E.L. Slyusar, USSR

SUNFLOWER BREEDING FOR RESISTANCE TO RUST BY THE METHOD OF INTERSPECIFIC HYBRIDIZATION

Sunflower rust (Puccinia helianthi Schw.) is widespread and severely affects sunflower in all the areas of its cultivation in this country and abroad.

Taking into account vast spread of the disease and heavy damages it causes the development of rust-resistant varietiss should be considered a major objective in sunflower breeding. The breeding for rust immunity is a promising method of controlling this pathogen. Intraspecific breeding for rust immunity carried out for many years by plant breeders gave no positive results. Our investigations involving a method of artificial inoculation missed the mark, too.

In 1956 G.V. Pustovoit, a plant breeder at All-Union Research Institute for Oil Crops, started breeding sunflower for group immunity, using the method of interspeciffc hybridization. Perennial wild species of Helianthus were used for crosses as a source of immunity to the main pathogens of sunflower crop. The hybrids obtained from the crosses had different breeding characters and included biotypes possessing field resistance to rust. It became necessary to create initial stock immune to that disease.

Extensive initial stock was investigated to determine immunity sources. It has been found that all the varieties of world breeding are susceptible to rust. The sources of immunity to the pathogen were found among perennial wild species of Helianthus originating from North America, and among interspecific hybrids of VNIIMK breeding.

Some investigated lines of the US and

Canadian origin, created on the basis of interspecific hybridization, showed considerable resistance to rust. Sundak variety of the American breeding is ummune to the pathogen. Some susceptible plants have been recorded within its population having the infection rate of up to 5%. Unfortunately, this variety and its lines are susceptible to downy mildew and have a low oil content and a high husk percentage. Interspecific hybrids of higher generation of Helianthus tuberosus x VNIIMK 8931 were used in sunflower breeding for rust immunity.

In some year the disease is weakly manifest in our conditions. Sine it is not always possible to make a precise estimation and culling with the normal time of sowing, we apply the late provocative sowing method suggested by Academician V.S. Pustovoit for revealing susceptible biotypes before flowering. The first stages of sunflower growth take place within the period of maximum accumulation of rust infection. Moreover, it is necessary to make an estimation of artificial inoculation both under field and green-house conditions. Methods and conditions for a long-term preservation of viable rust spores have been worked out by the VNIIMK sunflower laboratory. The spores are preserved under negative temperatures.

Covering sunflower leaves with uredospore suspension is a most effective method of artificial inoculation. An infection load in this case is 16,000 spores per 1 cu cm of suspension. The Goryaev's meter was used for counting the amount of spores. Sunflower plants are heavily rusted at the stage of 1-4 pairs of formed leaves. It has been stated that the pathogen successfully penetrates into a plant and the infection process develops at the temperature of 18-22°C, relative air humidity of 100% and a six hour exposition of moist chamber. All the required conditions are provided in a special chamber.

We apply the same method of artificial inoculation for field conditions. Inoculation

should be carried out in cloudy evenings with increased relative humidity of the air.

The estimation of the rust infection rate under field and green-house conditions was carried out taking into account the percentage of affected plants as the basic index of susceptibility. The affection degree is counted according to Melchers' and Parker's scale.

For further breeding work elite heads were selected from the plots which showed high resistance degree omitting solitary resistant plants from heavily attacked plots.

In the rust-resistant breeding stock we apply three methods of sunflower hybridization suggested by Academician V.S. Pustovoit. These methods comprise interpollination of resistant biotypes under free flowering, pair interpollination and group interpollination of resistant plants under isolated flowering. Moreover, selfed lines are available and recurrent breeding method is under investigation.

The hybrids population that has been under study since 1973 had 10% of resistant plants (Fig. 1).

Estimations and selections carried out in hybrid population by the method of artificial inoculation both for field and green-house conditions help annually increase resistance to rust incidence. In 1974 rust resistance was distributed as follows in the groups of hybrids obtained by different breeding methods: 28% under free pollination, 40% under pollinated with a pollen mixture, 47% in the group of recurrent breeding, 59% under paired pollination and 60% under self-pollination. In 1975 the resistance degree increased to 40, 56, 54, 75 and 84%, respectively.

Comparing the data obtained we can conclude that self-pollination and paired interpollination under isolated flowering are most effective on making the breeding stock homozygotic in terms of immunity.

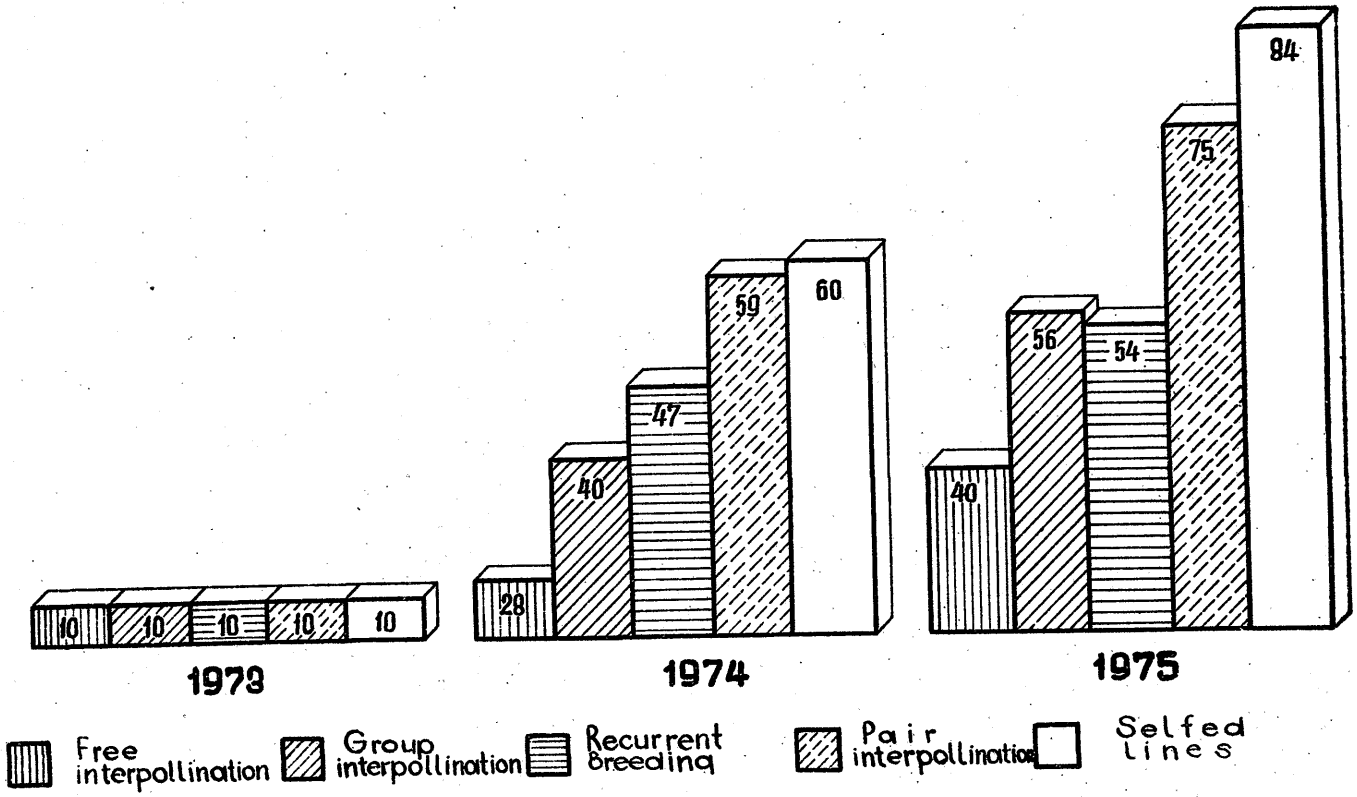

Fig. 1. Efficiency of interspecific hybrid breeding method for rust resistance, %

With the recurrent breeding method resistant biotypes accumulate at the same rate as under free pollination, but recurrent breeding, connected with self-pollination, decreases population productivity.

Selections have led to marked increases in the hybrid population resistance in all the groups, and decreased the affection rate. The latter can be traced in the group of hybrids obtained from 5-fold paired interpollinations. Breeding work with these hybrids started in 1971, when the population had 15.3% of resistant plants; 28.2% had a 5% degree of affection; 34.8% had a 10% degree and 18% had a 25% degree. There also were biotypes with a high degree of affection (Table 1).

The paired method of hybridization has considerably increased the number of plants with a slight and moderate degrees of affection. There are practically no families with heavy rust incidence.

Our laboratory has produced selfed lines of the fifth generation possessing complete rust resistance. All interspecific hybrids resistant to rust are also resistant to downy mildew. Estimation for downy mildew resistance has been performed under artificial inoculation. Breeding elite is systematically selected for immunity and for other valuable economic characters. These valuable traits are slightly reduced in hybrids obtained under isolated flowering.

We have created a large group of interspecific hybrids with complete immunity to rust, downy mildew, low husk percentage (19-21%) and high oil content (up to 54-59%) (Table 2).

Table 1

Influence of Selection on Rust Affection Degree of Sunflower Interspecific Hybrids, %

Years of trials	Degree of affection						
	0	5	10	25	40	65	100
1971	15.3	28.2	34.8	18.4	1.2	2.0	0.1
1972	39.0	30.4	21.2	7.0	1.4	1.0	0
1973	62.2	22.7	8.0	4.9	2.2	0	0
1974	75.0	19.7	2.6	1.7	0.8	0.2	0
1975	85.3	11.2	1.5	1.4	0.6	0	0

Table 2

Best Entries of Sunflower Interspecific Hybrids from the Group of Free Interpollination

VNIIMK, 1975

Elite number	1000 seed weight	Husk percentage	Oil content, %	Affection, %	Affection, %	
					in field	in a greenhouse
989	73	19.0	59.1	0	0	0
967	76	21.8	57.7	0	0	0
1063	90	20.4	55.6	0	0	0
981	74	19.0	55.5	0	0	0
759	68	20.0	55.5	0	0	0
815	67	19.0	54.0	0	0	0