SOIL FERTILITY MANAGEMENT WITH DAIRY COMPOST IN AN ORGANIC, HIGH-ELEVATION ALFALFA SYSTEM

Lauren A. Hunter[1], Christi L. Falen, Cindy, A. Kinder, Amber Moore, and Anita Falen

ABSTRACT

Researchers examine mineralization of nitrogen (N) and plant available phosphorus (P) and potassium (K) from applied dairy compost in a high-elevation, dryland, organic alfalfa system over two growing seasons. Mineralization results for N and plant available P and K reveal similar nutrient value trends under different application rates, 0, 5, and 10 tons/acre of dairy compost. With further analysis of dairy compost mineralization and plant available nutrients, growers will have better information to help match crop nutrient demand to compost nutrient release.

INTRODUCTION

Organic acreage in Idaho has tripled from 1998 to 2008. Additionally, the value of Idaho organic products has grown from $4.1 to $10.6 million. The majority of organic production occurs in south-central Idaho with both Blaine and Camas Counties being major producers of organic alfalfa and malting barley (ISDA, 2009). A limited yield environment, with higher elevations and a shorter growing season (USDA zone 4b-5b), increases the incentive for farmers to grow organically in order to receive higher price premiums. However, these producers evaluating costs and benefits of organic production lack adequate information regarding integration of dairy compost into their cropping system.

Organic nutrient sources such as dairy compost can be an effective soil fertility management tool for providing soil macro- and micro-nutrients, as well as soil organic matter (OM). Increasing OM has numerous additive benefits that help improve overall soil quality and structure (Seyedbagheri, 2010). In organic farming systems, compost can be the primary source of soil nutrients. Soil mineralization, with the help of soil microbes, converts organic nutrient sources into a plant available form (Munoz et al., 2004). The mineralization of nutrients in dairy compost essentially acts as a slow-release fertilizer for organic cropping systems (Seyedbagheri, 2010). The nutrient benefits of dairy compost are not always understood due to variability in compost nutrient composition and the site-specific mineralization rates that help determine when nutrients are made plant available. Different methods used in the composting process can create variability in the source compost composition (Gagnon and Simard, 1999), which therefore might limit grower adoption due to uncertainty in compost nutrient quality and optimal application rates.

More research is needed to understand the process of mineralization of dairy compost to help organic growers match nutrient release to crop nutrient demand (Seyedbagheri, 2010). Although there has been research done on N mineralization in southern Idaho, little to no studies have looked at plant available P and K during the growing season. In general, P contribution from composted manure and plant uptake is less understood (Gagnon and Simard, 1999). In this study, researchers look at rates of soil mineralization of N and plant available P and K from dairy compost applications, 0, 5 and 10 tons/acre. The mineralization study will help determine how nutrients from dairy compost are broken down in this high-elevation growing area where a concentration of organic production occurs.

---

[1]L. Hunter, Univ. of Idaho Blaine County Extension, 302 First Avenue South, Hailey, ID 83333, lhunter@uidaho.edu. Published **In**: Proceedings, Idaho Hay and Forage Conference 1-2 March 2012, Burley, Idaho, UI Extension.

METHODS

On a producer field, dairy compost was fall applied on an organic, dryland alfalfa stand in 2009, 2010, and 2011. The research site near Picabo, ID is considered a high-desert farming system, with a relative elevation of 5,000 ft. Compost was applied at three application rates, 0, 5, and 10 tons/acre, on 50' x 350' randomized plots, replicated four times. Compost was applied with a commercial, calibrated compost spreader truck.

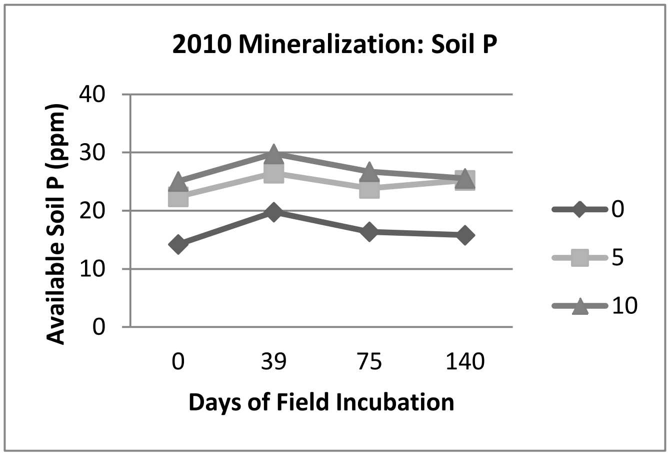
Mineralization of plant available N, P, and K were monitored for the 2010 and 2011 growing season using the buried bag technique outlined by Westermann and Crothers (1980). A total of three mineralization bags were buried in 2010 and four bags were buried in 2011. Mineralization bags were pulled on average every 46 days during the growing season.

Soil analyses included nitrate (NO_3^-), ammonium (NH_4^+; data not shown), and available P and K. The available P and K were measured using the Olsen's extracting solution, 0.5M sodium bicarbonate buffered at pH 8.5 (Olsen and Sommers, 1982). The P and K solutions were analyzed using an inductive coupled plasma (ICP) spectrometer (iCAP 6000) instrument. The Olsen extraction method is useful with calcareous, alkaline or neutral soils. The method of extraction for NO_3^- and NH_4^+ were 2M potassium chloride (KCl) and the analyses performed used an automated flow injection analysis (FIA). The resulting color intensity for both NO_3^- and NH_4^+ were determined by the amount of inorganic N present (Keeney and Nelson, 1982).

RESULTS AND DISCUSSION

In general, plant available P and K had the highest values in the 10 tons/acre for both the 2010 and 2011 growing season. In 2010, plant available soil P had the highest value of 28 ppm at 39 days of decomposition in the 10 tons/acre application rate compared to less than 20 ppm of P in the control. In 2011, the highest value of 26 ppm of plant available P was found at 34 days of decomposition in the 10 tons/acre compared to a very low value of 9 ppm of soil available P in the control (Figure 1). Alfalfa removes large quantities of P from the soil (8-16 lb P_2O_5 removed per ton of hay at 88% dry matter; Koenig et al., 2009).On this particular organic site, any application of dairy compost is ideal to maintain adequate soil P levels. With much of the P from compost already in a mineral and plant available form, the results indicate that the little organic P added as compost is not mineralizing. If organic P was being mineralized, researchers would expect to see an increase in soil P throughout the growing season. The mineral P added from the compost is likely making the initial soil P concentration higher, rather than the conversion of organic P to a mineral P.

Available soil K in 2010 also had the highest value of 169 ppm at the second buried bag interval (day 39) in the 10 tons/acre compared to 119 ppm of plant available K in the control plots (Figure 2). The 2011 soil available K showed a different pattern with the highest value of soil K (194 ppm) found at the beginning of the growing season in the 10 tons/acre replicated plots. The control also had its highest value in the beginning of the season at 81 ppm. A range of 160 to 200 ppm of soil K is ideal for optimal alfalfa growth. Potassium deficiencies are uncommon in Idaho soils but can develop with fields planted with alfalfa for many years (Stark, Brown, & Shewmaker, 2002). Most of the K in compost is already plant available (mineral K), therefore little fluctuation is expected throughout the growing season in terms of soil available K. The differences seen in soil K between 2010 and 2011 might be from variations in compost nutrient content from year to year.



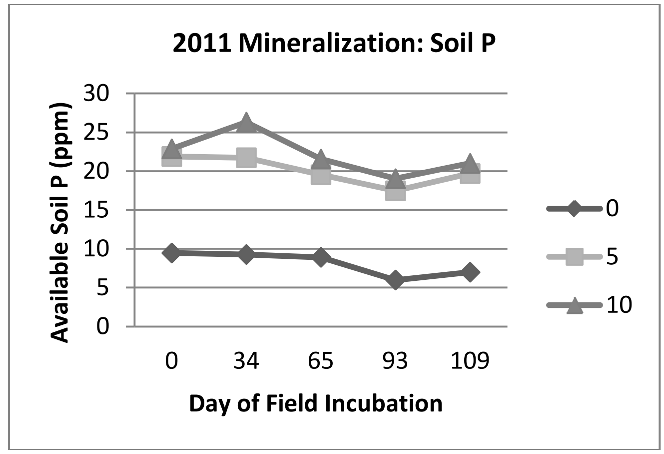
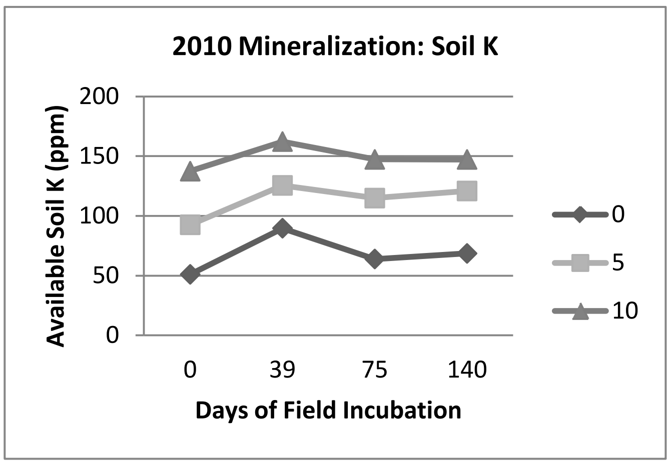


Figure 1. Mineralization of plant available P over the 2010 and 2011 growing season in the replicated 0, 5, and 10 tons/acre compost plots.



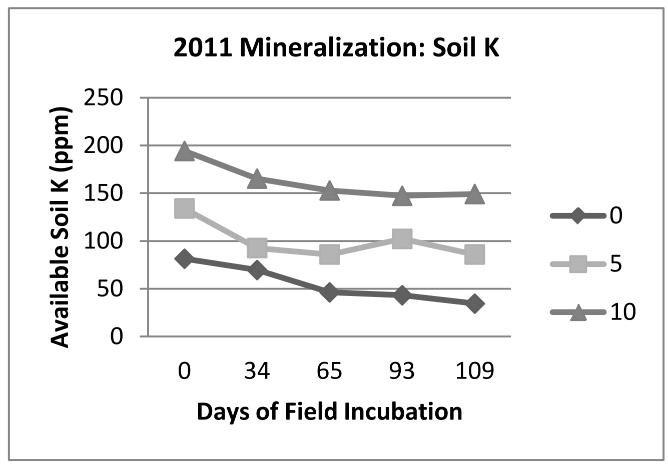


Figure 2. Mineralization of plant available K over the 2010 and 2011 growing season in the replicated 0, 5, and 10 tons/acre compost plots.

Mineralization of soil N increased over the 2010 growing season (around 40 ppm), but there was no significant difference between application rates (Figure 3). With alfalfa being a N-fixing crop, N mineralization is primarily a concern when evaluating soil N levels for crop rotation needs and when seeding a new stand of alfalfa, especially in an organic system (Stark, Brown, & Shewmaker, 2002).

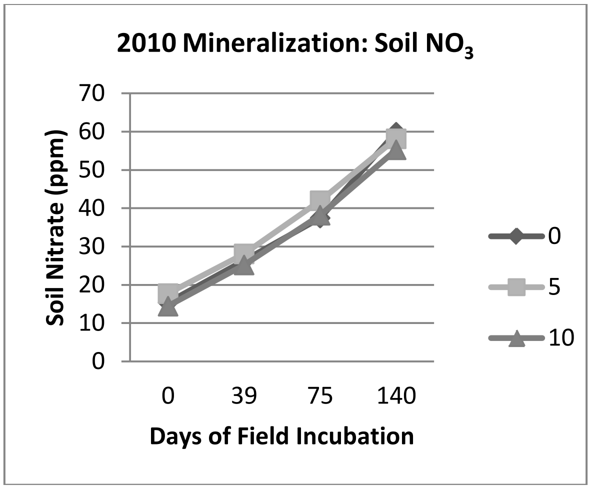


Figure 3. Nitrogen (nitrate) mineralization over the 2010 growing season.

CONCLUSIONS

The preliminary analyses reveal that the 10 tons/acre application rate showed the greatest amount of plant available P and K. A further look at the data will help indicate optimal application rates between the 5 and 10 tons/acre for increasing soil P and K and ultimately helping to build soil residual P and K levels. Differences in available soil P and K between growing years might indicate variation in compost quality. Researchers will continue to take a closer look at mineralization and its relationship with building soil residual nutrients and possible effects of source compost quality from year to year.

Dairy compost and its ability to add soil nutrients and increase OM may offer a sustainable practice to both organic and conventional producers in southern Idaho. With Idaho being the second highest value US producer of alfalfa hay (NASS, 2011), organic producers will need more information on how best to utilize a local organic nutrient source for soil fertility and crop yield management.

ACKNOWLEDGEMENTS

Thanks to Jodi Johnson-Maynard for soil analyses funding and research support as part of a USDA Tri-State Organic Grant.

REFERENCES

Gagnon, B., and R., Simmard. 1999. Nitrogen and Phosphorus Release from On-Farm and Industrial Composts. Canadian Journal of Soil Science. April, 481-489.

ISDA. [Organic Agriculture in Idaho]. Unpublished raw data. 2008.

Keeney, D. R. and D. W. Nelson. 1982. Nitrogen-Organic Forms. *In* Page, Al. L., R. H. Miller, and D. R. Keeney (eds.), Methods of Soil Analysis, Part 2. ASA No. 9, pp 643-693.

Koenig, R.T., D. Horneck, T. Platt, P. Petersen, R. Stevens, S. Fransen, and B. Brown. 2009. Nutrient Management Guide for Dryland and Irrigated Alfalfa in the Inland Northwest. Pacific Northwest Extension Publication. PNW0611.

Munoz, G.R., K.A., Kelling, J.M., Powell, and P.E., Speth. 2004. Comparison of Estimates of First-Year Dairy Manure Nitrogen Availability or Recovery Using Nitrogen-15 and Other Techniques. Journal of Environmental Quality. 33:719-727.

Olsen, S. R., and L. E. Sommers. 1982. Phosphorus Soluble in Sodium Bicarbonate. ***In*** Page, Al. L., R. H. Miller, and D. R. Keeney (eds.), Methods of Soil Analysis, Part 2. ASA No. 9, pp 24-54.

Seyedbagheri, M.M. 2010. Compost: Production, Quality, and Use in Commercial Agriculture. University of Idaho, College of Agricultural and Life Sciences. CIS 1175.

Stark, J., B., Brown, and G., Shewmaker. 2002. Southern Idaho Fertilizer Guide: Irrigated Alfalfa. University of Idaho, College of Agricultural and Life Sciences. CIS 1102.

NASS. 2011. Crop Values 2011 Summary. USDA. [Online] Available at http://www.nass.usda.gov/Publications/Todays_Reports/reports/cpvl0212.pdf. (Verified February 2012).

Westermann, D.T., S.E., Crothers. 1980. Measuring Soil Nitrogen Mineralization Under Field Conditions. Agronomy Journal. 72 (Nov-Dec):1009-1012.