Importance of Potassium in Resistance to Crown Rot Disease in Alfalfa

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Nitrogen, phosphate, and potassium (potash, K_2O) are the three most important nutrients in alfalfa growth and development. Nitrogen fertilization is not required since alfalfa has a high rate of biological nitrogen fixation. Phosphorus and potassium are frequently applied as fertilizer, but potassium is the most common nutrient deficiency of alfalfa stands. Although potassium requirements can vary with the alfalfa cultivar, a general rule of thumb is harvesting 1 ton of forage removes an average of 60 lbs of K_2O from the soil. Therefore, a 5 ton/ac crop removes a lot of potassium from a soil. Soil potassium levels with alfalfa-grass mixtures need to be monitored closely since grasses are more efficient in potassium uptake and can starve alfalfa of this vital nutrient. Potash applications should be based on recent soil tests (soiltest.cfans.umn.edu/). Over-fertilization should be avoided since alfalfa will take up more potassium than it needs (luxury consumption), which can lead to animal health problems when the forage is fed. Crop calculators are available to determine nutrient needs based on yield goals and soil test results: extension.umn.edu/agriculture/nutrient-management/crop-calculators/.

Figure 1. Symptoms of potassium deficiency on alfalfa leaves.

Of all the nutrient deficiencies, potassium deficiency is the easiest to identify. Small, white to yellow spots, or freckles, appear at the margins of lower leaflets (Figure 1). As the problem intensifies, spots can grow together, turn yellow, and leaves die and drop from the stem. Symptoms appear first on the lower leaves since potassium is mobile within the plant. Stand loss, winterkill, and grass weed invasion are indicators of potassium deficiency at the whole field level.

Research has shown the need for balanced potassium and phosphorus nutrition for alfalfa stand persistence. Potassium is reported to reduce disease susceptibility, although little data supports this observation, and the interaction of potassium with disease resistance is not well understood. In a recent Australian study, researchers reported significant reductions in common leaf spot symptoms as well as defoliation reductions with adequate potassium fertility. Potassium application also had a beneficial impact on root nodulation, herbage

yields, and leaf to stem ratio. To better understand the relationship between potassium and stand persistence, researchers with the USDA-Agricultural Research Service in St. Paul, MN, and University of Minnesota colleagues have carried out several experiments to measure the impact of potassium fertility on forage yield and crown rot disease.

In the first experiment, five cultivars were evaluated at four Minnesota locations with diverse soil types and environments. Potassium was applied as potash (K_2O) at rates of 0, 125, or 350 lbs/ac each year. Plants were rated for the amount of crown rot at the end of the third production year. There was a clear benefit of potassium fertilization to crown rot resistance across all locations and cultivars (Figure 2). With potassium fertilization, the percentage of plants with no symptoms of crown rot increased significantly. Maintaining crown health is directly related to maintaining crown buds for vigorous shoot regrowth after cutting, for winter survival, and for efficient nutrient transfer between roots and shoots. Also, cultivars responded differently to potassium fertilization. In the 0 and 125 lb K_2O treatments there were no differences for the amount of crown rot. However, at the higher rate, two cultivars had higher percentages of healthy plants, suggesting potassium fertility revealed their genetic potential for greater disease resistance (Table 1). Results suggest one reason potassium fertility increases winter survival and stand life is due to a reduction in crown rot disease.

In a second ongoing experiment, forage yields and crown rot of a single cultivar were evaluated at Waseca, MN, on a clay loam soil. Forage yield responses to two potassium treatments, 200 and 400 lbs K_2O/ac, were compared with a control not receiving any potassium fertilization. Surprisingly, there were no differences in forage yields over 18 harvests made to date. The plots receiving no potassium performed as well as those receiving 200 or 400 lbs of K_2O each year. However, a significant reduction in crown rot with potassium fertilization was observed (Figure 3). Results indicate that even though a yield response to potassium fertilization may not be apparent, plants can be responding below ground with improved health and vigor paying dividends in the long run.

Figure 2. Increased crown health with potassium fertilization.

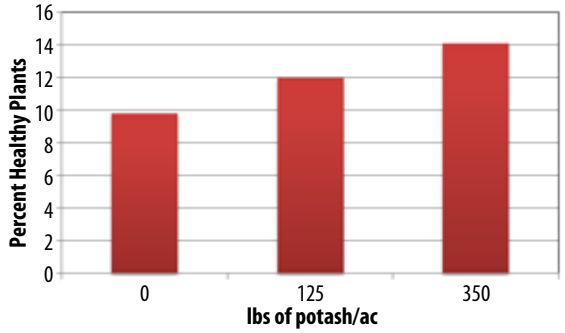

Table 1. Percentage of healthy plants with potassium fertility treatments. Cultivars 1 and 3 had significantly more plants without crown rot in the 350 pounds K_2O treatment compared to the 0 pounds K_2O treatment.

Potassium rate	Cultivar 1	Cultivar 2	Cultivar 3	Cultivar 4	Cultivar 5
0 lbs	15	11	9	12	14
350 lbs	23	8	14	14	11

Figure 3. Decreased symptoms of crown rot with potassium fertilization.