Variability of Telial Formation of *Puccinia coronata*

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The variability exhibited by the crown rust fungus, *Puccinia coronata* Cda. var. *avenae* Fras. and Led. is not limited to pathogenicity differences but also occurs in other physiological characters. Differential development of the telial stage has been observed for a number of rust fungi. Previous investigators attempted to show by experimentation or observation that telial formation was affected by differences or changes in one or a combination of the following: (1) condition of host vigor, (2) stage of host development, (3) relative host resistance, (4) inherent character of the fungus, and (5) environment.

Waters (12), Johnson (4), and Gordon (3) have reviewed and discussed the literature on factors affecting telial formation of rust fungi. Magnus (5) in 1891 first proposed that the relative condition of the host plant affected the occurrence of telia. Gassner (2) concluded that the determining factor was physiologic aging, the stage of host development governing teliospore formation. Bailey (1) subsequently reported the stage of host development not to be important for *P. graminis* Pers. f. sp. *avenae*. Parker (7) reported that the production of telia of crown rust on oat seedlings was related to host resistance. Murphy (6) observed a similar relationship on both seedlings and adult plants. Parson (8), however, found some cultures to form telia as early on susceptible varieties as on resistant.

Raines (10) believed that the protoplasmic constitution of the fungus itself was the important factor, finding wide differences in the tendency towards telial production in different cultures of the crown rust fungus. In further observations of such differences Bailey (1) and Gordon (3) reported a correlation between virulence and rapidity of teliospore development for cultures of *P. graminis* f. sp. *avenae*. Parson (8) and Murphy (6), in contrast, suggested that early telial formation may be characteristic of narrowly specialized races of *P. coronata*. Parson as well as Murphy also reported that some cultures of *P. coronata* studied never produced telia. Murphy observed differences in telial development among different cultures of the same race of *P. coronata*.

Waters (12) reported telial production to be related to a lack of maintenance of vegetative vigor and thus influenced by any internal or external combination of factors affecting this, such as light, temperature, or moisture. Peturson (9) and Simons (11) showed that telia of *P. coronata* developed more rapidly at 25° C than at lower temperatures. Johnson (4) and Gordon (3) found that higher temperature also favored early telial formation of *P. graminis* f. sp. *tritici* and *P. graminis* f. sp. *avenae*, respectively.

The present investigation was undertaken to obtain knowledge of telial formation pertinent to the development of telia for studies involving the completion of the life cycle of *P. coronata*. A preliminary report has been made (13).

Materials and Methods

Single monosporus cultures each of races 202, 203, 264, 294, and 295 and 3 monosporus cultures of race 293 of *P. coronata* var. *avenae* were studied. The relative rapidity of telial formation on seedling and mature plants of resistant and susceptible host varieties was investigated by inoculating each culture on the oat varieties, Appler (CI 1815), Bond (CI 2788), Canuck (CI 4024), and Clintland (CI 6701). After incubation the plants were placed on greenhouse benches and observed daily for the appearance of telia. Appler and Bond were susceptible to all cultures tested; Clintland was highly resistant to races 202 and 203 but susceptible to the others; whereas Canuck was susceptible to races 202, 203, and 264, but only moderately susceptible to the cultures of races 293, 294, and 295.

The influence of temperature on telial formation of races 202, 203, 293 (culture B), 294, and 295 on these oat varieties was determined by inoculating seedlings and subjecting them to constant temperatures of 60°, 70°, and 80° F at a photoperiod of 16 hours.

Races 264 and 293 (culture C) which did not produce telia were inoculated on these 4 and additional oat varieties in the seedling, juvenile, and mature plant stages. These inoculated plants were subjected to one or a combination of the following treatments: (1) temperature fluctuation, 12 hours in light at 80° F followed by 12 hours in darkness at 60° F, (2) low fertility, (3) low soil moisture, and (4) removal of infected leaves and floating upon a 7% sucrose solution.

Results

The results of the test with different rust cultures, oat varieties, and stages of growth are presented in table 1. These show that different

Table 1. Days after inoculation of seedlings and mature plants of 4 oat varieties that telia of *P. coronata* were first observed.

Race	Days to telial formation							
Variety:	Clintland		Appler		Canuck		Bond	
Stage:	Seedling	Mature	Seedling	Mature	Seedling	Mature	Seedling	Mature
202	14^R	15^R	17	16	20	20	18	18
203	24^R	26^R	20	22	22	25	29	19
264	*—	—	—	—	—	—	—	—
293A	14	21	14	23	24	26	16	22
293B	18	23	17	22	22	25	18	20
293C	*—	—	—	—	—	—	—	—
294	21	24	23	21	20	24	19	19
295	16	18	17	19	21	29	16	21

R = Resistant reaction
* = No telia produced

cultures of the same race as well as different races vary in their ability and rapidity in producing telia. No relationship was shown between the virulence of a particular culture on the differential variety Clintland and the rapidity of telial formation, nor was there any relation of host resist-

ance and susceptibility to the rate of telial formation of the 2 differential races, 202 and 203.

The time required for the initiation of telia following inoculation of these 4 varieties in the seedling stage with the 6 telia-producing cultures was generally less than the time required on the same varieties inoculated in the mature plant stage; however, the relative differences varied widely and exceptions were found (table 1).

Increase in incubation temperature decreased the time required for the initiation of telia (table 2). The difference between 60° and 70° F

Table 2. Days after inoculation that telia of *P. coronata* were first observed on 4 oat varieties kept at 3 constant temperatures.

Race	Variety	Days to telial formation		
	Temperature:	60°F	70°F	80°F
202	Clintland	25	18	14
	Appler	26	20	17
	Canuck	28	24	19
	Bond	28	22	17
203	Clintland	32	24	22
	Appler	31	22	20
	Canuck	33	24	21
	Bond	30	21	16
293B	Clintland	28	23	16
	Appler	28	21	19
	Canuck	29	25	23
	Bond	29	22	18
294	Clintland	29	24	16
	Appler	31	23	19
	Canuck	30	24	20
	Bond	28	21	17
295	Clintland	23	19	16
	Appler	26	23	19
	Canuck	27	24	20
	Bond	24	21	17
AVERAGE		28.3	22.3	18.3

resulted in an average decrease of 6 days in time of telial development of 5 cultures of *P. coronata* on 4 oat varieties. The difference between 70° and 80° F further decreased the time required for telial formation by 4 days.

The culture of race 264 tested and culture C of race 293 did not produce telia under any experimental conditions including the addition of other host varieties to broaden the available range of host-parasite inter-

actions, fluctuation of temperature, subjection to low fertility and low moisture, and floating of detached leaves on a 7% sucrose solution.

Discussion

Rapidity of telial formation does not appear to be characteristic of a race as defined by its specific pathogenicity, in agreement with the earlier report of Murphy (6). Although 3 cultures of race 293 tested were similar in specific pathogenicity, they differed in their ability and rate of telial formation. Two cultures produced telia readily on all varieties tested, but at somewhat different rates, while the remaining culture was similar to race 264 in that it did not produce telia. Race 264 has different specific virulences than race 293 and a wider range of virulence. The similarity of races 264 and 293C in failing to produce telia and the differences among the cultures of race 293 suggest that no correlation either positive or negative exists between specific virulence or range of virulence and rate of telial production.

All telia-producing monosporus cultures developed telia more readily on some varieties than on others. Thus, telial production is not due entirely to inherent tendencies of the rust. None of the 4 oat varieties tested affected in a consistent manner the rapidity at which a number of cultures produced telia. Therefore, the rapidity at which an element of the rust population produces telia appears independent of reaction type and host variety as well as specific virulence or range of virulence but dependent on the specific capabilities of the rust entity concerned in relation to the specific host-parasite combination.

The results obtained with the effect of temperature on rate of telial development support the previous work in this area.

Failure to stimulate races 264 and 293C to produce telia suggests that these cultures may lack factors essential for telial formation. As the major source of primary inoculum of the cereal rusts consists of airborne urediospores, it is doubtful if this deficiency has any adverse effect on perpetuation in nature of such a rust. The inability of a particular race to produce telia may actually favor multiplication in that uredial production continues throughout the growing season. Gordon (3) proposed that the rapidity at which a given race of *P. graminis* f. sp. *avenae* produced telia was inversely related to the prevalence of that race.

Summary

Eight monosporus cultures representing 6 races of *P. coronata* var. *avenae* were investigated for telial formation. The rapidity at which a culture produced telia was not correlated with range of virulence of the pathogen, specific virulence of the pathogen, resistance of the host, or host maturity. Rapidity of telial formation appeared to be a function of a specific relationship existing between the particular host and parasite. Temperature was found to directly alter the rate of telial formation. A culture each of races 264 and 293 did not produce telia under any experimental conditions tried, and thus may not have the capacity to produce telia.

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