
Experimental Studies on the Response of Alternate Host Species of the Genus *Thalictrum* to Oklahoma Populations of the Leaf Rust of Wheat

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Puccinia recondita Rob. ex. Desm., the orange leaf rust of wheat, has been observed to be a stable, endemic organism in Oklahoma. This obligate parasite can be found in wheatfields throughout the state every spring, sometimes in such abundance as to cause substantial economic damage to the crop.

Wheat leaf rust is a typical macrocyclic rust, with spore stages that infect two unrelated hosts. Wheat, and sometimes closely related genera, is host to the uredial (vegetative dicaryophase) and telial (diploid) stages of the organism. Only the uredial, or repeating cycle stage, has been observed to function here in nature. Teliospores are seen in abundance on the maturing wheat plants, but they have never been observed to carry the infection to the alternate host in Oklahoma.

The alternate hosts of this organism, where the gametic (pycnial) and recombinant (aecial) stages occur, include species found in three genera of the Ranunculaceae, of which *Thalictrum* spp. are most abundant in the United States. Leaf rust infections on *Thalictrum* were first produced under laboratory conditions (Jackson & Mains, 1921), and it was doubted if they occurred in nature until twenty years later (D'Oliviera, 1951) when the presence of field infections on *Thalictrum spectosissimum* in Portugal were reported. It was still thought that such infection did not occur on the American continent, since American species of *Thalictrum* are generally more resistant to infection (Mains, 1932).

The evidence is not yet complete, but there are indications now that field infections on *Thalictrum* occur in the United States. Levine & Hildreth (1954) reported a single collection of leaf rust taken from *Thalictrum*, and an intensive investigation by H. C. Young, Jr. in 1961 (unpublished) should give near confirmation that field infections do occur in the United States.

Another important line of evidence concerning the natural role of

the alternate host species is the demonstration of susceptibility by laboratory inoculations, and this comparative susceptibility is dealt with in the experiment described below.

Experimental Procedure

It was undertaken in the summer of 1962 to determine the susceptibility of certain American species of *Thalictrum* to infection by biotypes of *Puccinia recondita* native to Oklahoma. The teliospore inoculum for the test was grown on 'Bison' wheat at Stillwater, and the telial-bearing straw was collected from the field in mid June. This mass population of teliospores probably consisted of a mixture of races 5, 9, 15, 35, and 105. Random sampling (unpublished data) has shown that these races dominate Oklahoma populations, and that races 9 and 15 are to be found at high frequency at all locations.

Preliminary experiments (unpublished data) in the spring of 1962 had shown that near optimum conditions for teliospore germination and the subsequent infection of *Thalictrum* could be attained by the following procedure: Plants were placed in large plastic chambers, about 2' x 3' x 3', with the telium-bearing straw suspended above them. The interior of the chamber was thoroughly wetted, using a fine spray nozzle at about 5:00 P.M. in the afternoon and the moisture retained overnight on both straw and leaves while the temperature was being lowered from 75 to 60 F.

Results

The teliospores used in the test germinated about five weeks after maturing in the field (July 9), and probably could have been germinated earlier if the test had begun sooner. Apparently the high temperatures endured by the teliospores in the field in mid-June did not significantly damage their viability as suspected by earlier investigators (Mehta, 1940), because each attempted inoculation served to produce massive infections on the susceptible check species (Table 2.)

In order to make sure that the species not infected in these tests were actually resistant, it was necessary to know that the distribution of sporidial inoculum from the germinating teliospores was uniformly heavy throughout the inoculation chamber. This was determined by randomly placing several susceptible check species (Table 2) in every test. The infection on the most susceptible of the check varieties was often too dense to merit counting sometimes exceeding 50 separate infection sites per leaflet. The actual number was dependent upon the leaf area of the plant and the age of the tissues exposed — older leaves being more resistant to infection than newly developed leaves. Since heavy infection appeared on the check plants following every inoculation, it was assured that the American species being tested were adequately exposed to inoculum so that the absence of infection after several inoculations represented a high degree of resistance to the germinating races of rust.

Perhaps the most important aspect of the test was the demonstration of wide differences in reaction within a single species group of the alternate host. This is most striking in *T. dasycarpum* (Table 1), where one plant produced 165 functional pycnial infections, while 5 other plants produced none in 7 or more inoculations. Three other plants showed slight susceptibility, producing only a single functional infection. Slight differences were noted in other groups also.

A total of 34 plants representing about 8 American species were tested, with 11 of them developing at least one confirmed pycnium. Seven other plants showed flecking which apparently was due to some slight development of the fungus that was insufficiently strong to produce

distinguishable morphological structures. Some degree of susceptibility to *Puccinia recondita* was found to be present in some of the individuals of each species group included in the test.

Discussion

The American species *T. dioicum* (Mains, 1932) and *T. dasycarpum* (Brown & Johnson, 1949) have previously been reported to have some susceptibility to wheat leaf rust. However, this is apparently the first report of confirmed infection on *T. alpinum*.

The data presented here seem to be the first documented demonstration indicating wide differences in susceptibility to a discrete rust population among plants of a single species of *Thalictrum*. The existence of distinguishable biotypes within a single alternate host species is not necessarily surprising, for there are all degrees of susceptibility to the dicaryophase stage of the rust to be found in varieties of wheat.

It is highly unlikely that such a small number of plants represents the range of susceptibility types possible in nature. Studies are now underway at the Oklahoma Experiment Station at Stillwater that may reveal much more in regard to this problem.

TABLE 1. RESPONSE OF AMERICAN SPECIES OF THALICTRUM TO MASS SPORIDIAL INOCULATION BY WHEAT LEAF RUST

Plant Species* & Sources	Length Times of test inoc. (days)		Fleck	Infection Recorded		aecial	Total
				pycnial non-func.	func.		
I. Species Groups:							
<i>(A) T. alpinum</i>							
1. Grant, Colo.	41	9	—	—	19	—	19
2. Grant, Colo.	11	1	—	—	—	—	—
3. Grant, Colo.	11	1	—	—	—	—	—
<i>(B) T. dasycarpum (male)</i>							
1. Lyons, Colo.	13	6	153	7	165	5	325
2. Laramie, Wyo.	41	9	15?	—	1	—	16? **
3. Lyons, Colo.	20	2	—	—	1	—	1
4. Ft. Collins, Colo.	41	9	—	—	—	—	—
5. Lyons, Colo.	11	1	—	—	—	—	—
<i>(C) T. dasycarpum (female)</i>							
1. Ft. Collins, Colo.	20	2	—	—	1	—	1
2. Custer, S. Dakota	27	8	—	—	—	—	—
3. Ft. Collins, Colo.	41	9	19?	1?	—	—	20?
<i>(D) T. dasycarpum (sex undetermined)</i>							
1. Ft. Collins, Colo.	21	7	—	—	—	—	—
2. Ft. Collins, Colo.	20	7	—	—	—	—	—
<i>(E) T. dasycarpum var. hypoglaucum</i>							
1. Stillwater, Okla.	43	12	?	—	—	—	?
2. Stillwater, Okla.	41	9	125	—	2	—	127
<i>(F) T. dioicum (sex undetermined)</i>							
1. Jackson, Wyo.	20	7	—	—	—	—	—
2. Wisconsin	26	5	—	?	25	—	—

Table 1. (continued)

(G) Species "X" (female)						
1.	La Veta, Colo.	27	8	25?	—	25?
2.	Cimarron, N. Mex.	20	7	—	—	—
3.	La Veta, Colo.	41	9	20?	—	20?
4.	Westcliffe, Colo.	41	9	—	—	—
5.	Westmore, Colo.	41	9	—	—	—
6.	Cimarron, N. Mex.	20	6	—	—	—
(H) Species "Y" (Male)						
1.	Steamboat Sprs., Colo.	41	9	?	—	?
2.	Bighorn Mts., Wyo.	27	8	50?	1	51?
(I) Species "Z" (Male)						
1.	Westcliffe, Colo.	27	8	?	—	?
2.	Cimarron, N. Mex.	27	8	?	3	3
II. Miscellaneous Plants of Undetermined Species:						
1.	Steamboat Sprs., Colo.	27	8	150?	—	150?
2.	Westcliffe, Colo.	41	9	—	—	—
3.	Westmore, Colo.	41	9	—	—	—
4.	Encampment, Colo.	41	9	4	1	6
5.	Cimarron, N. Mex.	11	1	—	—	—
6.	Cimarron, N. Mex.	41	9	50?	2	63?

* All but four of the plants listed here were obtained by the Oklahoma Experiment Station through a research program supported jointly by a Guggenheim Fellowship and a Rockefeller Foundation grant.

** "?" Indicates difficulty in establishing an exact count.

TABLE 2. RESPONSE OF EURASIAN SPECIES OF THALICTRUM TO MASS SPORIDIAL INOCULATION BY WHEAT LEAF RUST

Species	Length of test (days)	Fleck	Infection Recorded pycnial	aecial	Total
1. <i>T. speciosissimum</i> (4)*	15	—	50 ±	20 ±	50 ±
2. <i>T. speciosissimum</i> var. <i>illuminator</i> (2)	15	—	50 ±	20 ±	50 ±
3. <i>T. sparsiflorum</i> (1)	15	8	40	—	48
4. <i>T. flavum</i> (1)	15	—	50 ±	20 ±	50 ±
5. <i>T. diptercarpum</i> (1)	15	4	30	—	34
6. <i>T. alpinum</i> (2)	43	—	—	—	—
7. <i>T. aquilegifolium</i> (1)	20	—	—	—	—

* Numbers in parentheses indicate number of plants tested of each species that were uniform in reaction. All of the plants listed here with the exception of *T. alpinum* were grown from seed purchased from Thompson and Morgan Nurseries, Ipswich, England.

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