

Phosphorus and Potassium Affect Alfalfa Persistence

By Jerry Nelson, Daryl Buchholz, Kevin Moore, and John Jennings

Missouri research demonstrates that phosphorus (P) and potassium (K) fertilization are keys to both alfalfa yields and stand persistence. Adequate K has a strong effect on increased stem numbers per plant, a major factor in yield improvement in thin stands.

ALFALFA, the queen of forages, is recognized widely for its high yield potential and excellent forage quality. Only a few management studies, however, have included plant persistence evaluations over a long period of time. Recently, there has been an increased interest in persistence of alfalfa, arising largely due to:

- the high cost of establishment;
- the need to prevent erosion during establishment on marginally-productive soils;
- the interest in high quality forage for low-cost feeding systems;
- the growing recognition that alfalfa is cost-effective for growing beef animals as well as dairy production.

Invariably, with this shift in adaptation to more marginal sites, there is a need to focus more managerial attention toward persistence. The life of the stand becomes a very important economic factor.

The Stand

A major objective in alfalfa management is to rapidly establish a high number of plants that can be maintained over a long period of time. Alfalfa (with 90 percent germination seeded at 15 lb/A) has a potential of 70 seedlings per square foot. At the end of the seeding year, however, 20 to 25 plants per square foot is considered an excellent stand. Thereafter, the stand will decrease in plant density, rapidly at first as self-thinning occurs, until about 6 plants per square foot remain (generally about 3 years later). Depending on management, the stand then depletes slowly,

until the plant density no longer supports economic yields (**Figure 1**).

Missouri Research

Research on plant persistence began because farmers needed management

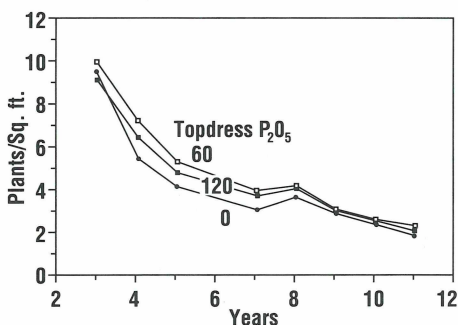
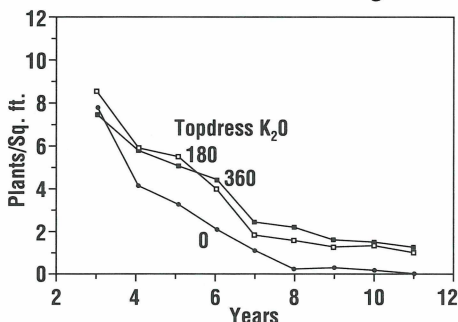


Figure 1. Plant density decreased over time in experiments without adequate P or K. Plots were topdressed annually with K (top) or P (bottom), the other nutrient being kept at a high level. Note the rapid decrease in plant density, and how failure to topdress with K led to continued rapid plant loss.

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information. Many in Missouri were experiencing problems with longevity of alfalfa on certain soil types (especially those with poor fertility or drainage). The objectives of this research were focused mainly on marginal soil sites and involved conservative management variables to maintain production and improve persistence. Alfalfa yields and the effects on plant stem growth were monitored over time as plant densities decreased. These findings were based on six separate experiments, some lasting more than 10 years.

Two fertility trials in Howell county, MO, conducted for the past 10 years, have demonstrated that fertilizer management is a critical aspect of a productive alfalfa system. **Figure 2** shows the direct effect of fertility on yield, but persistence also has great economic implications for farmers. Sound fertility management allows the farmer to extend the useful life of the stand (possibly 2 to 4 more years) and decrease amortized establishment costs. Clearly, a good economic strategy for longer crop persistence is fertilizer management.

Research Results

Plowdown treatments of K on a soil with 92 parts per million (ppm) extractable K had only a small influence on yield and plant persistence (limited to the first 2 years). For example, averaged over topdressing treatments, plots receiving no plowdown K yielded about 85 percent as much as plots receiving 200 or 400 lb/A plowdown K_2O , which were equal (data not shown). The 100 lb/A K_2O plowdown treatment was intermediate. There was no influence on plant density. In contrast, topdressing treatments of K had a marked effect on both plant persistence (**Figure 1**) and yield (**Figures 2 and 3**).

At a second site with a low Bray P-1 level of 4.5 ppm, there was a slight yield response for the first 2 years due to plowdown treatment of P (data not shown), but the major long-term effects came from topdressed P (**Figure 3**). These data emphasize the importance of annual topdressing of P and K.

Annual topdressing (especially in the later years), averaged over plowdown treatments, had a marked effect on yield

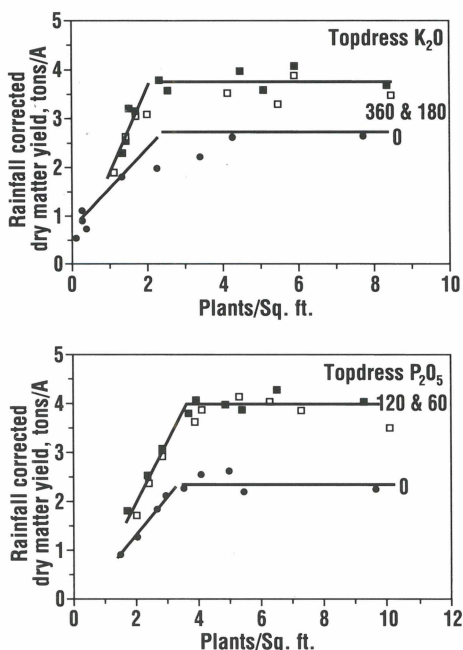
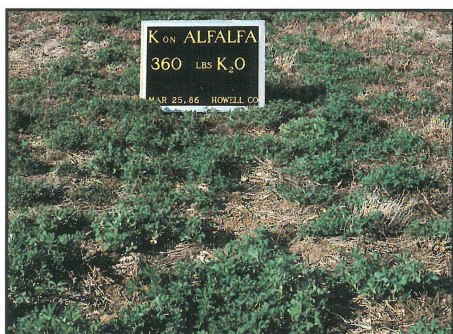


Figure 2. Yields corrected for year-to-year variation in rainfall, then plotted relative to plant density. The "trend" is for a minimal density of about 2 to 3 plants per square foot for maintaining high yield. Topdressed P or K treatments were averaged because they responded similarly. Note that yield tended to be independent of plant density at high densities, but topdressing increased yield at a given density.

and plant density. Stand density declined more rapidly without topdressed K (**Figure 1**) reaching the critical value of three plants per square foot after the 5th year (1985). After 10 years (1990), plots receiving 180 or 360 lb K_2O/A had been reduced to fewer than two plants per square foot, and yield was decreasing (**Figure 2**).

Weed control was a critical aspect of extended yield and stand life. Winter annuals were treated with paraquat when plant density was below four plants per square foot. Both winter and summer annuals were treated when density was below three plants per square foot. When costs of annual weed and insect control were included, the topdressed stands were still economic after 8 years (when yield began to decline).



POTASSIUM is important in maintaining alfalfa plant stands as well as yields. Photos above show plots which received 360 lb/A K_2O rates (left) compared to plots receiving no K_2O (right).

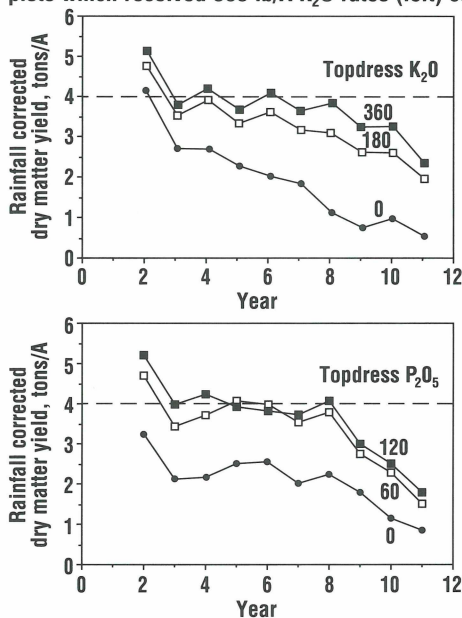


Figure 3. Alfalfa yield corrected for yearly differences in rainfall. Yield was lower when plots received no topdressing. Yield responses of the 180 and 360 lb K_2O /acre treatments gradually separated, suggesting that the value of extra K may not be realized until late in the stand life. The dashed line represents average yield of the best treatment for years 3 through 8.

In 1986, a smaller experiment (within the main experiment) was begun to try and revive the stand which had previously received no K topdressing. Phosphorus was maintained at an adequate level. Surprisingly, when K was applied, alfalfa yields approached those of well fertilized plots. Topdressed K caused the remaining

plants (1.5 plants per square foot) to compensate by increasing the number of stems per plant (Figure 4). This suggests that stems per plant is the main factor involved in the yield response of thin stands to K.

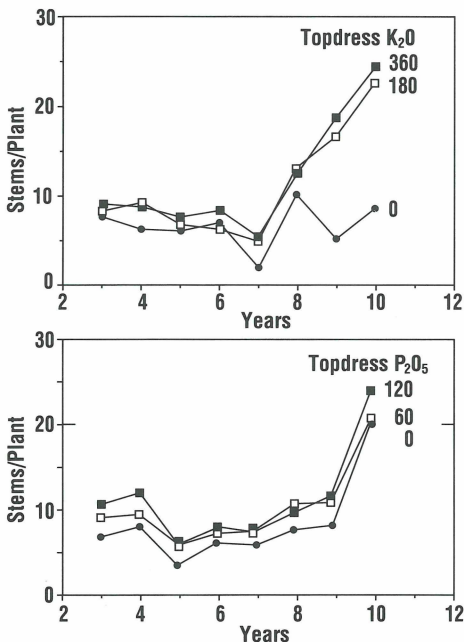


Figure 4. Stems per plant increased over time as the plants per square foot decreased. Note that the plants receiving no annual topdressing generally had fewer stems per plant than plants receiving annual topdressing. As plants thin, K is critical for yield compensation when nearby plants die. There were also more stems per plant with topdressed P, but stems per plant increased with time because of annual K topdressing.

This new information needs to be transferred to plant breeders and crop management specialists. To date, their primary emphasis has been on plants per square foot.

Summary

This research clearly shows that alfalfa properly fertilized with P and K can be maintained economically for long periods of time. The data also show that returns will offset herbicide applications when the alfalfa stands become thin and less competitive. With good P and K fertility, minimal plant density is between 2 and 3 plants per square foot. As farmers look for

long-term sustainable programs, well-managed alfalfa can contribute a quality forage to the system. However, the economics of fertilization regimes will be a critical management consideration. Top-dressing is vital to persistence. The plow-down treatments help out early in the life of the stand, but do not sustain productivity.

Future assessments of stand condition are likely to place more emphasis on shoots per square foot than on plants per square foot. Not only does K help plants persist, but it promotes shoot growth of remaining plants if a neighboring plant dies, thus maintaining yield potential. ■

“Roots of Plant Nutrition” Conference Proceedings Available from PPI

PROCEEDINGS of the “Roots of Plant Nutrition” Conference are available from the Potash & Phosphate Institute (PPI). The conference, which took place July 8 to 10 in Champaign, IL, was organized by PPI and the Foundation for Agronomic Research (FAR). Co-sponsors included USDA/ARS, Agriculture Canada/Research Branch, USDA/ARS National Soil Tilth Lab, National Fertilizer Environmental Research Center/TVA, and University of Illinois Department of Agronomy.

The Proceedings includes 43 papers presented at the conference, with a variety of topics including “Effect of Nutrients on Root Growth and Ion Uptake,” “Tillage and Compaction Effects on Root Distribution,” and “Variable Rate Application Systems.”

Copies of the Proceedings cost \$15.00 each. Send payment to: PPI/FAR Roots Conference, Potash & Phosphate Institute, 2805 Claflin Road, Suite 200, Manhattan, KS 66502. ■

Potash & Phosphate Institute and Foundation for Agronomic Research Announce New Headquarters Location

THE HEADQUARTERS offices of the Potash & Phosphate Institute (PPI) and the Foundation for Agronomic Research (FAR) are moving in August of 1992.

The new office location will be 655 Engineering Drive, Suite 110, Norcross, GA 30092-2821. Beginning August 24, the new telephone number will be (404) 447-0335 and the fax number will be (404) 448-0439. Since 1979, the offices have been located at 2801 Buford Highway, N.E., Atlanta, GA 30329.

“The new location should provide a more efficient facility for the functions of our agronomic research and education programs,” noted Dr. David W. Dibb, President of PPI. “We have planned the move to minimize the disruption of services to PPI members, FAR contributors, and others.”

Normal operations of PPI and FAR are expected to resume by September 1. ■