Alfalfa Response to P & K in Association with Calcium, Magnesium, & Harvest Time

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Application of phosphorus (P) and potassium (K) can provide the alfalfa plant with essential nutrients for an enhanced physiology and growth. However, fertilizing alfalfa with P and K alone may not warrant their availability in the soil and uptake by the plant. Concentrations of available K, calcium (Ca), and magnesium (Mg) in the soil have high potential to influence availability and uptake of P and K by alfalfa for adequate growth. Maturity stage of alfalfa can also influence the levels of nutrients to be plant available for uptake due to the processes involved in accumulating carbohydrate root reserves. The objective of the study was to determine the response of alfalfa to P and K application in relation to the levels of K, Ca, and Mg along with harvest time for sustainable alfalfa production. The study was conducted at the University of Wyoming James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle from 2019 to 2021. Treatments included 18 selected combinations of three P (0, 34, and 67 kg P_2O_5 ha^{-1}), three K (0, 168, and 336 kg K_2O ha^{-1}), two Ca (0 and 560 kg CaO ha^{-1}), and two Mg (0 and 56 kg MgO ha^{-1}); and two harvest times (early harvest, late bud to early [10%] bloom; late harvest, 7 days after early harvest). The sources of P and K were triple superphosphate and muriate of potash, respectively. Treatments were arranged in a randomized complete block design with three replications. Alfalfa (“Hi-Gest 360”) was planted in early September of 2019. There was a significant ($P < 0.05$) effect of treatments on forage accumulation of alfalfa. Alfalfa fertilized with P × K generally produced higher forage accumulation than alfalfa fertilized with only P or K. This trend was generally observed for treatments with and without the association of Ca and Mg (Ca560Mg56). The P67K336 and P67K336Ca560Mg56 treatments produced the greatest (> 11 Mg ha^{-1}) annual forage accumulation, whereas P0K0 produced the lowest (8.1 Mg ha^{-1}) annual forage accumulation. Harvest time affected ($P < 0.05$) forage accumulation of alfalfa with higher forage accumulation at late harvest (10.1 Mg ha^{-1}) than at early harvest (9.6 Mg ha^{-1}). There was a linear and quadratic response between P rate and forage accumulation (with and without Ca560Mg56) under early and late harvest systems, respectively. With Ca560Mg56, K rate and forage accumulation produced a linear response under both harvest systems. The relationship between P × K rate and forage accumulation (with and without Ca560Mg56) at both harvest times was linear. In general, nutritive value was not affected by the treatments. Tissue P and K in alfalfa and their uptake were high in alfalfa that received P and K, respectively. Tissue K and K uptake were generally high compared to tissue P and P uptake. Under early and late harvest systems, tissue P and K were similar and comparable. Overall, the study results suggest that high rates of P and K are needed irrespective of amounts of K along with Ca and Mg present in the soil for maintaining high alfalfa productivity.