

TRITICALE BOOT-STAGE FORAGE K, MG, CA, S, AND MICRONUTRIENT CONTENT

B. Brown¹, J. Dalton², M. Chahine³, B. Hazen⁴, S. Jensen⁵, S. Etter⁶

¹University of Idaho, Parma R&E Center, Parma, ID

²University of Idaho, Caldwell R&E Center, Caldwell, ID

³University of Idaho, Twin Falls R&E Center, Twin Falls, ID

⁴University of Idaho, retired

⁵University of Idaho, Owyhee County Extension Office, Marsing, ID

⁶University of Idaho, Twin Falls County Extension Office, Twin Falls, ID

ABSTRACT

Boot stage triticale forage is used for double cropping with silage corn in Confined Animal Feeding Operations (CAFO) enterprises to increase forage production and phosphorus (P) removal. An Extension survey conducted in 2004 and 2005 in southern Idaho was used to provide the basis for triticale Phosphorus concentration default values in the One-Plan nutrient management planning software. Since the primary focus was P, other nutrients received less attention. Triticale forage total K, Ca, Cl and Mg were weakly correlated with increasing soil test P, but better correlated with soil test K, tissue P, or tissue K concentrations. Luxury consumption was greater for K than P. Several triticale nutrient concentrations including high K, low Mg, and K:Mg ratio indicate greater potential for contributing to hypomagnesemia in soils enriched with excessive manuring. The Ca:P ratio declined and P/Zn ratios also declined with increasing tissue K concentrations. Forage Cu was frequently low to marginal for animal diets. Greater triticale forage nutrient imbalance for animal health is apparently exacerbated in soils excessively enriched with dairy manure and may be a concern if fed alone or as significant portions of the ration.

INTRODUCTION

Boot stage triticale forage is used for double cropping with silage corn in CAFO to increase both forage production and phosphorus (P) removal. Crop P removal is important given that manuring rates in fields managed by most CAFOs are limited to crop P uptake or removal. OnePlan Nutrient Management planning software uses default values for forage P concentrations. A Cooperative Extension survey conducted in 2004 and 2005 in southern Idaho manured fields was used to provide the basis for triticale P concentration default values. Soil test P ranged from low values likely limiting forage production to highly enriched soils (>400 ppm) from excessive manuring. Since the primary survey focus was P, other forage triticale nutrients such as total K, Ca, Mg, Zn, Mn, and Cu were reported but not discussed or examined as thoroughly. Excessive manuring can lead to forage yield limiting salt accumulations. Excessive manuring effects on forage quality may be ignored. The effect of highly manure enriched P soils on boot stage triticale forage nutritional quality has seldom been reported.

Specific forage nutrient concentrations are used for assessing nutrient sufficiency or toxicity for plant growth or animal nutrition and are routinely used for balancing forage rations. Low total Se concentrations have been related to white muscle disease, and other low forage nutrient concentrations can lead to their deficiencies in cattle. Since uptake of one nutrient by forage may inhibit uptake of other nutrients, eg. K and Mg, nutrient ratios are at times used for

the same purposes. For dairy and beef cow nutrition a high K:Mg ratio increases the potential for hypomagnesemia, or grass tetany, and milk fever, which are common in southern Idaho. The forage Ca:P ratio has been used to indicate imbalances of these nutrients as they relate to bone structure maintenance. The P:Zn ratio has been used to indicate the imbalance occurring from excessive P induced Zn deficiency in crops.

The objective of this report is to re-examine data from the 2004-2005 Extension boot stage triticale survey with a focus on nutrients other than P, their total concentrations and selected ratios and their relation to the wide ranging soil and tissue P and K.

METHODS

Three samples of triticale were collected in spring 2004 (April 23-May 14) from each of 34 southern Idaho manured fields managed by dairies and from 10 fields in 2005 (May 12-23). The samples ranged in maturity from late stem extension to heading with most samples in the early boot stage. Samples were rinsed to remove surface deposits of lagoon water, oven dried, the percent dry matter determined, ground, and forwarded to Dr. Dale Westermann, USDA-ARS Kimberly for total mineral analysis using ICP. Soil samples collected from each site were air dried and analyzed for NaHCO₃ extractable P and K. The results for tissue total nutrients were listed in a report for the 2006 Idaho Nutrient Management Conference Proceedings (Brown, et al., 2006). Correlations among the measured nutrients were obtained from the regression feature of SigmaPlot version 9.0.

RESULTS AND DISCUSSION

Wide ranging soil test P (8-432ppm) and K (101-1587ppm) in manured soils reflect the cumulative effects of historical excessive manure P and K applied. Either soil test P or K might serve as proxies for historical excessive manuring and one might expect them to be correlated, but the relation of soil test K and soil test P (Fig. 1) was relatively poor ($r^2=0.176$). In fact, triticale forage nutrient concentrations other than P were at best weakly correlated to soil test P, with r^2 values ranging from 0.006 to 0.186. The poor correlations for triticale tissue nutrients and soil test P are consistent with those reported for southern Idaho silage corn nutrient concentrations and soil test P in manured soils (Moore et al., 2010). However, Moore et al. reported weak negative correlations of Ca, Mg, Zn, and Mn with soil test P but triticale tissue correlations for these with soil test P, however weak, were consistently positive.

Tissue nutrient concentrations other than P were consistently better correlated to soil test K than soil test P. Significant correlations with soil test K included tissue K ($r^2=0.505$), Mg ($r^2=0.441$), Ca ($r^2=0.302$), P ($r^2=0.334$), Cl ($r^2=0.337$), and Cu ($r^2=0.529$). Correlations with soil test K for Zn ($r^2=0.203$) and Mn ($r^2=0.195$) were poorer.

Triticale forage K and Mg concentrations were previously shown (Brown et al, 2006) to be positively correlated with tissue P concentrations ($r^2=0.498$ for K and $r^2=0.224$ for Mg). The correlations for tissue K and Mg were equally good or better with soil test K; $r^2=0.505$ for K and $r^2=0.411$ for Mg (Fig 2). Tissue K and Mg are of interest particularly in relation to hypomagnesemia or grass tetany, and milk fever. Tissue K% required for maximum forage production is 2.5 – 3.0% and with few exceptions tissue K exceeded 3.0% (Fig. 3). Tissue Mg concentrations higher than .25% are promoted in forages to avoid contributing to hypomagnesemia. Hardly any survey triticale tissues exceeded 0.25% Mg. In addition to the absolute concentrations, the K:Mg ratio has been used for indicating the need to balance rations to avoid hypomagnesemia with a ratio of 23 known to be related to the malady. Most samples

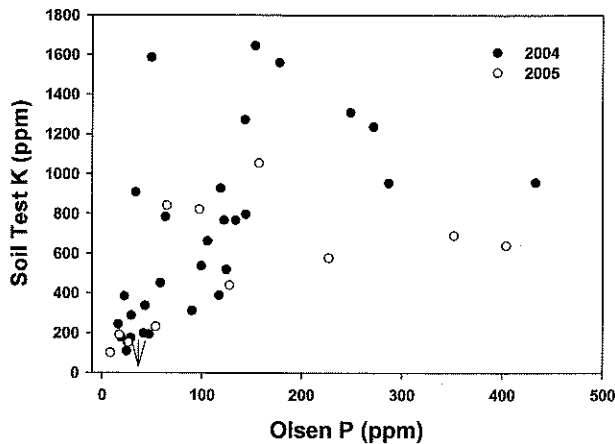


Fig. 1. The relationship of Olsen extractable soil test K and P in soils from manured fields.

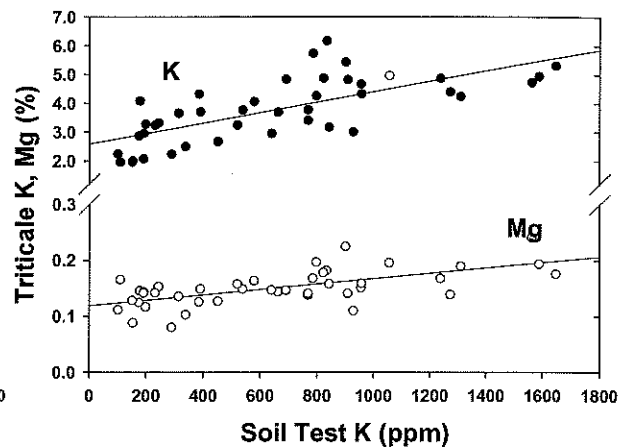


Fig 2. Triticale boot stage forage total K and Mg concentration relation to Olsen extractable K.

had K:Mg ratios exceeding 23. Tissue K and Mg increased with soil test K (Fig 2) over its entire range, but the K:Mg ratio was poorly correlated with soil test K ($r^2=0.128$). However, the K:Mg ratio was correlated ($r^2=0.325$) with tissue K (Fig. 3). Triticale grown in manure K enriched soils present greater risks of contributing to hypomagnesemia.

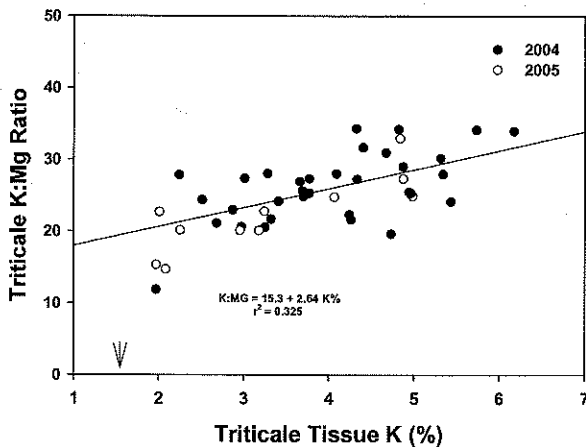


Fig. 3. The triticale K:Mg ratio as affected by tissue K in samples from manured soils.

Calcium and P balance in forage is important for cattle bone structure maintenance. Tissue Ca was weakly correlated with tissue P ($r^2=0.23$), better correlated with soil test K ($r^2=0.302$) and best correlated ($r^2=0.409$) with tissue K (Fig. 4). Tissue Ca:P ratio was negatively correlated ($r^2=0.424$) with tissue P (Fig. 5). If Ca:P ratios of 1.1 are desired then over half the values were less than optimal. If ratios above 2 are desired basically all triticale tissues would contribute to an imbalance of Ca to P.

Triticale Zn, Mn, and Cu concentrations were not significantly correlated with soil test P, and though poor, they were positive. In silage corn Moore et al reported declining tissue Mn with increasing soil test P. Correlations of triticale tissue Zn, Mn, and Cu with tissue P ($r^2=0.291$ for Zn, $r^2=0.175$ for Mn, and $r^2=0.363$ for Cu) were positive and higher than with soil test P but not as high as with tissue K; $r^2=0.482$ for Zn, $r^2=0.251$ for Mn, and $r^2=0.424$ for Cu (Fig 4). Copper forage values of 4ppm are considered deficient and 4-7 marginal for cattle diets. Over half the triticale values were deficient or marginal.

Since excessive available P has reduced plant micronutrient concentrations the P:Zn, P:Mn, and P:Cu ratios were calculated. The P:Zn, and P:Mn ratios were not correlated with tissue

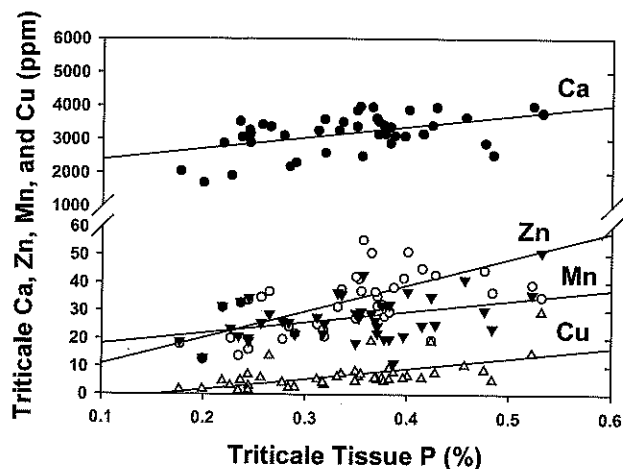


Fig. 4. Triticale forage total Ca, Zn, Mn, and Cu concentrations as related to tissue K.

enriched soils should not result in a S induced Cu deficiency.

Triticale tissue Cl concentrations, obtained only in 2004, were strongly correlated ($r^2=0.845$) with tissue K (Fig. 8) but less well correlated with soil test K ($r^2=0.337$). Tissue Na was not significantly correlated to tissue P and only weakly correlated with tissue K ($r^2=0.18$).

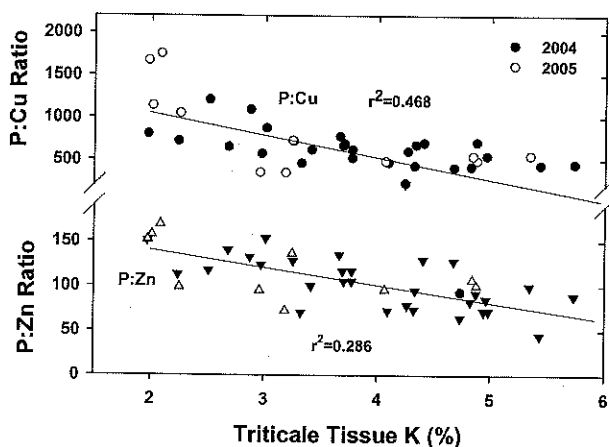


Fig. 6. The relation of P:Zn and P:Cu ratios to triticale forage K concentrations.

P and the correlation for P:Cu was weak ($r^2=0.171$). The correlations of ratios with tissue K were improved; $r^2=0.286$ for P:Zn and $r^2=0.468$ for P:Cu (Fig. 6).

Tissue S was significantly correlated with tissue P ($r^2=0.414$) and tissue K ($r^2=0.525$) but was not significantly correlated with either soil test P or soil test K. Tissue S can be important to Cu nutrition as high S can suppress Cu availability. To avoid low Cu, S below 3500ppm is recommended. Triticale tissue S did not exceed 3000ppm in this survey (Fig 7). The ratio of S to Cu declined with increasing tissue K ($r^2=0.219$) and suggests triticale in

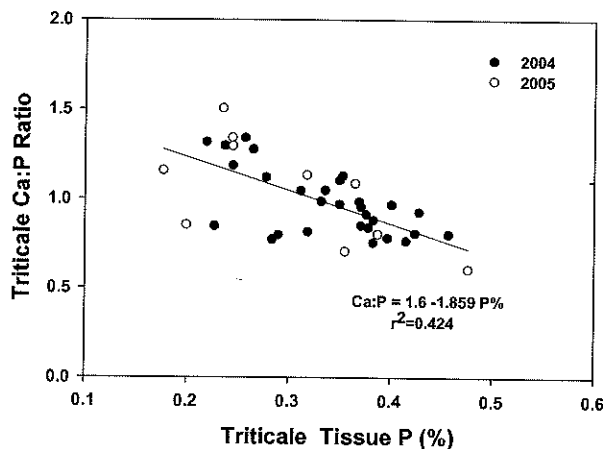


Fig. 5. Triticale forage Ca:P ratio as related to triticale tissue P.

Much of the survey results suggest that the triticale grown would require supplementation to address nutrient imbalances in the forage if fed as the sole feed source. Apparently soils highly enriched with manures can exacerbate nutrient imbalances in forage triticale despite increasing the overall nutrients available. In practice little if any triticale boot stage forage is fed alone to dairy or beef, but rather is fed as part of a mixed forage ration. Most other forages would largely if not fully compensate for the

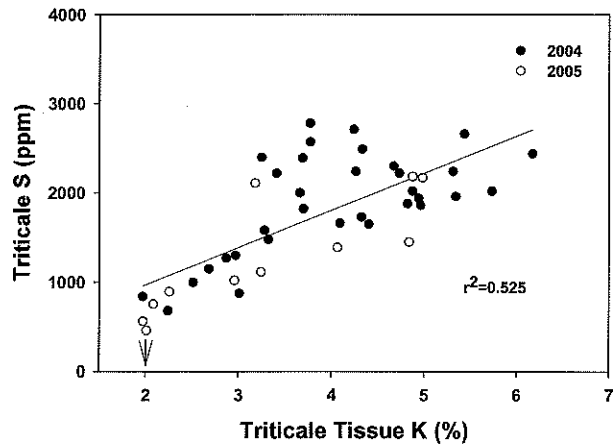


Fig. 7. Triticale forage S relation to triticale K.

imbalances in triticale boot stage forage. The triticale portion of the ration is likely minimal <5% in any case. Also, it is not clear whether the double crop triticale acreage has been maintained since this survey. Increased forage costs and the abiding need for P removal would encourage double cropped triticale but triticale acreage is not tracked.

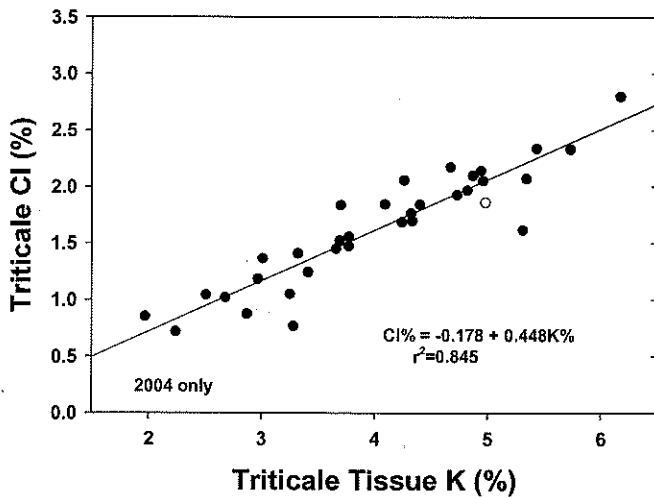


Fig 8. Triticale forage Cl concentration as related to tissue K.

CONCLUSIONS

Boot stage triticale forage in manure enriched soils generally has increased nutrient concentrations. However, ratios among nutrients in the forage suggest greater imbalances between K and Mg, P and Ca, as well as P and the micronutrients Zn and Cu, when boot stage triticale is harvested from manure enriched soils. Fortunately, the boot stage triticale is seldom fed alone, constitutes a small fraction of the ration, and nutrient imbalances are mitigated with other ration components or supplementation.

REFERENCES

- Brown, B., J. Dalton, M. Chahine, B. Hazen, S. Jensen, S. Etter. 2006. Southern Idaho Winter Triticale Forage P in Manured Fields. Idaho Nutrient Management Conference Proceedings, Twin Falls, ID, March 7.
- Moore, A., S. Hines, B. Brown, M. de Haro Marti, C. Falen, M Chahine, T. Fife, R. Norell, and J. Ippolito. 2010. Phosphorus Uptake by Silage Corn in Southern Idaho. Idaho Nutrient Management Conference Proceedings, Shoshone, ID. March 9.