

# Germinability and Longevity of Teliospores of *Puccinia coronata* f. sp. *avenae*

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## ABSTRACT

Teliospores of *Puccinia coronata* f. sp. *avenae* produced on field-grown *Avena sativa* germinated well when exposed to weathering from 2 October to 18 April. Teliospores weathered for shorter pe-

riods either germinated poorly or not at all. Once germinable, teliospores retained germinability for over 22 months when stored at  $-196^{\circ}\text{C}$  or  $-13^{\circ}\text{C}$ . *Phytopathology* 60:617-618.

To expose varieties of oats (*Avena sativa* L.) to a wide genetic potential of crown rust (*Puccinia coronata* f. sp. *avenae* Fraser & Ledingham), epidemics are established each spring on buckthorn, *Rhamnus cathartica* L., the alternate host. Infection of buckthorn requires germination of teliospores in the spring, and subsequent penetration of young buckthorn leaves in the spring by basidiospores.

Attempts to germinate teliospores of crown rust in the laboratory have met with mixed success. Germination often fails after natural overwintering (3, 4, 5). Others (1, 2) reported germination of unweathered teliospores produced in the greenhouse after alternate wetting and drying. Attempts to induce severe crown rust infection on buckthorn in Minnesota with teliospores produced on field-grown oats have been only partially successful. The need for consistent infection of buckthorn has prompted studies to define requirements for crown rust teliospore germination and the effect of temperature on the longevity of germinable teliospores.

**MATERIALS AND METHODS.**—Teliospores were produced on oats sown in May or July adjacent to buckthorn bushes from which aeciospores were released in April and May. Straw was collected and stored under various conditions for different lengths of time to determine the effect of environment on germination of teliospores the following spring. Teliospores shown to be germinable were placed in glass vials, then sealed and stored at  $-196$ ,  $-13$ ,  $5$ ,  $15$ , and  $30^{\circ}\text{C}$  to determine the effect of temperature on longevity. Germination tests were made by placing bits of straw bearing teliospores on 2% water agar at  $15^{\circ}\text{C}$  for 18-24 hr.

**RESULTS.**—*Effect of overwintering environment on teliospore germination.*—Teliospores on oats sown in May were collected during August 1965 and placed in an unheated building. On 30 December 1965 and 16 April 1966, straw was placed outside, either on the ground or atop buckthorn bushes. Another batch of straw from oats sown in May was taken directly from the field and placed atop buckthorn bushes in August. Straw from oats sown in July was either left on the ground throughout the fall and winter or placed atop buckthorn bushes on 30 December. Teliospores from each treatment were tested for germinability on 22 April and 20 May 1966. Teliospores on May-sown oats stored inside until 30 December 1965 or 16 April

1966 did not germinate on 22 April or 20 May. Teliospores on July-sown oats that were weathered on the ground and those on May-sown oats that were weathered atop buckthorn bushes germinated on 22 April and 20 May 1966. Teliospores on July-sown oats weathered atop buckthorn bushes did not germinate on 22 April, but germinated on 20 May.

Once germinable, teliospores germinated after storage at  $5^{\circ}\text{C}$  for 8 months. Teliospores that did not germinate on 20 May did not germinate after storage at  $5^{\circ}\text{C}$ .

Another experiment measured the duration and type of weathering favoring germination of teliospores in the spring. Straw bearing teliospores from a mixture of May-sown oats and from the varieties Portage and Coachman planted in mid-July was collected on 29 September 1966. The straw was dried for 2 days at room temperature ( $25^{\circ}\text{C}$ ) and placed in small, 4-mm mesh nylon packets or polyethylene bags that were later sealed. On 2 October, teliospores were placed under the following conditions: (i) outside on the ground; (ii) outside suspended 60 cm above the ground; and (iii) at  $5^{\circ}\text{C}$  in a refrigerator. Teliospores placed outside were protected from direct sunlight. Straw placed on the ground was covered by snow and ice from January through mid-March, and that suspended 60 cm above the ground was covered by snow for about 1 month in February. Straw bearing teliospores from each treatment was transferred from the refrigerator ( $5^{\circ}\text{C}$ ) to the field, and was placed either on the ground or 60 cm above the ground. At the same time, straw from each treatment was removed from the outside, dried for 1 day at room temperatures ( $25^{\circ}\text{C}$ ), and placed in the refrigerator at  $5^{\circ}\text{C}$ . On 10 May 1967, the percentage of telia that produced basidiospores was determined for each treatment (Table 1).

Teliospores stored in polyethylene bags failed to germinate regardless of storage conditions. Results of germination tests for teliospores stored in nylon-mesh packets are given in Table 1. Teliospores that were weathered in the field for most of the period germinated well on 10 May. Up to 14% of the telia placed on the ground 19 December germinated; those placed 60 cm above the ground on the same date did not germinate.

Germination of teliospores placed outside for short periods was rare. Teliospores left outside until as late as 11 April usually did not germinate, even though

TABLE 1. Effect of overwinter weathering on the germination on 10 May 1967 of teliospores of *Puccinia coronata* f. sp. *avenae* formed on oat straw held at ground level or at 60 cm above the ground

Date moved		Spore germination by type of straw					
		Ground level			60 cm aboveground		
		Mix <sup>a</sup>	Portage <sup>b</sup>	Coachman <sup>b</sup>	Mix <sup>a</sup>	Portage <sup>b</sup>	Coachman <sup>b</sup>
		<i>Moved from inside to outside</i>					
		%	%	%	%	%	%
1966:	Oct. 2	56 <sup>c</sup>	47	7	27	18	1
	Dec. 19	0	14	2	0	0	0
1967:	Feb. 27	0	1	0	4	0	0
	Mar. 23	0	0	0	1	0	0
	Apr. 3	0	0	0	0	0	4
	Apr. 11	0	0	0	0	0	0
	Apr. 18	0	0	0	0	0	0
		<i>Moved from outside to inside</i>					
		%	%	%	%	%	%
1966:	Oct. 2	0	0	0	0	0	0
	Dec. 19	0	0	0	0	0	0
1967:	Feb. 27	0	0	0	0	0	0
	Mar. 23	0	0	0	0	0	0
	Apr. 3	0	0	0	0	0	0
	Apr. 11	0	0	0	0	0	0
	Apr. 18	54	18	18	20	32	36

<sup>a</sup> Sown in May.

<sup>b</sup> Sown in July.

<sup>c</sup> Percentage of 50-150 telia that produced basidiospores.

they were exposed for the entire winter; those left outside until 18 April germinated abundantly. Teliospores from May-planted oats germinated as well or better than those produced on July-sown Portage and Coachman oats, even though teliospores on early-planted oats were exposed to longer periods of hot weather during the summer (Table 1).

Crown rust teliospores produced in the field required exposure to weathering during the fall, winter, and early spring in order for germination to occur in the spring. Teliospores overwintered on the ground and covered by snow and ice usually germinated better than those overwintered 60 cm above the ground.

*Effect of storage temperature on teliospore germination.*—Telia on May-sown oat straw that overwintered on the ground were tested for germination on 25 April 1965. All produced basidiospores after incubation for 18 hr at 15 C. Some of this telia material was dried for 1 day at 25 C, cut into small bits, and placed in small glass vials that were sealed and placed in liquid nitrogen at -196 C or in incubators at -13, 5, 15, and 30 C. Germination tests were made after 18, 131, 237, 317, and 672 days to determine the effects of storage temperature on the percentage of telia that produced basidiospores. Spores stored in liquid N were heated for 4 min at 26 C in a water bath before glass vials were opened.

All telia produced basidiospores after storage for 18 days at all temperatures (Table 2). After 131 days, germination of teliospores stored at 15 C was greatly reduced; those stored at 30 C did not germinate. Teliospores stored at -196 C or -13 C germinated well

TABLE 2. Percentage of crown rust telia that produced basidiospores after storage at five different temperatures

Storage time	Germination after storage at given temp <sup>a</sup>				
	-196 C	-13 C	5 C	15 C	30 C
<i>days</i>	%	%	%	%	%
18	100	100	100	100	100
131	72	78	54	6	0
237	56	78	22	12	0
317	90	82	84	12	0
672	66	50			

<sup>a</sup> Each figure is the average of 50 telia.

after nearly 2 years. Once germinable, crown rust teliospores stored at low temperatures retained germinability for long periods.

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