Proceedings of the Iowa Academy of Science

Volume 68 | Annual Issue Article 18

1961

Testing Oats in the Field With Specific Races of Crown Rust

M. D. Simons
Iowa State University

Testing Oats in the Field With Specific Races of Crown Rust[1]

M. D. SIMONS[2]

Abstract. Different methods of testing were compared under field conditions. Inoculation procedures in which rust spores were applied directly to the plants were generally not as satisfactory as procedures in which highly susceptible rust-spreader plants were inoculated heavily early in the season. Certain strains of oats were shown to be resistant to two of the races of crown rust used and susceptible to the third. Other strains were resistant to all three races.

Crown rust, caused by *Puccinia coronata* Cda. var. *avenae* Fraser & Ledingham, is the most serious disease of oats in the major oat-producing areas of the world. The appearance within recent years of certain races of the crown rust fungus that parasitize all known sources of seedling resistance among the hexaploid oats (Simons, *et al.*, 1957) has led to increased interest in adult plant or field resistance as a means of controlling the disease. Strains of oats having seedling resistance can be easily and accurately tested as seedlings in the greenhouse for reaction to specific races of the crown rust fungus. Field-resistant oats, on the other hand, are susceptible as seedlings, and their reactions in the greenhouse, even as older plants, are not always indicative of their field behavior. When planted in the field in conventional oat disease nurseries they are subject to infection by all rust races that might be in the area. Consequently, information on their reactions to specific races of rust, which is very important in developing resistant varieties, is difficult to obtain. The investigation described was undertaken with two objectives in mind. One was to compare the efficiency of different means of obtaining the reactions of field-resistant oats to specific races of the crown rust fungus under field conditions. The other was to obtain information on the reactions of certain promising strains of oats to specific races under field conditions.

MATERIALS AND METHODS

Unless otherwise noted the methods of obtaining, isolating, and increasing cultures of the crown rust fungus were similar to those described in the literature (Finkner, Atkins, and Mur-

[1] Joint contribution of the Iowa Agricultural and Home Economics Experiment Station (Journal Paper No. J-4077, Project No. 1176), and the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture.

[2] Plant Pathologist, Crops Research Division, A.R.S., U. S. Department of Agriculture, and Professor of Plant Pathology, Iowa State University.

[3] The mention in this publication of a trade product, equipment, or a commercial company does not imply its endorsement by the U. S. Department of Agriculture over similar products or companies not named.

phy, 1953, and Murphy, 1935). Previous investigations (Simons, 1955, and unpublished data) of field resistance, in which little effort was made to control the racial composition of the inoculum, showed that some oat strains had very good field resistance to what ever races were present. The most promising of these strains were chosen for the present study. Two of the races of crown rust used (races 203 and 216) are widely prevalent in nature, whereas the third (race 205) is rare. All three can be sharply distinguished on certain differential varieties. The necessary differential varieties were always planted along with the field-resistant strains to check the effectiveness of the different methods of inoculation. The more interesting of the oat strains and varieties used are shown in Table 1.

Table 1. Average seedling and field reaction types[1] of certain strains of oats to races of the crown rust fungus.

Oat strain	Race 203		Race 205		Race 216	
or variety	Seedling	Field	Seedling	Field	Seedling	Field
P.I. 174544	4.0	0.5	4.0	1.0	4.0	3.5
P.I. 174545	4.0	0.0	4.0	0.0	4.0	0.0
P.I. 184002	4.0	0.5	4.0	1.0	4.0	4.0
P.I. 184019	4.0	0.5	4.0	1.0	4.0	4.0
P.I. 185783	4.0	0.0	4.0	0.0	4.0	0.5
P.I. 197278	4.0	0.0	4.0	0.0	4.0	0.5
P.I. 197279	4.0	0.5	4.0	0.5	4.0	3.5
Saia	0.0	0.0	4.0	3.5	0.5	0.0
Victoria	1.0	1.0	0.5	0.5	4.0	4.0

[1] Reaction types range from 0 (highly resistant) to 4 (highly susceptible). Reaction types shown are averages of types observed in three years' trials described under "Indirect Inoculation Procedures".

Results

Direct Inoculation Procedures. The most common method of initiating rust in the field artificially is to inoculate plants of highly susceptible varieties by any one of several possible means. The rust then spreads naturally from the initial infection sites to other "spreader plants" and thence to the plants being studied. This method has the advantage of being simple and reliable and of closely approximating natural disease development. Its principal disadvantage is that it requires several weeks for the rust to build up before data can be obtained. During this time spores of undesired rust races from other sources may attack the test plants. A solution that immediately suggests itself is to inoculate the test plants directly with spores of desired races before significant numbers of spores from other sources are present.

Geis, Futrell, and Garrett (1958) used cellophane tape to hold a piece of filter paper which had been moistened in a suspension of spores against wheat leaves to effect inoculation with specific

races of *Puccinia graminis* Pers. f. sp. *tritici* Eriks. & E. Henn. This method was successful in the field only under certain weather conditions. In the author's tests, spores were applied to portions of oat leaves. Moisture in the form of a fine mist was then applied, and the leaf section was wrapped immediately in Parafilm (a thermoplastic film manufactured by the Marathon Corp., Menasha, Wisconsin).[3] This was done late in the afternoon, and the Parafilm was removed early in the morning to avoid heating by direct sunlight. These tests were carried out during an extended period of unusually dry weather, but in all cases the Parafilm maintained what appeared to be an optimum amount of moisture on the leaves. Infection, however, was light and erratic, and the method will obviously have to be refined before it can be used in a practical large-scale testing program.

Rowell and Hayden (1956) and Rowell (1957) successfully inoculated field-grown wheat with *P. graminis tritici* by spraying with spores suspended in light oil. Their results indicated that this method would probably not be effective unless weather conditions were favorable for infection. In the present tests spores of crown rust fungus were suspended in a light oil (Mobilsol 100, as used by Rowell, 1957) and sprayed directly onto the test plants in the field. This procedure was repeated on several evenings, but weather conditions were not espcially favorable for spore germination on any of the nights following inoculation. The resulting infection was sufficiently uniform and heavy to serve as a focus from which the pathogen could spread, but was not heavy enough to provide the immediate and thoroughly convincing data on rust reaction that had been desired.

Oat plants in the heading and even later stages of growth are routinely inoculated in the greenhohuse by dusting spores on moistened leaves and then retaining them overnight in a polyethylene or other type of chamber to prevent drying of the leaves. To test this method in the field, polyethylene chambers, lined with wet burlap, were placed over plants onto which spores had been dusted. A ½% solution of Tween-20 (Rowell and Hayden, 1956) was applied to the leaves in a fine mist, and as an additional precaution the soil around the plants was wet thoroughly. The infection resulting from this method of inoculation also was adequate to initiate subsequent disease development, but was not as heavy as had been desired.

Indirect Inoculation Procedures. Modifications of the customary indirect inoculation procedures, in which spreader plants of susceptible varieties are inoculated, were also studied. These modifications consisted of varying the proportion and proximity of spreader plants and the proportion of spreader plants initially

inoculated. The modifications were, of course, in the direction of providing a greater concentration of inoculum on the plants to be tested at an earlier date than the usual method provides. The results presented here were summarized from three years' trials, one year of which provided little information because of extreme drought.

In one series of tests the strains to be tested were planted in two-foot-row plots, with the plot enclosed within a solid row of spreader plants. The small plots, each of which was inoculated with a single race, were separated from each other by a 15-foot area planted to a resistant oat variety. In a parallel series of tests, spreader and experimental plants were grown in alternate hills, the hills being in rows one foot apart. Two rows of a resistant variety separated each group of hills. Row plots and hill plots were replicated three times for each of the three races of crown rust used.

Spreader plants were inoculated with a hypodermic needle as early in the season as possible. A much higher proportion of the spreader plants was inoculated than is the case when infection is initiated in routine oat disease nurseries. Under these conditions the rust spread rapidly to the plants being tested and was present in amounts satisfactory for observation before there had been a chance for any appreciable infection from other sources. The plants, however, were old enough and mature enough to exhibit their true field reactions.

The differential varieties included furnished an estimate of the amount of contamination from outside sources and from plot to plot. In the last year the trials were run, susceptible plants were about 10% covered with uredia by mid-June. At this time no uredia could be found on the differential variety Saia in the race 203 and race 216 plots. The same was true of Victoria in the race 203 and race 205 plots. From this time on the rust increased rapidly, and only a week later averaged about 50% coverage on susceptible varieties. Contamination was then evident in most plots and ranged for Saia from a trace in the row plots to 10% in one of the hill plots. Victoria showed 20% infection in one of the hill plots.

Reactions of Field-Resistant Oat Strains. The reactions of the field-resistant oat strains, as observed in the row and hill plots before contamination was serious, showed that such strains can be resistant to one race and susceptible to another (Table 1). These differential reactions were most pronounced in the case of P.I. 184002 and P.I. 184019, which appeared to have good field resistance in the early 1950's, but later "became suscepti-

ble." Their increasing susceptibility corresponded to an increase in the natural prevalence of race 216. A test such as the one described here could have served as a basis for predicting the declining value of these strains several years before it became obvious in the customary oat disease nurseries.

P.I. 174544 and P.I. 197279 were much more susceptible to race 216 than to the other two races. They were not, however, highly susceptible to race 216 and might have fair resistance under commercial field conditions where the severity of infection would probably never equal that present in these tests.

The remaining three field-resistant strains were resistant to all three races, but, of course, might be susceptible to races not included in these trials.

Literature Cited

Finkner, R. E., R. E. Atkins, and H. C. Murphy. 1953. Inoculation techniques for crown rust of oats. Agron. Jour. 45: 630-631.

Geis, J. R., M. C. Futrell, and W. N. Garrett. 1958. A method for inoculating single wheat leaves with more than one race of *Puccinia graminis* f. sp. *tritici*. *Phytopathology* 48: 387-388.

Murphy, H. C. 1935. Physiologic specialization in *Puccinia coronata avenae*. U. S. Dept. Agr. Tech. Bul. 433, 48. p.

Rowell, J. B. 1957. Oil inoculation of wheat with spores of *Puccinia graminis* var. *tritici*. Phytopathology 47: 689-690.

Rowell, J. B., and E. B. Hayden. 1956. Mineral oil as carriers of urediospores of the stem rust fungus for inoculating field-grown wheat. Phytopathology 46: 267-268.

Simons, M. D. 1955. Adult plant resistance to crown rust of certain oat selections. Phytopathology 45: 275-278.

Simons, M. D., H. H. Luke, W. H. Chapman, H. C. Murphy, A. T. Wallace, and K. J. Frey. 1957. Further observations on races of crown rust attacking the oat varieties Landhafer and Santa Fe. Plant Dis. Reptr. 41: 964-969.