G.V. Pustovoit,
O. N. Krasnokutskaya,
USSR

WILD SPECIES OF HELIANTHUS AS INITIAL FORMS IN SUNFLOWER BREEDING FOR IMMUNITY

Sunflower is susceptible to numerous diseases of fungal, bacterial and virus origin. The most widespread and harmful are the following fungal diseases: downy mildew (incited by Plasmopara helianthi f. helianthi Novot.), sclerotinia (incited by Sclerotinia sclerotiorum Lib.), rust (incited by Puccinia helianthi Schw.) and broomrape (Orobanche cumana Wallr.), floral parasite plant. In some regions under favourable conditions sunflower plants are heavily affected by Botrytis, Rhizopus, and Verticillium.

Moreover, previously minor diseases have recently become potentially harmful in this country. Such facultative pathogens as Alternaria tenuis Nees., Sclerotium bataticola Taub., Phoma oleraceae Sace. annually expand their parasitic properties and this fact ranks them high among the most dangerous pathogenes of sunflower. Newly emergent strains of broomrape markedly affect sunflower varieties formerly resistant to this parasite. Hence, sunflower breeding for immunity is a most urgent breeding problem of to-date. Accordingly, plant breeders strive to combine resistance to different pathogens in one variety.

Breeding for immunity has up till now been based on natural mutations and on genetic stock which is available in the populations of commercial varieties. A lack of forms resistant to such diseases as Plasmopara helianthi f. helianthi Novot., Puccinia helianthi Schw., Sclerotinia libertiana Fuck. and some other within cultivated varieties made it necessary for sunflower breeders to search for immunity sources among wild species. It became obvious that the interspeci-

fic hybridization method previously used by plant breeders was insufficient for modern breeding programmes. So we concentrated on the wild species of Helianthus of North-American origin.

Collection of wild sunflower species was organized by G. V. Pustovoit at the All-Union Institute of Oil Crops. 24 species were investigated for resistance to the seven main diseases: Plasmopara helianthi f. helianthi Novot., Puccinia helianthi Schw., Sclerotinia libertiana Fuck., Verticillium dahliae Kleb., Sclerotium bataticola Taub., Orobanche cumana Wallr. and two pests: Homoeosoma nebulella Hb. and Brachycaudus helichrysi Kalt. There are annual and perennial sunflower species in the collection, where annual species are represented by diploids, and perennial species contain diploids alongside a poliploid series: hexaploids and tetraploids.

Estimation of wild species for resistance to diseases was carried out under artificial inoculation and in natural conditions. Different methods of artificial inoculation were used, depending on biology of a pathogen. A local fungi population was used for inoculation.

Field estimation was carried out in natural conditions on the introductive-quarantine nursery.

Phytopathological estimation of wild species in natural conditions revealed their field resistance. Annual wild forms that stand closest to cultivated varieties proved to be most susceptible to diseases. They showed field resistance against two pathogens only: downy mildew (Plasmopara helianthi f. helianthi Novot.) and broomrape (Orobanche cumana Wallr.); H. petiolaris showed additional resistance to Phoma sp. and Sclerotium bataticola Taub.

There were no diseases recorded on perennial wild species under natural conditions except Verticillium dahliae Kleb., which equally attacked all the wild sunflower species. As for H. tomentosus, it possesses immunity against this pathogen.

The most precise estimation of wild species

resistance was obtained under artificial inoculation. The annual wild species of sunflower were severely affected by all diseases (Table 1), including downy mildew (Plasmopara nelianthi f. helianthi Novot.) and broomrape (Orobanche cumana Wallr.), to which they had previously had field immunity. H. petiolaris alone was resistant to Sclerotium bataticola Taub. Of course, this group has no practical value.

Sources of immunity to all the investigated causal organisms and pests were identified on perennial species; moreover, the following regularity was noticed: the higher the species' ploidity, the higher and more extensive is their immunity.

That is why the poliploid group deserves special attantion (Table 2).

Within this group there are species possessing absolute immunity to five or six pathogens simultaneously. Thus, complete resistance to five pathogens: Plasmopara helianthi f. helianthi Novot., Puccinia helianthi Schw., Phoma sp., Sclerotium bataticola Taub., Orobanche cumana Wallr., was discovered on wild species of a hexaploid group: H. Tuberosus, H. rigidus, and H. subcanescens under optimal and heavy infection loads. These species also showed resistance to Sclerotinia libertiana Fuck., but this resistance is of age character and at the seedling stage the diseased plants perish completely. Differentiation on resistance is only revealed from the flowering stage.

Tetraploid H. tomentosus and hexaploid H. macrophyllus are both immune to five pathogens and are also immune to Brachycaudus helichrysi Kalt. It should be mentioned that H. tomentosus is the only species among all the investigated ones which has complete resistance to Verticillium Dahliae Kleb. under heavy infection loads, while the rest show 100% susceptibility to this pathogen. This is the only weak point in the immunity of wild sunflower species.

Tetraploid H. subcanescens has immunity to

Table 1

Phytopathological Evaluation of Helianthus Annual Wild Species under Artificial Inoculation (% of affected plants)

Species	2n	Plasmopara helianthi f. helianthi Novot.	Puccinia helianthi Schw.	Sclerotinia libertiana Fuck.	Verticillium dahliae Kleb.	Phoma sp.	Sclerotium bataticola Taub.	Orobanche cumana Wallr.	Brachycaudus helichrysi Kalt.
H. debilis Nutt.	34	100	100	6.6	100	90	30	100	4
H. lenticularis Dong	34	100	100	5.9	100	70	71	100	4
H. argophyllus T. et G.	34	100	100	60	100	90	40	100	4
H. petiolaris Nutt.	34	100	100	3.3	100	20	0	100	4
Check variety VNIIMK 8931	34	100	100	100	40	100	95	100	4

Table 2

Phytopathological Evaluation of Helianthus Perennial Wild Species under Artificial Inoculation (% of affected plants)

Species	2n	Plasmopara helianthi f. helianthi Novot.	Puccinia helianthi Schw.	Sclerotinia libertiana Fuck.	Verticillium dahliae Kleb.	Phoma sp.	Sclerotium bataticola Taub.	Orobanche cumana Wallr.	Brachycaudus helichrysi Kalt.
H. tomentosus Michx.	68	15.5	0	0	0	0	0	1.9	0
H. lactiflorus Pers.	68	25	0	0	100	10	0	1.3	2
H. scaberimus Ell.	68	22	0	0	100	20	0	0	3
H. divaricatus L.	68	3.7	0	0	100	20	100	0	-
H. tuberosus L.	102	0	0	0	100	0	0	0	4

Table 2 (cont.)

1	2	3	4	5	6	7	8	9	10
H. macrothyllus Willd	102	0	0	0	100	0	0	0.56	0
H. rigidus (Cass) Desv.	102	0	0	0	100	0	0	0	3
H. subcanescens Gray.	102	0	0	0	100	0	0	0	4
Check variety VNIIMK 8931	34	100	100	100	40	100	95	100	4

four pathogens. There are also wild species with the same complex resistance among perennial diploids: H. mollis, H. giganteus, H. argialis. The rest of the species of the tetraploid and diploid groups are immune to one, two or three pathogens. Moreover, they keep high resistance to other diseases which affect them in a small degree.

It should be added that all the wild species of Helianthus genus possess a well-formed phytomelanin layer, protecting sunflower seeds against sunflower moth.

Finally, observation on wild species collection in years with a high density of Brachycaudus helichrysi Kalt. revealed their absolutely different reactions to this pest. Three species: H. tomentosus, H. macrophyllus, and H. mollis proved resistant to the pest.

So, perennial wild species possessing sources of immunity against all investigated causal organisms and pests can be widely used as initial stock in breeding interspecific hybrids with group immunity.

Thus, wild sunflower species may be regarded as a genetic stock containing genes resistant to the causal organisms of the main diseases.