SOIL PHOSPHORUS DYNAMICS AS AFFECTED BY A GREEN MANURE CROP GROWN WITH PHOSPHATE ROCKS

Interim Research Report E2006-13

INTRODUCTION

Organically managed soils have been found to become deficient in plant-available phosphorus (P) over time (Entz et al. 2001). P fertilization on organic farms depends primarily on the on-farm recycling of organic materials such as compost, green manures, mulches and farmyard manures with minimal inputs. To avoid eventual nutrient deficiencies P must enter the system at the same rates as it is removed. Phosphate rock (PR) application may be an option to correct any P deficiencies on organic farms. High pH soils, as are found in Ontario, greatly reduce P release from PRs, however. Planting a green manure crop, such as buckwheat, may increase plant-available soil P for subsequent crops. Buckwheat (*Fagopyrum esculentum*) has an enhanced ability to take up P from PR compared to other plants through root exudation of protons. Preliminary research showed that yield and tissue P% of buckwheat was increased when grown with some types of PR and P fertilizer.

The goal of this study is to determine if a green manure crop can improve the effectiveness of phosphate rock. The objectives are to determine if the straw from buckwheat grown with phosphate rocks can enhance soil P flux and soil test P in the spring following initial PR and mulch application; and to determine if the quality (tissue P %) of the buckwheat straw affects soil P flux in the mulched plots.

WHAT WAS DONE

Phosphorus dynamics were examined in soils at an organic and a conventional dairy farm that had been amended in the previous year with buckwheat straw. The buckwheat had been fertilized with various sources and rates of PR in June 2004.

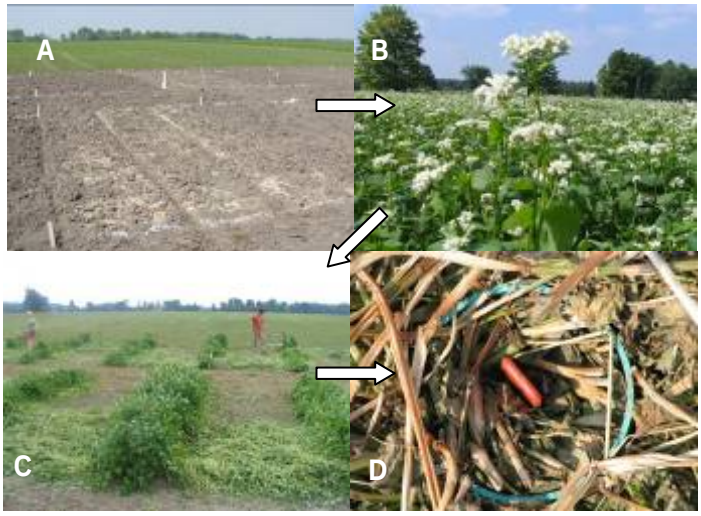
Treatments included:

- Control: no P added
- C400: Calphos PR at 400 kg P ha^{-1}
- C800: Calphos PR at 800 kg P ha^{-1}
- V800: Volcanaphos PR at 800 kg P ha^{-1}
- T800: TSP fertilizer at 800 kg P ha^{-1} (conventional site only)

As shown in the photos below, buckwheat was seeded on all plots after PR application and harvested after seven weeks of growth in August 2004. Immediately following harvest, the buckwheat straw (2.73 to 3.04 t DM ha^{-1}) was returned to half of each plot from which it originated, resulting in a split plot design with PR as the main plot and straw mulch as the subplot.

The flux of soil P in the buckwheat mulched and unmulched plots was determined using anion exchange membranes encased in plastic, called Plant Root Simulator™ probes (Western Ag Innovations, Saskatoon, SK). The PRS™-probes act as a rudimentary plant root and can measure the flux of P ions per unit area per time. Three probes were installed per subplot, and exchanged every two weeks for eight weeks in total from April to June 2005. Soil P flux was assessed for all treatments at the organic site, and for the control and T800 treatment at the conventional site.

Soil samples (0-15 cm) were taken on all mulched and unmulched plots on all three sites for Olsen ($NaHCO_3$-extractable) P analysis in April 2005.



Graphical schematic of the project methods: (A) amendments are applied, (B) buckwheat is planted, (C) buckwheat mulch is applied, and (D) soil P is measured

PRELIMINARY RESULTS

The P applied as mulch, which ranged from 12.16 to 36.01 kg P ha^{-1}, was 4, 49, 83, and 184 % greater than the control, for main plots which had received V800, C400, C800, T800, respectively (Figure 1). Olsen P (Figure 2) and cumulative P flux (Figure 3) were similarly affected by PR, with C400 and C800 significantly increasing Olsen P and C800 increasing P flux in the year following PR application. Decomposition of buckwheat straw increased soil P, as shown in Figure 2 and 3.

Soils fertilized with TSP supplied 746 % more P to the soil solution as determined by PRS^{TM}-probes than C800 (data not shown). Buckwheat tissue P (%) explained 74 % of the variation in cumulative soil P flux. P flux was greatest for soils amended with C800, which corresponded to tissue P values of buckwheat straw greater than 0.30 % (data not shown).

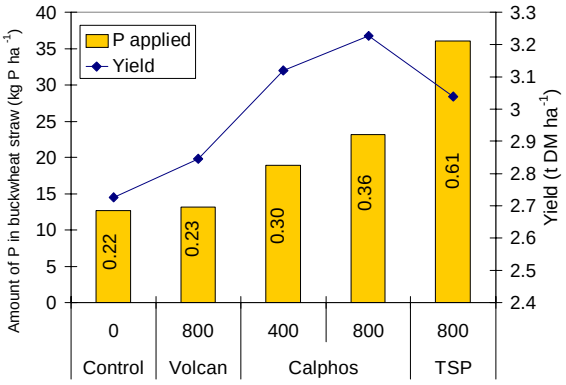


Figure 1. Effect of PR on buckwheat yield and amount of P applied to the soil in the buckwheat straw (tissue %P values written on bars)

THE BOTTOM LINE...

Although the use of PR and buckwheat mulch treatments significantly affected soil P flux and Olsen P, the low P values are unlikely to provide agronomic benefits. The P released from the residual PR and mineralized buckwheat straw may be quickly adsorbed to soil due to high Ca and pH. Further research will determine the effects of the buckwheat straw and PR on a subsequent crop.

CREDITS

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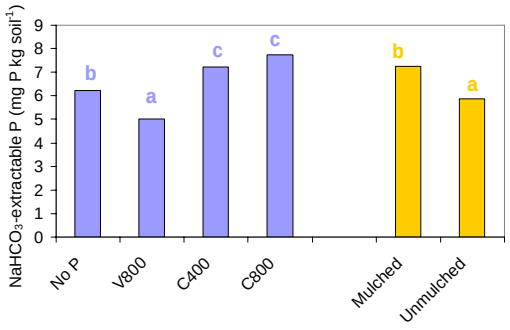

Figure 2. Effect of amendment addition on Olsen P for PR (on R) and mulch treatments (on L) on the organic farm, spring 2005. Means within a treatment with the same letter are not significantly different (P<0.05, Fisher's LSD)

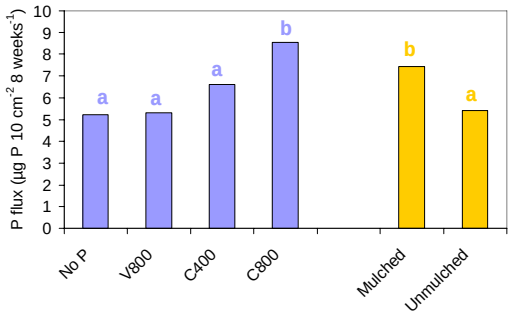

Figure 3. Effect of amendment addition on cumulative 8-wk soil P flux for PR (on R) and mulch treatments (on L) on the organic farm, spring 2005. Means within a treatment with the same letter are not significantly different (P<0.05, Fisher's LSD)

REFERENCES

Entz, M.H., Guilford, R. and Gulden, R. 2001. Crop yield and soil nutrient status on 14 organic farms in the eastern portion of the Northern Great Plains. Canadian Journal of Plant Science 81(2):351-354.

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