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Wheat streak mosaic virus Management in Idaho Cereals

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Introduction

ESPECIALLY DURING DRY SEASONS, *Wheat streak mosaic virus* (WSMV) is a serious disease that can challenge wheat production in Idaho. Transmitted by the wheat curl mite, WSMV infects winter and spring wheat and can also infect barley, oat, rye, corn, sorghum, and several grassy weed species. Yield loss varies among varieties and may reach more than 50% in fall-infected plants, based on studies conducted in Oklahoma. To date, the presence of WSMV has been reported from eight south-central and southeastern counties in Idaho: Bannock, Bear Lake, Bingham, Caribou, Cassia, Minidoka, Power, and Twin Falls. This virus, however, is likely to occur in other counties and can potentially become a threat to Idaho wheat production. With corn acreage on the increase during the past few years in central and eastern Idaho (corn is known as an important host of the wheat curl mites and the virus), raising more awareness of the disease complex and the interactions among its components is essential to prevent outbreaks. This document is intended to provide information about WSMV, its wheat curl mite vector, the disease cycle, and available management options. As there is no effective chemical control for WSMV, adopting area-wide cultural practices is essential to successfully disrupt the disease cycle.

Disease Symptoms

Although WSMV may affect both winter and spring crops, severe losses usually occur in fall-planted cereals. Spring wheat seeded in the proximity of already infected fall-planted fields also risks exposure and potential yield loss. The virus infection mostly occurs in late summer or early fall, depending on the region. Initial disease symptoms include light green streaks becoming visible on the leaves in the spring, when temperatures above 80°F persist over a few days. As the disease progresses, the light green streaks gradually turn to yellow, giving the affected plant a “mosaic” appearance (Figure 1).

The discoloration in the leaves reflects the degradation of chlorophyll, which subsequently reduces light-dependent reactions in photosynthesis and photosynthetic efficiency. The affected plants also have reduced tiller numbers and shoot and root biomass. The hindered foliar and root development reduces plant water and nutrient uptake, which results in yield loss. Necrosis and plant death may follow when severe infections occur during the early stages of plant growth. Generally, the earlier that plants are infected (e.g., the growth stages of 3–5 leaves) the more severe are the losses compared to those infected during later stages of growth (e.g., jointing and booting).

At the field scale, an edge effect is present as the severity of the disease symptoms follows a reducing gradient with the increased distance from the source of the infection. This pattern, however, may not be present in severely affected fields as symptoms may be uniformly distributed due to widespread infestation by its vector (Figure 2).

Figure 1. Typical symptoms of *Wheat streak mosaic virus* in wheat. Photo by Fekede Workneh.

Figure 2. A wheat field severely affected by *Wheat streak mosaic virus*. Photo by Fekede Workneh.

Pathogen Spread

Although WSMV can be transmitted mechanically (e.g., contact between infected and healthy leaves), the primary means of transmission is through an arthropod vector known as the wheat curl mite, *Aceria tosichella* (Prostigmata: Eriophyidae). The mite is extremely small and not visible to the naked eye (Figure 3).

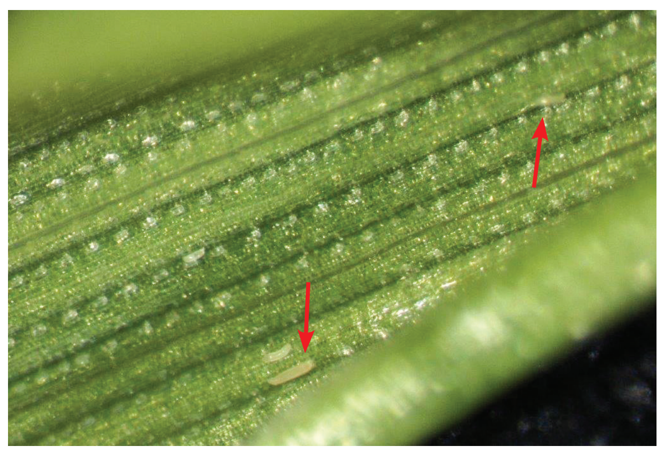

Figure 3. Cigar-shaped wheat curl mites (see arrows) feeding on a wheat leaf, observed under a microscope. Photo by Monica Brelsford.

Under a microscope (or a powerful magnifying glass) they appear as pale and cigar-shaped organisms. Not as evident is the surprising fact that they have only two pairs of legs toward the head. Given their small size, the wind can transport them for miles, facilitating the virus spread. Wheat curl mites may overwinter at different stages of their development (e.g., eggs, nymphs, or adults) by taking refuge in the crowns of winter wheat and other grassy hosts. Adult mites feed on succulent leaf tissue and seek alternative food sources as their host plant starts to dry or mature. Thus, infection of newly emerged early-planted winter cereals may occur when mites disperse from maturing corn and wheat, or from volunteers and grassy weeds. Volunteer plants and grassy weeds present in and around neglected cereal fields can be suitable “green bridges” for infected mites until cultivated cereals emerge. Examples of commonly found grassy weed species in southern

Idaho include downy brome (*Bromus tectorum* L.), green foxtail (*Setaria viridis* (L.)), and foxtail barley (*Hordeum jubatum* L.). Figure 4 represents a schematic of the WSMV life cycle.

Disease Management

There is no remedy for plants once they are infected with WSMV, and neither is there a pesticide that effectively manages wheat curl mite populations. However, resistance to WSMV has been identified, and wheat varieties with resistance to or tolerance of WSMV have been developed. For example, Joe, Clara CL, and Oakley CL, developed by Kansas State University, and TAM 112, developed by Texas A&M University, are wheat varieties that are resistant, or show moderate resistance, to WSMV. Susceptibility of commonly planted Idaho varieties to WSMV has yet to be evaluated.

Although grain yields of WSMV-infected wheat may be improved by additional nitrogen (N) applications, such yields remain lower than those for uninfected healthy crops. It is also important to note that increased N availability could result in an increase in wheat curl mite populations and consequently WSMV spread. Wheat curl mites typically immigrate into winter cereal fields in the fall, during which fertilization should be avoided. It has been suggested that farmers in high-risk areas could split fertilization between the fall and spring or postpone it until the spring.

Managing the disease's incidence via irrigation strategies creates its own trade-off. Reducing irrigation causes more yield loss in WSMV-infected wheat than in unaffected wheat as drought stress

Figure 4. *Wheat streak mosaic virus* life cycle. Photos provided by Jifei He, Chad Jackson, Arash Rashed, and Juliet Marshall.

and associated nutrient deficiencies exacerbate the damage by WSMV. Increasing irrigation would not considerably benefit the grain yield. Thus, when deciding how to manage WSMV-infected fields, growers should aim to optimize the economic return by considering grain yield and production inputs (e.g., irrigation, energy, and labor) instead of maximizing grain yield.

Another strategy involves altering the environment the wheat curl mite most prefers. Because the mites are unable to survive in the absence of green tissue, removing green bridges within and around fields two weeks before planting is an effective tactic. It will eliminate food sources for mites, subsequently reducing their populations. The green bridge plants include volunteer cereals and grassy weeds within and around fields, which can be removed by cultivating the field or applying herbicides. Managing weeds within and around WSMV-affected fields, in particular, reduces the risk of postharvest mite/virus spread from those reservoir plants to newly emerged wheat crops. Eliminating weeds from fields also benefits the growth of the already affected crop by reducing competition for resources.

Planting windows are also a major consideration. The optimal window to minimize WSMV incidence and damage varies among regions; please consult county extension offices to obtain the recommended planting dates for specific regions. In high-risk areas with a history of WSMV, a rule of thumb is to plant winter wheat relatively late, after the winter/spring wheat harvest in adjacent fields. In cases where the infestation of spring seeded crop may be a concern, early spring planting may allow young seedlings to outgrow their most susceptible developmental stage prior to mite exposure. However, do not plant spring grain near WSMV/mite–affected winter wheat. Late fall planting and early spring planting are also recommended practices for managing the cereal aphid-borne *Barley yellow dwarf virus*, another recurring cereal disease in Idaho.

Cultural practices aimed at disrupting the life cycle of the mite vector are critical in minimizing the virus spread. Since mites may travel for miles, area-wide management practices are highly recommended to control the virus spread; the strategy is difficult, but highly effective when achieved. Talk to your neighbors to coordinate a management plan.

Conclusion

Because no effective chemical management is currently available, cultural control practices remain critical in managing WSMV. These practices include thorough management of volunteers and grassy weeds and late fall planting of winter wheat and/or early spring planting of spring wheat. In addition, planting tolerant or resistant varieties is highly recommended, where available.

Further Reading

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