Study shows temperatures may change disease resistance in wheat

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The leaves of the Ron L variety of wheat with bred-in resistance to wheat streak mosaic virus show significantly more damage than the leaves of TAM 112 after both being exposed to the same amount of mites and grown under the same environmental conditions, according to Dr. Charlie Rush, Texas AgriLife Research plant pathologist. Credit: Kay Ledbetter

(PhysOrg.com) -- Wheat streak mosaic resistance bred into several wheat varieties might be negated by the producer practice in the High Plains of planting wheat early and using it for both winter forage for cattle and grain, according to a Texas AgriLife Research scientist.

Dr. Charlie Rush, AgriLife Research plant pathologist in Amarillo, began a study in December that he “started out of necessity” after working for several years on the wheat streak mosaic virus.

While several varieties of wheat, such as Mace and Ron L, have resistance to the virus bred into them, there has been a problem with that genetic resistance breaking down in temperatures above 75 degrees, Rush said.

“That is terrible for those who plant in the Texas Panhandle for dual purpose,” he said. “The wheat is planted early when temperatures are very high and it’s too hot for genetic resistance to be effective. In our study, we want to see if the plant is able to grow out of it once temperatures cool down to where the genetic resistance should be effective.

“It’s really important to understand how the germplasm responds to the natural temperature fluctuations during the growing season,” Rush said. “Since we know most of the farmers in this area plant when it is too hot for the resistance, we need to know what happens once the temperatures cool down.”

Jacob Price, a research associate on Rush’s team, is running diagnostics for the virus and quantifying the infection of the plants. He is also looking at the virus quantity in the wheat curl mites, which are the vector of the disease, to see if that is altered among the varieties.

Wheat streak mosaic virus is the most prevalent disease in the southwestern wheat producing region of the U.S., Price said. Early diagnostics have shown that wheat curl mites have the potential to build high populations very quickly. When populations explode, wheat streak can spread to epidemic proportions in a short time, causing devastating losses throughout the wheat growing region.

Understanding how the temperatures affect this process is important, Rush said.

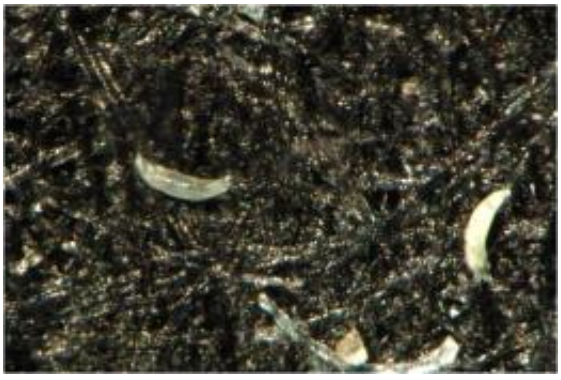
“If you have a lower number of mites, and a lower number of those are carrying the wheat streak virus, it will reduce the incidence of disease and reduce the potential for development of an epidemic,” he said.

Price said so far it looks like when the wheat plants, regardless of variety, become infected early with high mite and virus populations, it is difficult or even impossible for the plants to recover before they go into winter dormancy.

However, Rush said in the first replication of side-by-side comparisons of Mace, Ron L, TAM 112, TAM 111 and Karl 92, they have seen interesting results.

“We think that TAM 112 is exhibiting some tolerance to the vector,” he said. “If this holds up – these are preliminary results and must be repeated – but the thing that is so exciting about this is if you have the resistance to the mite, then you don’t have to worry about the virus building up.”

In his greenhouse study, Rush said the plants are exposed to 20 mites per pot at the same time and grown under the same environmental conditions. As they have grown out, TAM 112 exhibits healthy leaves while pots beside it planted to other varieties have twisted leaves and the typical streaking and striping associated with wheat streak mosaic virus.



Mites too tiny to see with the naked human eye are washed from wheat leaves and counted with a dissecting scope. Credit: Jacob Price

Mace has a specific gene for resistance to wheat streak, wsm1, and Ron L has a different gene, wsm2. The Karl 92 is planted as a check variety as it has no known resistance, and TAM 111 and TAM 112 were added to the study to see how they performed because they are regionally adapted, he said.

Angela Simmons, a new graduate student in Rush's program, is in the process of washing the mites from three tillers per pot and then counting them under a dissecting scope. The number of mites for Mace and Ron L are in the range of 2,000 to 3,000 and the number of mites for TAM 112 is in the range of 100 to 200, "so there is a tremendous difference in the mite population showing up, he said.

The leaves of TAM 112 have essentially no curling resulting from the mites and look almost normal, he said, but there are some symptoms of wheat streak exhibited indicating it has been infected by the virus.

"If you think about an entire field of this, with a field next door of a susceptible lines where you have massive numbers of mites, it can make a very real difference," Rush said. "If they blow into your TAM 112 field and the mites aren't building up to as high of a population, the virus isn't building up, so as they move across the field, the number of mites gets less and less.

"Overall, you may have some infection, but you will end up having a much healthier wheat field resulting in better yield and quality than if you had a cultivar with a specific resistance gene to wheat streak but it

was planted in late August or early September when the temperatures are too high for the resistance to be effective," he said.

That's what this whole study is about, Rush said, trying to look at how the temperature fluctuations that the crop goes through in the Panhandle at this time of the year are going to affect overall disease development.

"We are tremendously optimistic about what we've seen so far, but we know biological systems, by their very nature, are prone to change and that is why it is so important to go back and repeat the study and see if we get similar results in a repeated study," Rush said. "That will give us confidence that what we are seeing is indeed a response of that particular cultivar."

Following the second round of the study, Rush will work with other AgriLife Research scientists to try to determine the genetic reason TAM 112 has tolerance to the vector or mite.

"If we were able to identify the actual gene, or genes, responsible for mite resistance, it would be a huge advance to our overall wheat program because cultivars with these genes would have reduced susceptibility to all mite-vectored virus diseases and not just wheat streak mosaic virus," he said.

"This resistance, combined with the observed drought tolerance of TAM 112, would result in an exceptionally valuable combination for much of the southwestern Great Plains," Rush said.

He said further research might determine that these wheat varieties with the wheat streak mosaic resistance trait may be more effective in northern states where wheat is planted later when it is cooler.

"We've established a collaboration with researchers in Kansas, Nebraska,

Oklahoma and Montana to do a regional study on wheat streak and monitor the differences of certain cultivars in general," Rush said.

Knowing that, he said, they hope to determine why the differences are occurring and develop a disease forecasting risk assessment model for diseases vectored by the mite, including wheat streak mosaic, High Plains disease and triticum mosaic virus.

Provided by Texas A&M AgriLife

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