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Rust, A Persistent Threat to Wheat

E. C. STACKMAN, ***Emeritus Professor of Plant Pathology, University of Minnesota (Farm Campus), St. Paul***

Race 15B wheat rust poses some fundamental questions: Is there a final answer? Is there even a temporary solution?

How soon will a variety of wheat be produced that is resistant to race 15B of *Puccinia graminis tritici*, the parasitic fungus that causes wheat stem rust? This question has been asked many times since 1950, when 15B first became widespread and destructive to hitherto resistant varieties of bread wheats and durums. In the meantime race 15B has provoked many questions that can be answered only by extensive experimentation and intensive research. What is race 15B and what can it do?

E. C. Stackman

Race 15B is one of the 230 known and described parasitic races of wheat stem rust. These races are distinguished by their parasitic effects on 13 varieties of wheat, Einkorn, and emmer that were selected a number of years ago as representatives of several hundred varieties. To identify a rust race it is necessary to inoculate seedlings of the 13 varieties in the greenhouse. All of the 13 varieties except Khapli emmer are susceptible to 15B; all except Khapli emmer and Lee wheat are susceptible to race 15; and all except Khapli, Lee, and Vernal emmer are susceptible to race 11. In this way races are identified.

Each year since 1917 the United States Department of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station, has identified races from several hundred collections of rusted wheat from wheat-growing areas of the United States. Mexico has been included in most years and similar studies are made in Canada. Thus records are made of the identity, distribution, and population trends of races of wheat stem rust in North America; and through international cooperation on a vital international plant disease problem plant scientists are kept informed regarding the kinds of stem rust that are present over a wide geographical area.

As wheat varieties may be resistant to some rust races and susceptible to others, this mapping of the annual prevalence and distribution of races is essential in attempts to keep the stem rust in check by the use of resistant varieties. During the past 35 years varieties of wheat have been developed that were resistant for several years and then suddenly succumbed to stem rust because new rust races appeared or because certain nonprevalent races became more widespread and prevalent. Thus certain durums and the bread-wheat varieties Kanred and Ceres were resistant for several years, only to become susceptible to races that were nonprevalent or even nonexistent when the resistant wheat varieties were produced.

Barberry Host

Where did these new races come from? Most of them clearly came from rust-susceptible barberry bushes, because the stem rust fungus is heteroecious, which means simply that it needs two kinds of host plants to complete its full cycle of development. This is true of many of the more than 3500 plant rusts. The stem rust fungus, which is nothing more than a microscopic plant, can complete its full cycle only by developing some of its developmental stages on wheat, barley, and many grasses and on certain species of barberry bushes. The propagative nonsexual stage of the rust is on grains and grasses, but nature has decreed that the sexual stage can develop only on rust-susceptible species of barberry. When races of rust infect barberry they can hybridize and produce new or unusual races: hence the barberry eradiation campaign to check the early seasonal development of rust and to prevent the production of new and sometimes virulent races by hybridization.

But it has been impossible to eradicate all barberry bushes, especially from northeastern United States. Consequently new races are still being produced in that area. Nevertheless barberry eradication in the principal grain-growing areas and the development of resistant wheat varieties resulted in a decrease in the number of races, and for more than a decade prior to 1950 only four races were sufficiently prevalent in North America to be practically important. Spring wheat varieties had been developed that were resistant to these four races, and the rust was under control.

It was known, however, that race 15B was being produced occasionally on barberry bushes in certain eastern states. It was known also that 70 billion spores could be produced on a single bush and that they could be carried long distances by the wind, as their size is measured in thousandths of an inch. Plant breeders therefore started to breed for resistance to 15B, even when it did not appear to be really menacing.

Then came 1950, and 15B spread spectacularly over the United States, Mexico, and Canada, and by 1952 it was by far the most prevalent race. Then it was discovered that race 15B comprises many subraces and that certain wheat varieties that had been used in breeding for resistance against it are susceptible to some of these subraces and resistant to others. Moreover, a variety may be resistant at some temperatures and completely susceptible at others. And, unfortunately no known good commercial variety is resistant to all these subraces at all temperatures. But, worse still, certain old rust races that were either never prevalent or nonprevalent for many years, such as races 29 and 48, are threatening in 1954 to increase in prevalence, and they are even more dangerous than the 15B complex for certain varieties that were recently produced or are in process of production.

Intensive Studies the Only Hope

The question in the first sentence, therefore, is still unanswerable. And the question must be expanded to include races other than 15B. Is there a complete and final solution to the stem rust problem? This question cannot be answered until really basic investigations are made of the genes for resistance in the thousands of varieties of wheat and the genes for virulence in the hundreds, and probably thousands, of races of wheat stem rust.

Temporary solutions are possible but not absolutely assured. It may be necessary to sacrifice quality to obtain resistance. We can hope; we can express opinions; but we cannot know until more extensive and intensive studies are made than have been possible in the past.