

RESISTANCE TO *SCLEROTINIA SCLEROTIORUM* (LIB.) de BARY IN SUNFLOWER

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Summary

Sclerotinia sclerotiorum (Lib.) de Bary occurs in most of the sunflower growing areas of western Canada, varying in incidence from year to year. This pathogen affects a wide range of dicotyledonous plant species, suggesting that immunity within host species may not exist. However, in a series of field and controlled environment experiments we were able to demonstrate differences in susceptibility to wilt in cultivars and lines of *Helianthus annuus* L. In growth room tests the inbred HA 61, developed wilt symptoms at a slower rate than other cultivars and had a higher percent surviving plants. In field tests, using artificial inoculation, HA 61 consistently showed a greater ability to survive than the variety Krasnodarets. The partial resistance demonstrated by HA 61 appeared to be transferrable to F₁ progeny in some crosses.

Introduction

Sclerotinia sclerotiorum (Lib.) de Bary is widely distributed in soil in Western Canada. Most sunflower fields show at least a trace of infection and a few fields are found annually where a high percent of plants are diseased (2). The predominant symptom observed is wilt, initiated by root infections which progress upward into the stem. Infected plants may set seed, but their yield is reduced, and frequently these plants lodge before healthy plants are mature. Head rot occurs less frequently than wilt and is considered of secondary importance (1).

Unlike most plant pathogens, *S. sclerotiorum* has an extremely broad host range, affecting more than 300 plant species. In addition the pathogen affects primarily senescent tissue or infects juvenile tissue with the aid of a supplementary source of energy. Immunity to such a non-specific pathogen may not exist. However, within the genus *Helianthus*, differences in susceptibility among cultivars and lines have been noted (3,4,5,6,7). The work reported by Rollier (7) and preliminary studies in our laboratory suggested that the inbred line HA 61 and hybrids with this line as one of the parents, showed some resistance to *S. sclerotiorum*. Our objective in the work reported here was to compare the reaction of HA 61 and F₁ hybrids with HA 61 as the male parent with the variety Krasnodarets, selections from within the variety Krasnodarets, as well as several additional varieties.

Materials and Methods

Inoculum

Inoculum of *S. sclerotiorum* was produced in flasks on steeped, autoclaved rye kernels. Cultures were started with discs of mycelium from potato dextrose agar plates. After a 10 day incubation period at 20 C, the infested rye kernels were air dried. A standard amount of the air dry inoculum was placed at the base of plants to induce infection.

Infection in Controlled Environment

Plants from two seed sources of the inbred HA 61 were compared with the open pollinated cultivars Krasnodarets and Corona and five selections of Krasnodarets from plants surviving in a field wilt nursery. Twenty plants of each variety were grown in 13 cm pots in a soil-free potting medium (8). When flower buds were first visible plants were inoculated with *S. sclerotiorum* and kept in a saturated atmosphere for 48 hours. The number of plants showing wilt symptoms was recorded at 2-day intervals.

Field Experiments

Field plots were planted in 6 m rows with 46 cm spacing between rows. Plant populations were in the range of 40-50 plants per row. All treatments were replicated four times, however number of rows per plot varied because of limited quantities of seed of some varieties. Inoculum was scattered in the rows and lightly covered with soil when plants were approximately 40 cm tall. Percent surviving, or noninfected plants was recorded at maturity.

Experiment 1, 1976

Two sources of HA 61, INRA 7702, INRA 4701, Sundak, Corona, Krasnodarets and a selection of Krasnodarets from plants surviving in a wilt nursery in 1975 were evaluated for reaction to *S. sclerotiorum*.

Experiment 2, 1977

Reaction of HA 61 to *S. sclerotiorum* was compared with INRA 7702, Krasnodarets and a selection of Krasnodarets plants surviving in a wilt nursery in 1976.

Experiment 3, 1977

A selection of HA 61 plants surviving inoculation with *S. sclerotiorum* in a growth room experiment was hybridized with CM 400, CM 502, CM 506 and BL 1411. The reaction of the inbred and four hybrids to *S. sclerotiorum* was compared with Krasnodarets and CM 400 x Krasnodarets rf. Each line was planted in single row plots replicated four times.

Results

Infection in Controlled Environment

Symptoms began to appear 3-4 days after inoculation. Eight days after inoculation when all 20 Krasnodarets plants were wilted, 45 and 50% of the two HA 61 lines respectively were free of symptoms (Table 1). The Krasnodarets selections developed wilt symptoms more slowly than the parent variety, however after 16 days nearly all plants were wilted. While final numbers of plants surviving in the two HA 61 lines were relatively small, the rate at which these lines became infected was substantially slower when compared to the other lines tested.

TABLE 1. Response of Sunflower varieties to inoculation with Sclerotinia sclerotiorum under growth room conditions.

Variety ^a	Days after inoculation				
	4	6	8	12	16
	Number of Plants Surviving				
HA 61 1	15	15	10	8	7
HA 61 2	15	10	9	7	5
Krasnodarets	7	2	0	0	0
Corona	6	3	1	0	0
Krasnodarets sel 1 ^b	9	8	4	2	2
Krasnodarets sel 2 ^b	14	11	3	2	2
Krasnodarets sel 3 ^b	16	7	2	1	1
Krasnodarets sel 4 ^b	17	14	7	4	2
Krasnodarets sel 5 ^b	14	8	5	4	4
Y 2	6	1	1	1	1

^a Twenty plants for each variety.

^b Selections from plants surviving in a field wilt nursery.

Field Experiments

Experiment 1, 1976 - In the field, as in the growth room experiment, wilt symptoms began to appear within 4 days of inoculation. New infections continued to appear up to harvest in all varieties tested. Even with carefully controlled inoculation, the amount of wilt was extremely variable among rows within varieties (Table 2). However, in spite of the variation in amount of infection, the mean percent surviving plants and the range within varieties indicated that both HA 61 lines were more resistant than either the hybrids (INRA 4701, INRA 7702) or in the open pollinated varieties evaluated (Table 2). Furthermore, it appeared that selection within the variety Krasnodarets in a wilt nursery had not increased the level of resistance in the variety.

TABLE 2. Response of Sunflower varieties to inoculation with Sclerotinia sclerotiorum in a field nursery, 1976.

Variety	Percent plants surviving	Range
HA 61 1	69.0	57-81
HA 61 2	64.9	42-88
INRA 4701	30.0	19-41
INRA 7702	44.4	31-54
Krasnodarets	42.4	7-83
Krasnodarets sel	35.2	6-82
Sundak	34.4	6-62
Corona	35.6	11-71

Experiment 2, 1977 - This experiment was essentially a repetition of Experiment 1, but with fewer varieties. The results (Table 3) confirmed those of the previous experiment indicating that HA 61 was more resistant than Krasnodarets or INRA 7702. There was some difference between the two HA 61 lines, however one line was assessed on a smaller population. Selection within the variety Krasnodarets again did not improve its level of resistance.

TABLE 3. Comparison of response of HA 61, one hybrid and two open-pollinated varieties to inoculation with Sclerotinia sclerotiorum in a field nursery, 1977.

Variety	Percent plants surviving	Range
Krasnodarets sel ^a	19.9 d	4-39
Krasnodarets	23.6 cd	3-46
HA 61 1	47.3 a	20-67
HA 61 2	36.3 b	21-54
INRA 7702	30.5 cd	7-56

Means not followed by letters in common are different at the .05 level. Data based on 10-row plots replicated four times, except HA 61 2 where data were from 2-row plots.

^a Selection from plants surviving in a field wilt nursery.

Experiment 3, 1977 - HA 61 selection and two F₁ hybrids with HA 61 as the male parent were almost identical in percent plants surviving (Table 4). They were statistically different from Krasnodarets. Although they ranked higher in the test they were not statistically different from CM 400 x Krasnodarets rf and CM 502 x HA 61. As in the other field experiments, there was a large degree of variation in the amount of infection within varieties. The least variation occurred in the hybrid BL 1411 x HA 61.

The two inbreds CM 502 and CM 506 were not male sterile, therefore the percent hybrid plants in the CM 502 x HA 61 and CM 506 x HA 61 crosses was low. The data may not be an accurate reflection of the hybrid reaction for these two lines. CM 506 appeared to be extremely susceptible to wilt.

TABLE 4. Comparison of response of the varieties Krasnodarets and a selection of HA 61, and hybrids with either as the male parent, to inoculation with Sclerotinia sclerotiorum in a field nursery, 1977.

Variety	Percent plants surviving	Range
HA 61 sel ^a	52.3 a	26-80
CM 400 x HA 61 sel	49.2 a	33-64
BL 1411 x HA 61 sel	47.2 a	40-54
CM 400 x Kras rf	39.5 ab	16-67
CM 502 x HA 61 sel ^b	37.3 abc	24-56
Krasnodarets	32.6 bc	17-47
CM 506 x HA 61 sel ^b	10.3 d	1-17

Means not followed by letters in common are different at the .05 level. Data based on single-row plots replicated four times.

^a Selection from selfed plants surviving growth room inoculation test.

^b Female line not male sterile, therefore a high percentage of plants were not hybrids.

Discussion

The reaction of a host plant to a pathogen with a low level of specificity appears to be highly variable and dependent on environment. Photoperiod (4) and plant density (1) have been shown to affect infection of sunflower by S. sclerotiorum. In our own tests, in spite of efforts to standardize plant densities and amount of inoculum applied, there was a high degree of variation in infection within varieties.

The inbred variety HA 61, like other varieties evaluated was variable in reaction. However, in a series of experiments, HA 61 consistently ranked higher than other varieties in ability to resist infection under conditions of artificial inoculation. It appears that this inbred has a partial resistance, which in some crosses is transferred to its F₁ progeny. While recurrent selection in a wilt nursery failed to increase the level of resistance in the variety Krasnodarets, it would seem worthwhile to attempt to increase the level of resistance of HA 61 by this method. Complete immunity may not be essential for satisfactory control of wilt under field conditions.

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