



Reid Bevis, fieldman for Interstate Seed and Grain Co., checks seed set in a hybrid sunflower seed production field involving parental line RHA 271.

RHA 271, RHA 273 and RHA 274

Sunflower Parental Lines for Producing Downy Mildew Resistant Hybrids

G. N. Fick and D. E. Zimmer

Control of downy mildew, the most serious disease of oilseed sunflowers in North Dakota and Minnesota, is rapidly becoming a reality. The Agricultural Research Service, in cooperation with the North Dakota and Texas Agricultural Experiment stations, recently released three fertility restorer lines that can be used as male parents to produce high yielding downy mildew resistant hybrids. Seed for more than 50,000 acres of these resistant hybrids will be available for commercial production in 1975.

Production of high yielding hybrid sunflower varieties resistant to downy mildew became a reality with the release of three high oil sunflower parental lines, RHA 271, RHA 273 and RHA 274. These lines were developed cooperatively by the North Dakota and Texas Agricultural Experiment

Stations and the Agricultural Research Service, U.S. Department of Agriculture. An announcement of the release of RHA 271 was made April 1, 1973, and seed was distributed by the Texas Agricultural Experiment Station. The release of RHA 273 and RHA 274 was announced May 1, 1973, and seed was distributed by the North Dakota Agricultural Experiment Station.

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Yield tests at Fargo and Carrington, ND and Campbell, MN were conducted by C. M. Swallers, F. J. Sobolik and R. R. Bevis, respectively.

Downy mildew is estimated to reduce sunflower yields in the Red River Valley of North Dakota and Minnesota by 5 per cent annually. The incidence of infected plants is particularly high in fields that are subjected to heavy rains at

the time the sunflower seedlings are emerging from the soil. In such instances, fields with as high as 90 per cent infected plants have been observed.

All of the currently-grown open-pollinated and hybrid varieties are susceptible to downy mildew. Resistance to downy mildew was identified initially among certain experimental hybrids developed cooperatively by the Texas Agricultural Experiment Station and the Agricultural Research Service, U.S. Department of Agriculture. This resistance was derived from an inbred line, HA 61, which traces to a cross between a wild sunflower and a cultivated type. The resistance was found to be controlled by a single dominant gene which was designated Pl_2 (1). Research was initiated to incorporate the Pl_2 gene into fertility restorer lines which could be used to produce downy mildew resistant hybrids using the cytoplasmic male-sterile and fertility restorer system. RHA 271, RHA 273 and RHA 274 are the first such lines to be developed.

Breeding History

RHA 271, RHA 273, and RHA 274 were selected from the cross between cmsPI 343765/HA 119//HA 62-4-5 and single plant selections from the cross T66006-2 made in 1970 by M. L. Kinman, Agricultural Research Service, College Station, Texas. The parent, cmsPI 343765, was introduced from France in 1969 and contributed male-sterile cytoplasm to the cross. HA 119 is an inbred line from the Russian variety Jdanovsky 8281. HA 62, a sister selection of HA 61, contributed rust and downy mildew resistance and recessive branching. The male parent, T66006-2, is the same cross from which restorer lines RHA 265 and RHA 266 were derived and contributed genes for fertility restoration and rust resistance. The parentage of T66006-2 is Peredovik*2/953-102-1-1-41; the latter line is a selection involving wild *Helianthus annuus* L. isolated by Agriculture Canada, Morden, Manitoba.

The F_1 generation of the cross was grown in the greenhouse at College Station, Texas, in 1971. The F_2 and subsequent generations were grown in both Texas and North Dakota. All tests for downy mildew resistance were carried out in North Dakota. RHA 271, RHA 273 and RHA 274 are each composites of seed from four F_2 lines that trace to individual plants of a single F_4 line.

Disease and Agronomic Characteristics

The Pl_2 gene for downy mildew resistance is present in a very high frequency in RHA 271 and in a homozygous condition in RHA 273 and RHA 274. The lines have been resistant to downy mildew in both greenhouse and field trials. Rust resistance of RHA 271, RHA 273 and RHA 274 is

superior to that of the currently grown open-pollinated variety, Peredovik. The highest level of rust resistance is carried by RHA 273. A low frequency of completely rust-immune plants is present in RHA 271. However, because of a strong repulsion linkage between the Pl_2 gene and the rust gene, the rust-immune plants are downy mildew susceptible. RHA 271, RHA 273 and RHA 274 are all susceptible to *Verticillium* wilt, although RHA 271 may have some tolerance. When crossed with wilt-resistant female lines, such as HA 89 and P-21 VR1, the hybrids are resistant.

RHA 271, RHA 273 and RHA 274 are all recessive branching lines. The branching character allows for the production of pollen over a long period of time. Consequently, RHA 271, RHA 273 and RHA 274 can be used in hybrid seed production with female lines that flower up to three weeks later than the restorers. Because the branching is recessive, hybrids resulting from crosses with single-headed females are single-headed.

Under favorable conditions RHA 271, RHA 273 and RHA 274 grow four to five feet tall. RHA 271 is relatively late in maturity, whereas RHA 273 and RHA 274 are midseason. Petals and disc florets are medium yellow, and stems and leaves are dark green. Limited anthocyanin pigment is present in the stems of RHA 274.

Seed color of RHA 271 is predominantly brown with white stripes and a low frequency of solid brown. Seed colors of RHA 273 and RHA 274 are brown and black, respectively. Seeds of all lines are relatively small and elongated; oil content of RHA 274 is comparable to Peredovik, whereas oil contents of RHA 271 and RHA 273 exceed Peredovik by three to four percentage units.

Hybrid Performance

Hybrids involving RHA 271, RHA 273 and RHA 274 have been resistant to downy mildew in all field trials. In tests at Fargo and Casselton in 1973, with 50-100 per cent of the plants of susceptible varieties showing downy mildew symptoms, RHA 271, RHA 273 and RHA 274 hybrids all showed resistance. These results confirmed observations made in the greenhouse at Fargo that RHA 271, RHA 273, RHA 274 and their F_1 hybrids provided excellent protection against downy mildew.

Comparative performance of hybrids involving RHA 271, RHA 273 and RHA 274 crossed with female lines cmsHA 89 and cmsP-21 VR1 was obtained at four locations in North Dakota and Minnesota in 1973 (Table 1). The yields of the downy mildew resistant hybrids ranged from two



Dr. David Zimmer shows the large seed head of a downy mildew resistant variety from North Dakota being grown on an experimental plot in Romania this past summer.

to 31 per cent more than yields of Peredovik. Four of the six hybrids outyielded the currently grown Hybrid 896. Days to 50 per cent flowering and plant height were similar to those of Peredovik and Hybrid 896. Rust resistance of RHA 271, RHA 273 and RHA 274 hybrids was better than the resistance of Peredovik, but less than that of Hybrid 896. Most pustules appearing on the leaves were small and scattered. Test weights were high. Seed oil contents of RHA 271 and RHA 273 hybrids were higher than the two check varieties, whereas oil content of the RHA 274 hybrids was somewhat lower.

Increase and Distribution of Seed

Breeder seed of RHA 271 was increased in Hawaii during the winter of 1972-73. RHA 273 and

RHA 274 were increased at El Centro, California, during 1972-73. Seed of each restorer line was distributed to qualified hybrid sunflower seed producers for further increase and for use in production of hybrid seed. Seed for about 20,000 acres of downy mildew resistant hybrids produced from these lines was available for commercial production in 1974.

The North Dakota Agricultural Experiment Station will maintain purified seed stocks of each line as long as they are in demand.

Reference

1. Zimmer, D. E. and M. L. Kinman. 1972. Downy mildew resistance in cultivated sunflower and its inheritance. *Crop Sci.* 12:749-751.

Table 1. Performance of RHA 271, RHA 273 and RHA 274 Hybrids Compared with Peredovik and Hybrid 896 Grown at Fargo, Casselton and Carrington, North Dakota and Campbell, Minnesota in 1973.

Variety	Days to 50% Flower	Height, Inches	Downy Mildew*	Rust*	Yield, Lb/Acre	Test Wt. Lb/Bu.	Oil Percentage
cmsHA 89 x RHA 271	79	57	R	3R	1578	30.1	48.7
cmsP-21 VR1 x RHA 271	71	53	R	3R	1622	30.2	47.7
cmsHA 89 x RHA 273	75	63	R	1R	1501	30.2	47.0
cmsP-21 VR1 x RHA 273	72	56	R	1R	1802	31.5	47.8
cmsHA 89 x RHA 274	77	60	R	4R	1809	27.9	43.6
cmsP-21 VR1 x RHA 274	74	63	R	3R	1935	28.4	43.2
Peredovik	75	62	S	18MS	1475	25.1	44.3
Hybrid 896	77	61	S	0R	1603	27.0	46.4

* R = resistant, S = susceptible, MS = moderately susceptible.