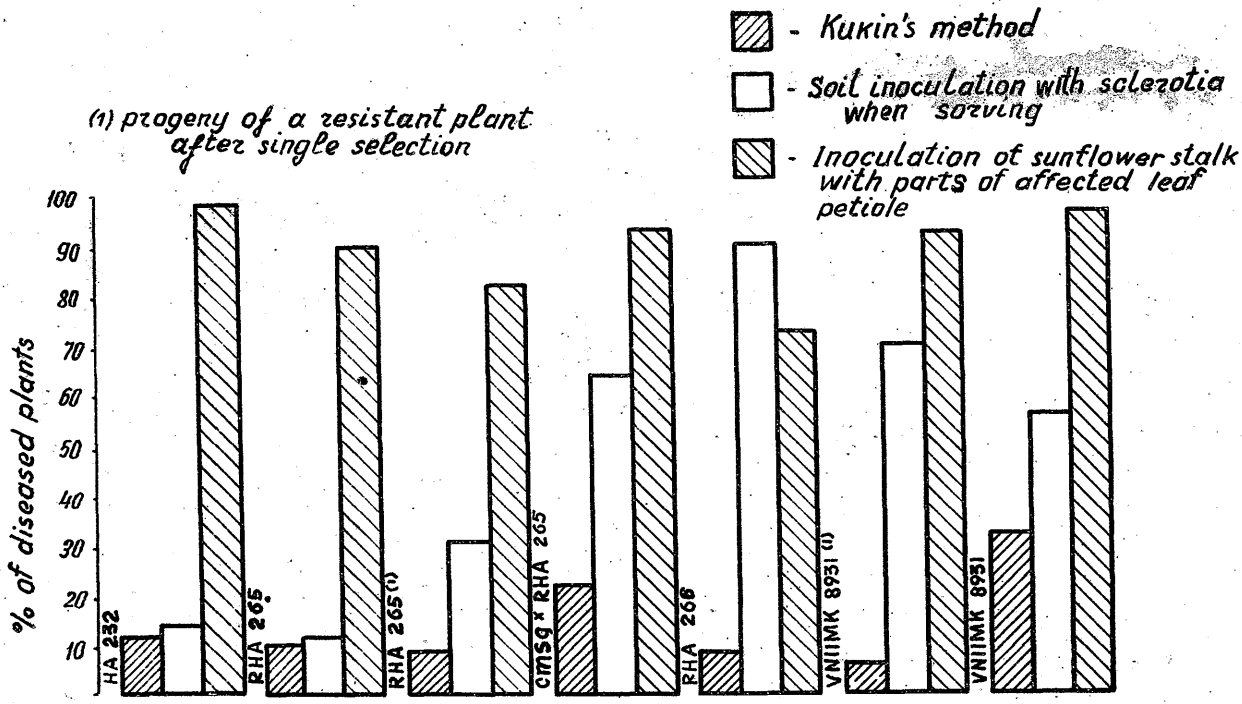

Fig. 1. Tests ot sunflower resistance against Sclerotinia libertiana using different methods of artificial inoculation, 1975

plants. Such considerable differences suggest that this method can be used for evaluation of the root form of the disease.

Discussion

Hyphae provided with sufficient reserve nutrients are capable to invade the superficial living cells of the host plant. The capability of infecting the plants depends on the hyphar's ability to penetrate through the cell membrane (A. de Bary, 1886; R. Lumsden, R. Dow, 1973).

Application of infected sunflower tissue on the stalks of the tested plants resulted in their total killing. In this case the fungus possessed sufficient food enabling it to invade the tissues of the host plant. Application of infected tissue with moist cotton wool round the stalk quickly leads to the killing of cells of the host plant. As the fungus has enough food it forms toxines killing cells and opens the path into the plant for itself. As soon as the fungus penetrates into the plant and starts utilizing the food of the freshly killed cells the host plant is no longer able to stop further development of the fungus.

When the infection is effected by ascospores the fungus does not possess additional reserves of nutrients and penetrates into the host plant with difficulty. The greater part of the above-ground portion of sunflower plant is resistant to ascospore infection. In the line RHA 265 the infection penetrates through the leaves. In 1975 under field conditions this line showed 40% diseased plants, though at the same time the line CMS HA 60 did not have any diseased plants (infected through the leaves). The hybrid combination CMS HA 60 x RHA 265 was also resistant to this form of disease indicating the dominant character of resistance in the CMS HA 60. Comparing the methods of artificial inoculation we may state that the line CMS HA 60 is highly resistant and the line RHA 265 is highly susceptible. This proves that resistance depends

on the possibility for the fungus to penetrate into the host plant rather than on the resistance towards the infection after its invasion into the host plant. The emergence of "susceptible spots" through which the fungus can penetrate into the plant is mainly dependent on the mechanical structure of superficial tissues rather than on the weakened physiological and biochemical protective mechanism of the host plant.

Differences in resistance expressed when fungus is introduced into the host plant tissues are also dependent on the structure of tissues. When the cut is effected on the stalk of the line RHA 265 the latter is easily cracked longitudinally causing the least damage of the cells. On the other hand the cut is rather difficult to be effected in the variety VNIIMK 8931, and when the fungus is introduced into the stalk this leads to a considerable damage of adjacent cells. Hence the fungus comes into a direct contact with available food increasing the percentage of diseased plants.

Conclusion

Under natural infection considerable differences are observed in sunflower resistance to Sclerotinia libertiana Fuck. The amount of damaged plants ranges from 3% to 75% indicating the possibility of selecting resistant genotypes.

The possibility of infecting the plant depends on the capability of fungus to penetrate through the membrane, to kill the cell and to obtain available reserve food. As soon as the pathological process in the plant has started the latter is no longer able to stop further development of the fungus.

The method of fungus introduction into the tissue of the host plant does not give significant results as well as the method in which micellium possesses available reserve food.

Emergence of "susceptible spots" through which the fungus mostly penetrates into the

plant is typical for every genotype. In the line RHA 265 infection proceeds through leaves at the stage of bud formation and lasts till the flowering phase.

Resistance of the line CMS HA 60 to the leaf infection is genetically dependent and inherited (in combination with RHA 265) as a dominant trait.