Ketterings, Q.M., G. Godwin, J. Cherney, and K. Czymmek (2011). Comparison of tissue K and whole plant K for alfalfa. What's Cropping Up? 21(4): 13-15.

Comparison of Tissue K and Whole Plant K for Alfalfa

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Introduction

Stakeholders have often referred to Cornell potassium (K) guidelines as too low to support high yields. However, increasing K fertilizer prices have many wondering if K applications can be reduced without impacting yield, quality or stand survivability. In collaboration with consultants, extension educators and farmers, we initiated a research station project on alfalfa K needs for alfalfa grown in rotation with corn. We report on the yield data for the K study in What's Cropping Up? 21(4): 8-12. Here we focus on assessing the impact of K addition on plant K status as well as the relationship between whole plant K content and tissue K content. We address the question: can whole plant K content from a forage analyses be used to diagnose a potential K deficiency?

Materials and Methods

At the Aurora Research Farm in central NY, a K rate study was initiated in 2007 on plots that had been planted to corn for five years and conventionally fertilized (i.e. no manure or compost history). The plots were classified as high in soil test K (average of 117 lbs K/acre in the spring of 2006) according to the Cornell Morgan soil test K interpretations for alfalfa. The trial consisted of five annual K application rates: 0, 83, 166, 255, and 335 lbs K_2O/acre. The 255 lbs/acre rate was the estimated crop removal rate for the site, assuming an average crop uptake of 56 lbs K_2O per ton of DM. In addition to the K rate study on plots that were conventionally fertilized during the corn years of the rotation, we also tracked alfalfa plots that during corn years had two compost application rates (20 and 34 ton/acre, representing P-removal and N-based application rates) and two liquid manure application rates (8,000 and 20,000 gallons/acre; representing P-removal based applications with incorporation of manure to conserve N, and N-based without incorporation of the manure, respectively). The organic materials were applied annually in the spring during the 5 years of corn that preceded the establishment of alfalfa and resulted in soil test K levels that were classified as very high (186 and 200 lbs P/acre for the P-based applications and 262 and 278 lbs P/acre for the N-based rates for compost and manure, respectively).

Alfalfa was established in 2006 and the K rate study initiated in 2007. All plots were sampled for tissue K (top 6 inches) during 3rd cutting in July of 2010. This was done in addition to yield sampling. All treatments were replicated five times (randomized complete block design) and alfalfa was typically harvested in a 4-cut system (except 2006, seeding year with two cuts, and 2007 which was harvested in three cuts due to drought). Whole plant and tissue samples were taken in 2010 (3rd cutting) and analyzed for total K.

Results and Discussion

A direct comparison of tissue K and whole plant K content across all plots in the study, showed a slope of 1.01 with an R^2 of 0.60, suggesting that whole plant K content explained 61% of the variability in tissue K (Figure 1). This indicates variability between tissue K and whole plant K but suggests that forage analyses can be use as a first indicator of the potential for a K deficiency or for excess K (high K forages).

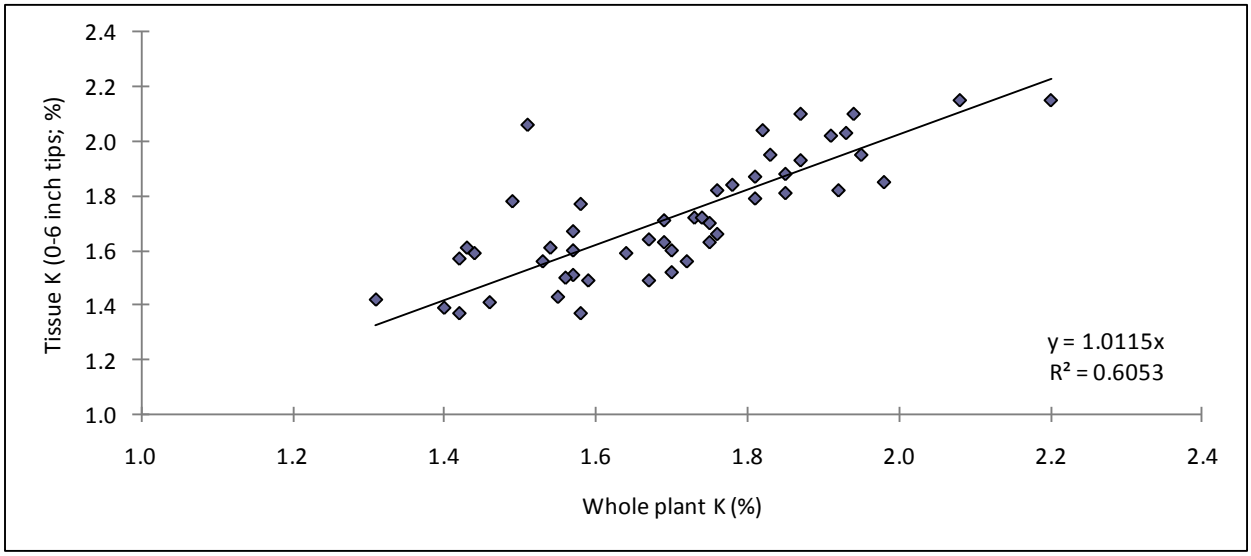

Figure 1: relationship between whole plant K and tissue K content across 50 plots sampled at 3rd cutting in 2010. The plots represent a variety of field histories.

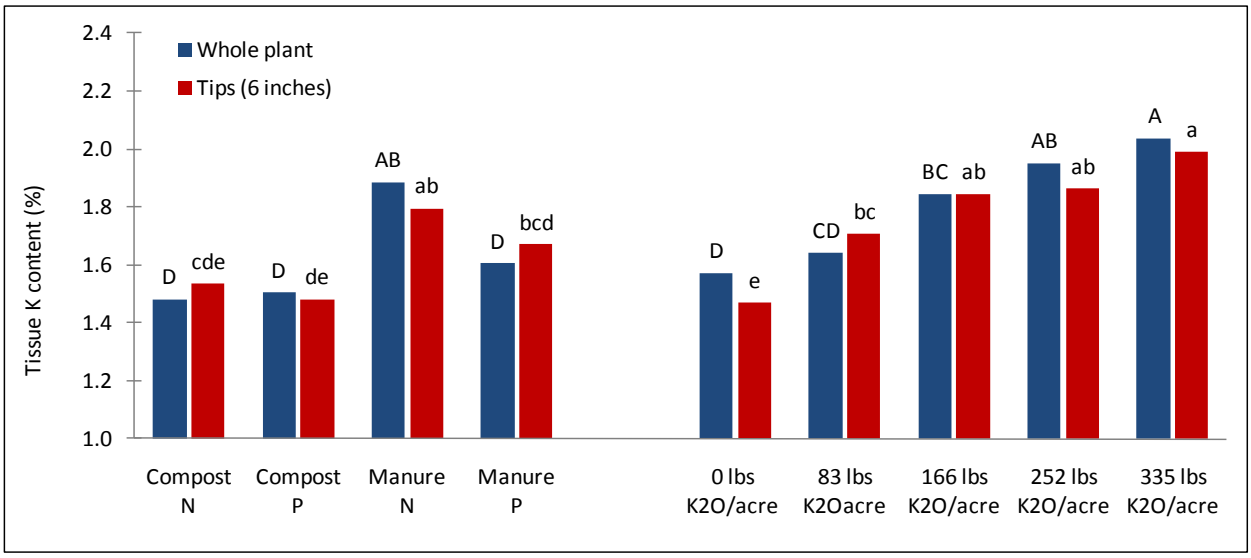

Figure 2: Tissue and whole plant K content as impacted by compost and manure history and K fertilizer application rate. In blue is whole plant K content while tissue K (top 6 inches) is represented by the red colored bars. Within tissue K (purple), lower case letters that are different indicate a significant change in tissue K. Within whole plant K (blue), upper case letters that are different among treatments indicate significant differences at $P \leq 0.05$.

Four years of application of K to alfalfa plots with no manure or compost history resulted in an increase in whole plant K from 1.57% without K addition to 2.04% with four annual additions of 335 lbs K_2O/acre (Figure 2). In the last year of the alfalfa stand, tissue K of fields that had received annual applications of compost under the five corn years prior to the alfalfa was as low as the tissue K of the zero K plots, while tissue K of plots that had received manure remained higher after five years of alfalfa harvest. However, for all but the highest K application rate, the average K content of the plants (whole plant and tissue K) was still less than 2% (Figure 2), the content typically reported as the critical tissue K level. These data, combined with the lack of yield response across rates and soil test K levels for the soil classified as high in soil test K, suggest the critical tissue K level might be lower than commonly reported in the literature..

Cornell Morgan soil test K results explained 62% of the variability in tissue K (tips) and 43% in whole plant K across all plots (Figure 3). The relationship was stronger for the plots that did not have a manure or compost history, in part reflecting a larger range in soil test K levels. However, tissue and whole plant K levels were not related to yield as is shown in Figure 4, also suggesting K was not yield limiting in this trial.

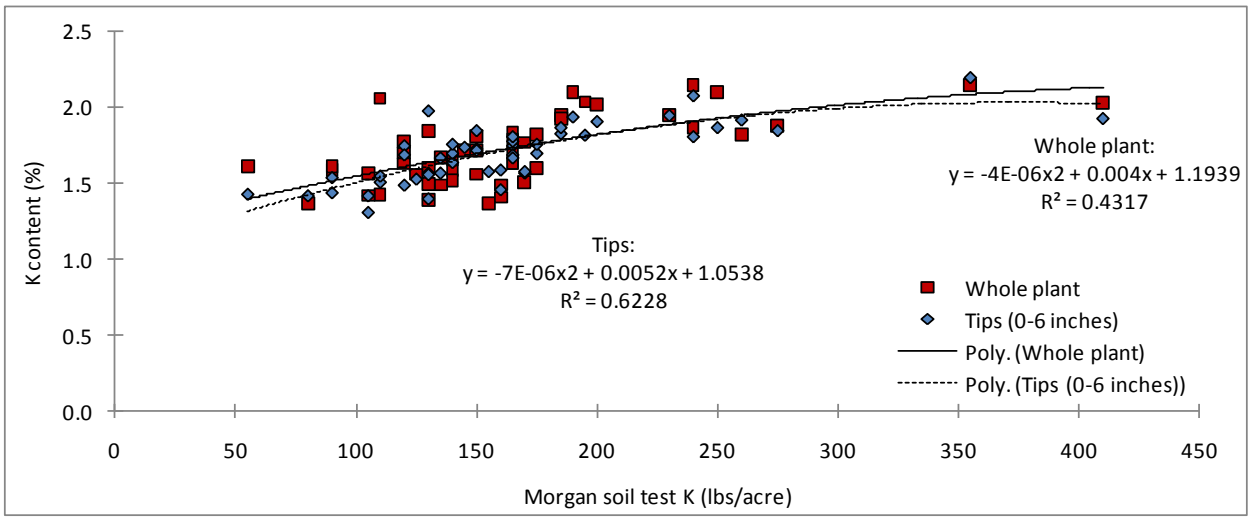

Figure 3: Tissue K contents leveled off at 1.8% when soil test K levels exceeded about 200 lbs/acre.

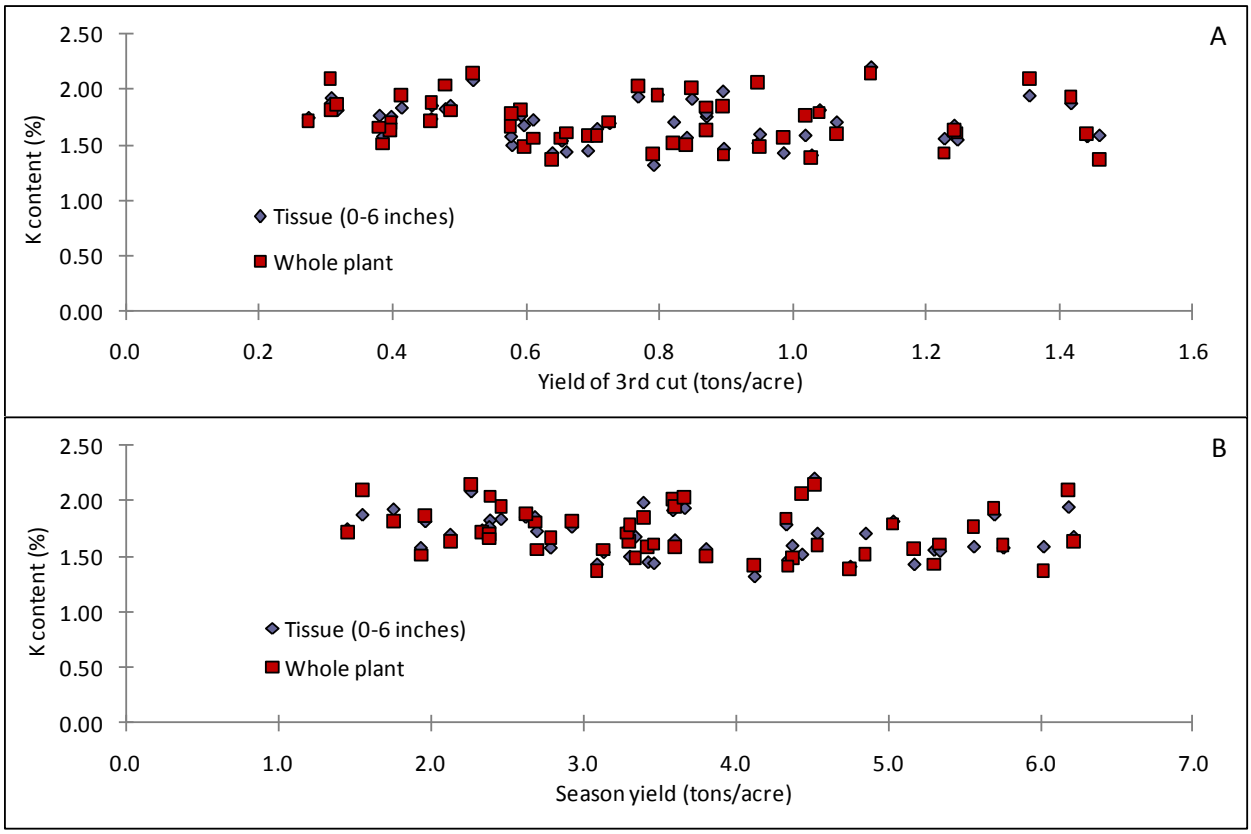

Figure 4: Tissue and whole plant K content of plots varying in (A) 3rd cut DM yield, and (B) full season DM yield across all treatments and plots.

Summary and Conclusions

Whole plant K and tissue K are correlated with a slope of 1 but whole plant K only explained 61% of the variability in tissue K across all fields. Potassium application resulted in an increase in both tissue K and whole plant K. Alfalfa K content of 3rd cutting in the 5th year after the last compost or manure additions remained elevated only where manure had been applied. We conclude that whole plant K and tissue K are correlated and producers may want to evaluate whole plant samples from individual fields to determine if a follow-up tissue test is warranted. However, additional work is needed to determine critical tissue K or whole plant K content as the results of the current study do not support the 2% critical value commonly reported in the literature. Based on the results of this study and the yield data reported in What's Cropping Up? 21(4): 8-12, we recommend basing K applications on Cornell Morgan soil test results rather than tissue or whole plant K contents.

Acknowledgments

We thank Federal Formula Funds, Northeast Sustainable Agriculture Research and Extension (NESARE) and Tom Bruulsema, Director or the Northeastern Region, North America Program of the International Plant Nutrition Institute (IPNI) for support for this project. For questions about this project contact Quirine M. Ketterings at 607-255-3061 or qmk2@cornell.edu, and/or visit the Cornell Nutrient Management Spear Program website at: http://nmsp.cals.cornell.edu/.