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Effects of meat bone meal as fertilizer on leaf nitrogen status in sugar beet and on soil nitrate concentrations

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Meat and bone meal (MBM) as a by-product from meat industry, is an important source for recycling of N and P. It contains about 8 % N, 5 % P, 1 % K and 10 % Ca. Field experiments were carried out for testing fertilization effect of MBM on yield and quality of sugar beet (2008-2009) and of carrot (2011-2012) in Finland and comparing with mineral fertilizer in conventional farming methods. In these experiments, MBM returned fair yields and generally better quality, in comparison to conventional mineral fertilization (Kivelä et al., 2015). These experiments were also used for studying N availability as nitrate in soil in the carrot experiments, and using SPAD measurements as resulting N status of sugar beet leaves. The SPAD measurements indicated in first experiment year about same N availability of MBM nitrogen as mineral fertilizer with sugar beet. In the second year SPAD measurements indicated lower availability of MBM nitrogen, but difference in the yield amount was about same. In the first year of the carrot experiments nitrate amounts in soil were lower in the beginning of growing season, but at the season end it was corresponding with conventional fertilization. In the other experiment, in year 2011 MBM gave highest nitrate amounts in soil over whole growing season, while at the same time the carrots from the MBM treatments had lowest nitrate concentrations and best storage quality. I conclude that MBM fertilization, while giving comparable yields and improved quality, produces a differing pattern of nitrate availability in soil, and a differing pattern of nitrogen status in the plant, in comparison to conventional mineral fertilizers.

Keywords: meat bone meal, organic fertlizer, nutrient content, recycling, sugar beet, carrot

1 Introduction

Meat and bone meal (MBM) is a by-product of the rendering industry.MBM contains about 8 % Nitrogen (N), 5 % Phosphorus (P), 1 % Potassium (K) and 10 % Calcium (Ca) (Ylivainio and Turtola, 2007), which makes it a valuable source of nutrients for plant production. Rock phosphate resources are limited and recycling P within the food system is extremely important for sustainable production (Cordell et al., 2011). A high P content makes MBM an important source for P recycling. In Finland for example, ca. 40 kg of animal by-products per capita (in total at least 200 million kg) are generated annually (Salminen 2002). The use of MBM as fertilizer has been tested on many cereals and other field crops, like oats and ryegrass (Jeng et al. 2004, 2006), barley and oats (Chen et al. 2011) and maize (Nogalska et al. 2012). In these studies MBM gave similar grain yields and grain protein content as those for corresponding cereals that had been treated by inorganic fertilizers. The relative N efficiency of total N in MBM compared to N from mineral fertilzers equalled about 80 % for oats and ryegrass (Jeng et al., 2004). Kivelä et al. (2015) reported equal (above 80 %) relative N efficiencies for sugar beet and for carrot. As the N in MBM is in organic form, the relative N efficiencies are fairly high. More detailed information about the N fertilization pattern of MBM is needed. Chlorophyll concentrations can be used as a proxy for nutriet supply patterns, escpecially for leaf N status (Tsialtas and Maslaris, 2012). In sugar beets, SPAD was proved a good, indirect assessment of leaf chlorophyll concentration and crop N availability.

The aim of this study was to reveal, using leaf chlorophyll concentration as indicator, possible differences between mineral and MBM fertilizaiton in leaf N status.

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Another aim was to compare soil nitrate concentration patterns between conventional and MBM fertilization.

2 Material and Methods

2.1 Material

MBM was tested as fertilizer for sugar beet in field experiments over two growing seasons by SjT (Sugar Beet Research Centre Finland) at Tuorla research farm in Piikkiö in Southwest Finland. The preceding crop for both experiments was spring wheat.The soil type in the 2008 trial was clay loam with organic matter 3.0-5.9 %, pH and acid ammonium acetate extractable -P levels were good, but K, Mg and Na were relatively low. The soil type in the 2009 trial was sandy clay with organic matter 6.0-11.9 %. P and K contents were on the margin of acceptability, Na was rather low, but Mg was good and Ca was high.

The varieties of sugar beet grown were 'Jesper' in 2008 and 'Lincoln' in 2009. The MBM fertilizer NPK analysis in 2008 for Viljo Yleislannoite™ MBM was 8-4-3 and in year 2009 Perus-Viljo 8-5-1. Three inorganic fertilizers were used for comparisons: Pellon Hiven Y2™ 18-3-6 (HY2), Hiven Y1™ 23-3-6 (HY1) and Nurmen NK1™ 20-0-7 (NK1), all from Yara Ltd. Any low potassium fertilizer levels was supplemented using potassium sulphate (K_2SO_4) by K+S Kali Ltd. The experinmental design was conducted by SjT personality.

With carrot two field trials were conducted, in 2010 and in 2011. Carrot varieties that were suitable for mechanised processing and handling were grown on a commercial farm in Teuva, in the province of Southern Ostrobothnia in Finland. The soil was fine sandy till in the 2010 trial, with temperate organic matter and soil pH was at an optimum level. In the 2011 experiment the soil was sandy loam, with high organic matter and acceptable pH. Other nutrients were on acceptable level.

In both trials, conventional inorganic fertilizers were compared with MBM (Aito-Viljo™, 8-5-1) supplemented with KSMg (Patentkali, K 25 %, Mg 6 %, S 17 %).In the 2010 carrot trial MBM was applied at 80 kg N ha^{-1} rate. The conventional fertilization rate used is 48 kg N ha^{-1}, thus supplements of 32 kg N ha^{-1} N was given to make up the experimental application rate of 80 kg N ha^{-1} rate.The N-fertilization rate in the 2011 trial was set at 60 kg N ha^{-1} in all the treatments This application rate was reduced from the 80 kg ha^{-1} rate used in 2010 because of the higher soil organic matter content in the field parcel used in the 2011 trial.

2.2 Methods

In sugar beet research the amount of chlorophyl was measured by SPAD 502-test equipment. SPAD measurements were conducted two times during growing season, by taking ten samples of every plot and counting an average amount from these measurements.

In the carrot experiment, nitrate amount in soil was measured by soil test kit (Typpisalkku 2, Yara Finland Oy). Three samples were taken from every plot for analysis.

3 Results

Chlorophyll measurements of sugar beet and quality effects

In 2008, MBM gave about same values in SPAD measurements in July and August as mineral fertilizers. Though in sugar beet root quality can be noticed that MBM gave the lowest amino N, free potassium and a quite low Na amount, which indicate a good quality. Extractability was highest with MBM. In 2009 MBM gave lowest numbers in SPAD measurements, yield amount being about 86 % of that achieved with mineral fetilizers.

Nitrate amounts in soil in carrot experiment

Nitrate appearance in soil was different with organic MBM fertlizer than with mineral fertlizers. From the organic MBM, nitrogen became generously available (as nitrate) in the middle of the growing season, and then immobilized towards the end of the season. The pattern of nitrate concentrations in soil generated by the split-applications was a more steady decline from the high levels early in the season to lower levels towards the end of the season. In 2011 in sandy loam, with high organic matter measured nitrate amounts in soil were whole summer higher than with mineral fertilizers. With MBM fertilization carrot yield nitrate was much lower (74 mg kg^{-1}) than with mineral fertilization (225 mg kg^{-1}) (Kivelä et al., 2015).

4 Conclusions

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References

CHEN, L. et al. (2011) Meat bone meal as fertiliser for barley and oat. In *Agricultural and Food Science*, vol. 20, no. 3, pp. 235-244.

CORDELL, D. (2010) The Story of Phosphorus. Sustainability implications of globla phosphorus scarity for food security. In *Linköping Studies in Arts and Science*, no. 509.

JENG, A. et al. (2004) Meat and bone meal as nitrogen fertiliser to cereals in Norway. In *Agricultural and Food Science*, vol. 13, pp. 268-275.

JENG, A.S. et al. (2006) Meat and bone meal as nitrogen and phosphorus fertiliser to cereals and rye grass. In *Nutrient Cycling in Agroecosystems*, vol. 76, pp. 183-191.

KIVELÄ, J. et al. (2015) Effects of meat bone meal as fertilizer on yield and quality of sugar beet and carrot. In *Agricultural and Food Science*, vol. 24. In press.

SALMINEN, E. (2002) Finnish expert report on best available techniques in slaughterhouses and installations for the disposal or recycling of animal carcasses and animal waste. In *The Finnish Environment*, vol. 539, p. 42

TSIALTA, J.T. and N. MASLARIS, N. (2012) Tracing nitrogen in soil-root-petiole-leaf continuum in sugar beets: can SPAD-502 help? In *Journal of Plant Nutrition*, vol. 35, pp. 556-566.

YLIVAINIO, K., UUSITALO, R. and TURTOLA, E. (2007) Meat bone meal and fox manure as P sources for ryegrass (*Lolium multiflorum*) grown on a limed soil. In *Nutrient Cycling in Agroecosystems, vol.* 81, pp. 267-278.