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DEVELOPMENT OF COUNTERPARTS RESTORING POLLEN FERTILITY AND RESISTANT TO BROOMRAPE (OROBANCHE CUMANA WALLR.) AND DOWNY MILDEW (PLASMOPARA HELIANTHI NOVOT.)

The main purpose of our sunflower breeding programme is the development and introduction into agricultural practice highly productive F_1 hybrids to obtain maximal yields in the dry steppe zone of the southern part of the Ukraine. One of the main aspects of the programme is the development of counterparts restoring pollen fertility which are resistant to broomrape and downy mildew in male fertile lines and have high general and specific combining abilities.

The counterparts restoring pollen fertility were obtained from lines OD 2586 and OD 2625 screened in the sixth inbred generation from sunflower variety Armavirsky 3497.

The Romanian line MZ 1398 was utilized as the source of restoring pollen fertility (V.A. Vranceanu, F.M. Stoenescu, 1971).

The source of complex resistance to broomrape and downy mildew was the line TA 1631 obtained at the All-Union Institute for Breeding and Genetics from an intervariatal cross H. tuberosus x H. annuus. This line is homozigotic in resistance to local races of broomrape and downy mildew.

The counterparts restoring pollen fertility and possesing complex resistance to diseases were obtained on the basis of V.F. Kukin's method of laboratory-field and laboratory-vegetation evaluation in the following sequence.

In 1974 the counterparts restoring pollen fertility, BC-4 OD 2586 and BC-4 OD 2625, showing no resistance to diseases, were castrated in the field and crossed with the source of complex resistance to broomrape and downy

mildew.

Male fertile F_1 hybrids were castrated in the greenhouse and crossed with the original line in autumn 1974.

In spring 1975 the seedlings BC-1 were inoculated with mildew zoosporangiae and planted in the greenhouse in the soil infestated with broomrape seeds. At the phase of two pairs of real leaves the humid chamber was created and all plants susceptible to mildew were killed. All plants susceptible to broomrape were eliminated from the greenhouse rack as a rule before flowering. Remaining male fertile plants were again backcrossed to the original line.

Similar work was done to obtain BC-3 seed and BC-4 seed in the field and greenhouse conditions in 1975.

The complete domination of the resistance traits to the mildew and broomrape was observed in F_1 obtained from crossing counterparts restoring pollen fertility and susceptible to diseases with the TA 1631 line homozigotic for resistance to them. All 15 plants of F_1 hybrid were thus resistant to these diseases.

Segregation for resistance to mildew in the progeny of the counterpart restoring pollen fertility of the line OD 2586 at BC-4 is shown in Table 1.

The domination of the trait of resistance to mildew in F_1 and actual segregation into classes studied in a proportion close to theoretical expectation (1:1) in the progeny of the cross between the counterpart BC-3, heterozigous in resistance, with the susceptible original line OD 2586, is the evidence that resistance to mildew is controlled by a single dominant gene P1. Results of our studies are in accord with earlier findings of other authors (V.A. Vranceanu, F.M. Stoenescu, 1971).

Remaining plants resistant to mildew were evaluated for resistance to broomrape. Plants showing flower bearers of broomrape were registered and eliminated before the flowering

Table 1.
Segregation for Resistance to Mildew (Plasmopara Helianthi Novot.) in BC-4 of the Counterpart OD 2586 Restoring Pollen Fertility. (Greenhouse, 1975)

Crosses	Hybrids	Number of plants		Predicted segregation	P
		resistant	susceptible		
1	BC-3 OD 2586 x OD 2586	25	22	1:1	0.75-0.50
2	"-"	11	13	1:1	0.75-0.50
3	"-"	14	12	1:1	0.75-0.50
Total		50	47	1:1	0.75

stage. Thus, by the time of the next backcross we possessed plants resistant to both diseases. Among them we registered male fertile and male sterile samples.

Segregation for resistance to broomrape and for restoring ability is presented in Table 2.

From the Table it can be seen that the actual segregation of the studied traits into phenotypical classes corresponds to theoretical expectation. Thus, progenies of the backcrosses segregated for both traits in proportion 1:1 and from the selfed heterozigote in proportion 3:1. This fact shows that traits of resistance to broomrape and restoring ability are controlled independently by one dominant gene Or and Rf.

Analyzing data presented in Tables 2 and 3 we may conclude that the three traits under study are inherited independently. Thus, among 50 plants resistant to mildew 27 were resistant

Table 2

Segregation for Resistance to Broomrape and for Restoring Ability (Greenhouse, 1975)

BC	Plants analyzed	Including		Exp. segregation	P	Res. plants	Among them		Exp. segregation	P
		res.	susc.				MF	MS		
BC-4 OD2586	50	27	23	1:1	0.75-0.50	27	16	11	1:1	0.50-0.25
BC-3 OD2625	23	12	11	1:1	0.90-0.75	12	7	5	1:1	0.75-0.50
Total	73	39	34	1:1	0.75-0.50	39	23	16	1:1	0.50-0.25
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BC-2 OD2586	41	28	13	3:1	0.50-0.25	28	20	8	1:1	0.75-0.50

Table 3

Comparison of Original Line with Counterparts Restorers of Different Backcross Levels in Main Agronomic Features. 1975

Backcross level	Huskness, %	Oil content, %	
		seed	kernel
BC-1 OD 25	29.7	54.20	38.1
BC-2 OD 2586	26.9	54.42	39.8
BC-4 OD 2586	25.0	58.20	43.7
OD 2586	24.3	58.40	44.2

and 23 susceptible to broomrape, and among 27 plants resistant to both diseases 16 were male fertile and 11 male sterile.

When restoring fertility counterparts were produced, the plants' agronomic properties were evaluated in addition to their selection for resistance to diseases.

The data in Table 3 make it clear that the counterparts restoring pollen fertility at the levels of BC-1 and BC-2 showed considerably lower agronomic characteristics that the original line and approached it only at the level of BC-4. Hence, at least 4-5 backcrosses are necessary to develop counterparts restoring pollen fertility.

Counterparts restoring pollen fertility created at the Institute will accelerate the development of highly productive sunflower hybrids based on CMS and possessing complex resistance to local races of broomrape and downy mildew.