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EPIDEMIOLOGY OF SUNFLOWER RUST

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INTRODUCTION

Rust (Puccinia helianthi Schw.) has been found on sunflowers (Helianthus annuus L.) almost everywhere in the world that the crops is grown (Anon. 1969). Host and pathogen are exposed to a wide range of climatic conditions from hot to cool, from arid to humid, from long days to short (Sackston, 1956, 1957).

Daylength, light intensities from 2 200 to 43 000 lux, and temperatures from 16° to 27°C during production of uredospores had little effect on subsequent germinability of the spores (Sood and Sackston, 1971).

Uredospores of the four "Canadian" races produced under standard controlled conditions germinated equally well at temperatures from 10° to 25°C, but less at 30° and least at 5°C. Optimum temperature for penetration into the host varied with race from 15° to 25°C.

Germination percentage of spores exposed to light during the germination process decreased with increasing light intensity from 2 200 to 17 600 lux. Penetration into the host was also adversely affected by increasing light intensity (Sood and Sackston, 1972).

Where sunflowers are grown under relatively moderate temperatures with adequate rainfall, conditions are favorable for rust development. Where they are grown in dry seasons or in arid regions under irrigation, free water on the leaves, from dew or infrequent light rains, may be present only for limited periods. Spore germination and infection of leaves must occur quickly for rust to develop under such conditions.

This paper presents the results of experiments to determine percentage germination of uredospores on agar and on leaves, and the degree of infection of sunflower plants, exposed to a range of temperatures for various intervals after inoculation with freshly harvested spores of "Canadian" races of rust produced under controlled conditions.

MATERIALS AND METHODS

The sunflower variety used in all experiments was S37-388, the "universal suscept". Plants were grown in controlled environment cabinets maintained at 25°C day and 16°C night temperature, with 16 hours of

light at 13 200 lux from cool white VHO fluorescent tubes supplemented with incandescent bulbs.

The four "Canadian" races of sunflower rust (Sackston, 1962) were produced on S37-388 in cabinets maintained under the same conditions. Freshly formed uredospores were harvested 16 to 18 days after inoculation and were used immediately. Spores were dusted onto 3 % water agar in 9 cm petri dishes and onto 14-day-old sunflower plants in a settling tower, to give approximately 1 000 to 1 500 spores per plate and 400 to 500 per leaf. Plants and plates were immediately transferred to a Percival dew chamber maintained at 7°, 10°, 15°, 20°, 25°, 30°, or 35°C in a series of experiments. Plates and plants were removed from the dew chamber after 1, 2, 3, 4, 5, 6, 7, 8, and 24 hours exposure respectively. One group of plants from each exposure was transferred immediately to a cabinet maintained under the usual conditions of light and temperature to determine rust infection after 14 days. The plates and another set of plants from each exposure were sprayed with 0.1 % trypan blue in 40 % acetic acid to kill and stain the spores (Boedijin, 1956). Approximately 250 spores per plate, one plate per treatment, and 250 spores per leaf, on 4 leaves from 3 plants per treatment, were counted and germination percentage determined. Spores were considered to have germinated if the length of the germ tube was greater than the diameter of the spore. Germination counts on agar were discontinued after 6 hours because the germ tubes became too long and tangled to be distinguishable. All germination counts were made using a Reichert Visopan projection microscope. Intensity of infection was rated on a visual scale in some experiments, and on number of pustules per leaf in others. All experiments were repeated twice.

RESULTS AND DISCUSSION

The results of one set of experiments with rust race 1 are presented in Table 1. Germination was appreciably slower on sunflower leaves than on agar. In earlier work in this laboratory, germination on leaf discs in petri dishes was essentially the same as on agar (Sood and Sackston, 1971). The difference in the present results probably reflects a delay in condensation of dew on the leaves of plants after they are placed in the dew chamber, so that the effective time for germination of spores in free water at the respective temperatures was less than the exposure time.

Results with race 3 differed in detail. Germination percentage on agar and on leaves was lower at all temperatures, and germination and infection occurred more slowly than in race 1. The optimum for germination and infection appeared to be 20° for race 3, and 25°C for race 1.

Experiments with races 2 and 4 are in progress, and the results are not available at the time of writing.

If free moisture as dew is available for as little as 3 hours at a temperature near 20°C, sunflower rust spores can germinate and infect host leaves. On the basis of results from other experiments, dew duration as brief as 3 hours would have to occur in the dark for infection to occur ; germination and infection would take longer in bright light (Sood and Sackston, 1972). This ability to become established in the host even with very short exposure to favorable conditions helps to explain the wide geographic distribution of sunflower rust.

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Table 1 - Effect of duration of exposure in a dew chamber at various temperatures on germination of uredospores of race 1 of Puccinia helianthi and on infection of sunflowers.

Temperature	Exposure in dew chamber -- hours								
°C	1	2	3	4	5	6	7	8	24
				Percentage germination on water agar					
7	0	0	27	52	68	64	-	-	-
10	2	68	72	92	92	97	-	-	-
15	11	46	86	94	97	96	-	-	-
20	13	58	90	92	91	92	-	-	-
25	76	94	97	93	98	98	-	-	-
30	0	15	52	60	62	63	-	-	-
35	0	0	0	0	0	0	-	-	-
				Percentage germination on sunflower leaves					
7	0	0	3	3	4	6	7	7	9
10	0	2	4	5	32	46	61	72	73
15	0	2	3	41	58	68	79	84	89
20	1	7	57	60	68	78	84	88	91
25	2	60	92	92	93	94	97	98	97
30	0	4	6	6	8	14	17	20	23
35	0	0	0	0	0	0	0	0	0
				Rust infection on sunflower plants					
7	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	++
15	-	-	-	+	+	++	+++	+++	+++
20	-	-	+	++	++	+++	++++	++++	++++
25	-	-	-	++	++	+++	++++	++++	++++
30	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-