NEW SOURCES OF FERTILITY RESTORATION (Rf genes) AND DOWNY MILDEW RESISTANCE (Pl genes) IN SUNFLOWERS

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Summary

Our study included the determination of new sources of Rf genes, for fertility restoration, and Pl genes, for resistance to downy mildew (Plasmopara helianthi). Rf genes were found in inbreds originating from local populations from the Netherlands, Czechoslovakia, Poland, and Morocco -- VIR-772, VIR-997, VIR-67, and VIR-2128, respectively. Rf genes were also found in the inbreds K-212, K-215, and K-216 developed from the Argentinian cultivar Klein, in the inbreds C-220 and C-222 developed from the Argentinian cultivar Ciro, and in the inbred M-13/4-3-1 developed from the cultivar Mayak.

The line NS-B-16, of unknown origin, which has recessive branching, possesses an Rf gene as well as Pl genes for the resistance to the European and American races of downy mildew. RHA-201 is a new restorer obtained by crossing H. tuberosus with the domesticated sunflower form. It is resistant to the American and European races of downy mildew. RHA-93 is a new restorer developed from the Argentinian cultivar Pehuen INTA. It has a Pl gene for the resistance to the European race of downy mildew. RHA-191-76 is the restorer developed from the French line HIR-34. The lines ODTA-5652 and ODTA-3722 possess Rf genes and are resistant to the European and American races of downy mildew.

Introduction

Practical utilization of heterosis based on cytoplasmic male sterility is possible providing that a parental line possesses restorer genes (Rf). Several sources of restorer genes have been recently determined. Anascenko (1977) made a detailed review of the sources of fertility restoration.

Kinman (1970) determined the existence of an Rf gene in the line T6606-2. This source of fertility restoration was largely applied in the development of sunflower hybrids. Leclercq (1971) determined the existence of a dominant gene for fertility restoration in F_1 generation of H. petiolaris. Vranceanu and Stoenescu (1971) found the gene Rf_2 in the line MZ 1398 derived from the local cultivar Mezehedeshy. The line MZ1398 has good agronomic characters and high combining ability.

Fick and Zimmer (1974) developed restorers with recessive branching resistant to downy mildew (RHA-271, RHA-273, and RHA-274) which play a particularly important role in the development of sunflower hybrids based on cytoplasmic male sterility. The confectionery cultivar Sundak may also be used as a source of Rf genes. Fick and Zimmer (1974) selected the restorers RHA-280 and RHA-281

from this cultivar. Restorer lines have also been selected from the Argentinian cultivar Pehuen INTA. This source of fertility restoration in F_1 generation was found by Fernandez et al (1974). Fick, Zimmer et al (1974) determined the existence of restorer genes in a large number of wild sunflower forms. These forms are a solid basis for the development of restorers resistant to certain diseases (downy mildew, etc.).

Material and Method

For this study, we used inbreds from the breeding stock of the Institute of Field and Vegetable Crops in Novi Sad. The inbred used had been developed from local populations which in turn originate from the collection of VIR, Leningrad. Some Argentinian cultivars and local populations were also used as well as some lines originating from the Federal Institute of Genetics in Odessa. We also used the lines developed from the French line HIR-34.

In 1975, a large number of inbreds was crossed with five cms-lines. The restoration of fertility was checked in 1976. Repeated crossings were performed in 1976 and the checks of fertility restoration in 1977. The ensuing F_1 combinations were comparatively tested, in three replications, to evaluate the combining ability of the tested inbreds.

All tested inbreds were inoculated in 1976 in Novi Sad to test their resistance to downy mildew. A part of the breeding material was tested for the resistance to downy mildew in 1976 by Dr. D.E. Zimmer, ARS, USDA, Fargo, North Dakota.

Results and Discussion

Besides the already known sources of fertility restoration in our breeding stock, we found several new sources of Rf genes. They were found in inbred lines originating from local sunflower populations from several countries -- a local population from the Netherlands (VIR-772), a local population from Czechoslovakia (VIR-997), a local population from Poland (VIR-67), and a local population from Morocco (VIR-2128). The newly-developed restorers have poor agronomic characters and thus cannot be directly used for the development of sunflower hybrids. The studies presently in course should determine whether the discovered Rf genes differ from those already known or not.

The inbreds K-212, K-215, and K-216 derived from the Argentinian cultivar Klein, were found to possess Rf genes, as well as the inbreds C-220 and C-222 derived from the Argentinian cultivar Ciro. These restorers have high combining ability and may be used for the development of early hybrids with stem height to 160 cm.

The inbred M-13/4-3-1 from the cultivar Mayak also possesses an Rf gene. This restorer has a high oil content in seed (higher than 50%) and combines well with certain cms-lines. Several experimental hybrids having this restorer as a parent brought high seed yields. They are early maturity.

A much more interesting breeding material are the lines which possess both Rf genes and the genes of resistance to downy mildew (Plasmopara helianthi).

The line NS-B-16, the origin of which is not quite known, which has recessive branching, possesses an Rf gene and is resistant to downy mildew. According to still unpublished results of Zimmer (1976) this line is also resistant to the American race of downy mildew. The seeds of NS-B-16 are small and whitish in color, therefore different from the seeds of American restorers with recessive branching and the French restorer HIR-34. It is most probable that this line originated from a free crossing of an inbred from the cultivar Armavirsky 3497 and some wild sunflower form. Besides its resistance to downy mildew, NS-B-16 is tolerant to the agents of leaf and stem spot, Alternaria helianthi and Phoma sp. NS-B-16 has a high GCA value and may successfully be used in sunflower breeding programs. The studies presently in course should determine which Pl genes are present in NS-B-16.

RHA-201 is a new restorer resistant to the European race of downy mildew and, according to the results of Zimmer (1976), also resistant to the American race of the disease. It was obtained by crossing H. tuberosus with the domesticated sunflower form. RHA-201 is short (about 90 cm), with short internodes. When crossed with the tested cms-lines, it yielded short and relatively early hybrids.

RHA-93 is a new restorer genetically resistant to the European race of Plasmopara helianthi and tolerant to Sclerotium bataticola. It was selected from the Argentinian cultivar Pehuen INTA and we do not know how different it is from the restorer developed by Fernandez et al (1974) from the same population. RHA-93 is medium late, with stem height of 180-190 cm. When crossed with the tested cms-lines, it brought high seed yields and late maturation. We have not determined yet whether RHA-93 possesses the Pl gene for the resistance to the American race of downy mildew.

RHA-191-76 is the restorer with recessive branching derived from the French line HIR-34. It is resistant to Plasmopara helianthi and tolerant to Sclerotinia sclerotiorum. Its hybrids are medium early; their stem heights are also medium (160-170 cm).

The lines ODTA-5652 and ODTA-3722 possess an Rf gene and are resistant to the European race of downy mildew. According to the results of Zimmer (1976) they are also resistant to the American race of downy mildew. These restorers also showed the resistance to Orobanche cumana.

The newly developed restorers which possess Pl genes for the resistance to downy mildew and other positive characters may be used for the development of sunflower hybrids.

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