Spring Glyphosate Recommendation for Established Alfalfa: Prevent Plant Damage by Bacterial Stem Blight

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Recent wet fall seasons have often delayed or prevented fall weed control in established alfalfa stands in some locations. Farmers anticipating applying glyphosate treatments in early spring to established alfalfa should be aware of recent changes in recommendations for spring applications. If applications of glyphosate are made to established stands of Roundup Ready alfalfa before the first cut, research has found herbicide timing is critical to prevent damage from a bacterial disease. In established alfalfa, glyphosate applications in spring should be done when alfalfa plants are ≤4" tall. Recommendations are unchanged for treating newly seeded alfalfa stands. The change for established stands is due to observations that herbicide application can promote frost damage and disease caused by a bacterial plant pathogen.

Several years ago, farmers in northern California reported increased frost damage to Roundup Ready alfalfa sprayed with glyphosate in early spring. The symptoms were plant stunting and yellowing along with frost damage. Close inspection of plants showed leaves had water-soaked areas that turned yellow and rotted, resulting in high amounts of leaf loss. Dark lesions were also seen on stems, often initiating at the axils where leaves attached to stems. A bacterial plant pathogen, *Pseudomonas syringae*, was consistently isolated from plants with symptoms. Inoculation of healthy plants with the bacterium reproduced the disease symptoms observed in the field. In some locations, a second species, *P. viridiflava,* was also found causing the same disease symptoms. The disease is known as bacterial stem blight and has been reported as widespread in the central and western U.S., including the Pacific Coast, and it occasionally occurs in the eastern U.S. In elevated, colder valleys of the western mountainous regions of the U.S., forage losses from first crop harvests have been reported as large as 40-50% for some cultivars. Most recently, bacterial stem blight has been identified in northern California, southern Oregon, the Cache Valley in northern Utah, southern Minnesota, and western Ohio.

Leaf surfaces support large populations of 1-10 million bacteria usually living in harmony with the plant without causing any symptoms of disease; *P. syringae* is often the dominant member of these microbial communities. Populations of *P. syringae* increase during cool moist weather in spring, moving to emerging leaves by water splash, wind, and insects. Populations are low when plants are <4" tall, which may be the reason early glyphosate application does not lead to disease. The size of the population and disease progression also depend on environmental conditions. The environment during early plant growth may not be conducive to disease. Experiments in controlled conditions are planned to address this possibility. Genetic studies of *P. syringae* isolated from California, Utah, Minnesota, and Ohio indicate they are similar, suggesting extensive movement of the bacteria across the U.S.

When *P. syringae* populations reach a threshold level, the plant is vulnerable to frost damage from ice nucleation activity of the bacterium. This damage creates a break in the leaf surface, releasing nutrients for bacterial growth and an entry point into the interior of the plant. A protein in the outer membrane of the bacterium mimics the crystal structure of ice, which will initiate ice formation. This protein is so efficient at starting ice formation it is used in artificial snowmaking. Once inside the plant, *P. syringae* produces toxins causing plant stunting and leaf yellowing while *P. viridiflava* degrades plant cell walls, causing rotting of tissues. As the weather warms, populations decline and bacterial stem blight is rare during summer months.

The interaction of glyphosate with bacterial stem blight and frost damage is under investigation. Experiments in California demonstrated glyphosate does not increase *P. syringae* populations on surfaces of alfalfa plants. Tests also found *P. syringae* isolated from Roundup Ready plants treated with glyphosate are not significantly more tolerant to glyphosate than *P. syringae* isolated from plants without treatment and strains isolated before Roundup Ready alfalfa was released. A current hypothesis is glyphosate aids in entry of *P. syringae* into alfalfa plants. In support of this idea was the observation that Roundup Ready alfalfa plants in Ohio treated with glyphosate in early spring 2019 showed disease symptoms but without frost damage. In that test location, temperatures were never low enough after glyphosate application for frost formation, but plants became diseased. The internal populations of *P. syringae* and *P. viridiflava* after glyphosate treatment will be tested in spring 2020.

The primary means of combatting diseases in alfalfa is through use of genetic resistance. For bacterial stem blight, resistance was found in several older cultivars having high winter survival traits. In research supported by USDA-NIFA, the genes conferring resistance are being mapped and resistance is being transferred into several genetic backgrounds by traditional plant breeding methods. Greenhouse tests found resistance is not specific to single strains but rather is broad and confers resistance to diverse strains from distant locations. Because bacterial stem blight is linked to frost damage in alfalfa, developing resistance to the disease may have the added benefit of increasing frost tolerance in alfalfa.