Fungicides Protect the World’s Wheat Crop from Rust

International Pesticide Benefits Case Study No. 31, October 2011
Leonard Gianessi and Ashley Williams

Wheat is one of the most important food staples for mankind, providing nearly 55% of the carbohydrates and 20% of the food calories consumed globally. Rust spores that land on wheat plants germinate and infect the plant. Tiny tubes penetrate host cells to withdraw nutrients. Fungus tissue proliferates beneath the epidermis until the epidermis bursts and pustules erupt. Each pustule contains thousands of spores that can be carried by the wind to infect other plants. Grain yield is reduced by interference with grain filling, which results in a reduction in the number and size of kernels.

Stem rust damaged wheat crops on a massive scale in the 1900s. Significant epidemics included central India in 1946-47 (20% loss) and Chile in 1951 (40% loss) [1]. Resistance to stem rust was successfully incorporated into wheat in the 1950s in Norman Borlaug’s breeding programs. These varieties were distributed worldwide. Smallholder farmers around the world have tended to rely entirely on resistance to control rust on wheat.

Large scale commercial and government-run wheat farms have generally chosen to plant rust-susceptible wheat varieties because they have a greater yield potential of 20%-25% than rust-resistant varieties [2]. In Argentina, Brazil, Paraguay, and Uruguay over 50% of the wheat area is planted to the high-yielding susceptible varieties [2]. Farmers are able to grow high yielding susceptible varieties by using fungicides. In recent years, fungicides have been used on 25% of the Argentine wheat area, on 0.5 million hectares of wheat in both Uruguay and Paraguay, and on 2.3 million hectares in Brazil [2]. The yield increase on susceptible varieties as a result of fungicide treatments is about 13% [2].

In Australia, foliar fungicide spraying has increased due to the breakdown of resistance to stripe rust in wheat varieties [3]. Thirty-nine percent of wheat acres are sprayed, reducing losses from yellow rust by AUS$359 million annually [3]. In China, epidemics of stripe rust in 1950, 1964, 1990, and 2002 resulted in losses of 6.0, 3.2, 1.8 and 1.3 million MT, respectively [4]. In 2009, the early occurrence of stripe rust posed the greatest threat in many years. Timely application of fungicides effectively prevented yield losses and further spread to the wheat production regions further east. Thus, a potentially huge yield loss nationwide was avoided through use of fungicides [4]. In China about 6 million wheat hectares are treated with fungicides.

Resistance to stem rust in most breeding programs was through the use of a single resistance gene, Sr31. In 1999, a new strain (UG99) was detected in Uganda on a wheat variety containing the Sr31 gene. Yield losses of up to 80% were reported. All the current commercial wheat cultivars in East Africa are susceptible to the new race and it is not possible to grow a profitable crop of wheat without the application of fungicides [5]. Fungicide tests in Kenya showed 50% higher yield in the treated versus the untreated plots [5]. Large scale wheat growers in Ethiopia are reported to spend around US$0.5 million annually on fungicides [6].

References