Potential of Rock Phosphate and Other Organic/Inorganic Amendments in Preventing P Deficiency in Barley on a P-Deficient Soil in Northeastern Saskatchewan

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Background

- In organic farming, synthetic inorganic fertilizers/chemicals are not applied to increase crop production, but adequate amounts of nutrients are essential for high sustainable production from agricultural crops.

- Any nutrient (s) limiting in soil can cause substantial reduction in crop yield. In the Prairie Provinces, most soils are deficient in plant-available N for optimum yield, many are low in available P, and some contain insufficient amounts of available S (mostly in the Parkland region) and K for high crop yields.

- On organic farms, deficiency of N can be prevented/minimized by growing/green manure N-fixing legume crops in the rotations, and deficiency of S by applying gypsum.

- However, if soils are deficient in available P, the only alternative is to use external sources to prevent P deficiency. Manure can provide this nutrient, but usually there is not enough manure to apply on all farm fields, and also may be uneconomical to use manure, particularly in remote areas, because of the cost of transporting manure long distances.

- On such soils, rock phosphate fertilizer, wood ash, bone meal ash and*Penicilliumbilaiae* may be used to correct P deficiency in crops, but the information on the potential of these products (especially rock P) in preventing P deficiency is lacking under prairie soil-climatic conditions.

Objective

The objective of this study was to determine the potential of rock phosphate and other organic/inorganic amendments on the availability of P in preventing P deficiency and increasing seed yield, straw yield, total P uptake and total N uptake of barley on a P-deficient soil.

Materials and Methods

- Field experiment was established in spring 2012 on a P-deficient soil at Kelvington, Saskatchewan, Canada.

- Black Chernozem (thin), loam, 3.4 kg P ha^{-1} in 0-30 cm soil.
- Crop – barley-barley-barley.
- Conventional weed control (recommended herbicides).
- N (34-0-0) broadcast and incorporated.
- P (0-45-0 and Rock Granular) side-banded at seeding.

- Blanket application (broadcast/incorporated) of K and S (potassium sulphate) to all plots.

***Treatments*:**

1. **Control** **$_{\text{(no fertilizer/amendment)}}$** **0 kg N ha^{-1} + 0 kg P ha^{-1}**
2. **$N_{(34\text{-}0\text{-}0)}$ Only** **100 kg N ha^{-1}**
3. **$P_{(0\text{-}45\text{-}0)}$ Only** **20 kg P ha^{-1}**
4. **$N_{(34\text{-}0\text{-}0)}$ + $P_{(0\text{-}45\text{-}0)}$** **100 kg N ha^{-1} + 20 kg P ha^{-1}**
5. ***Penicillium bilaiae* +** **100 kg N ha^{-1}**
6. **Rock phosphate granular $_{\text{(BC Mines)}}$** **20 kg P ha^{-1} + 100 kg N ha^{-1}**
7. **Rock phosphate granular $_{\text{(BC Mines)}}$** **20 kg P ha^{-1} + *Penicilliumbilaiae*+ 100 kg N ha^{-1}**
8. **Rock phosphate fine $_{\text{(BC Mines)}}$ 20 kg P ha^{-1} + 100 kg N ha^{-1}**
9. **Rock phosphate fine $_{\text{(BC Mines)}}$ 20 kg P ha^{-1} + *Penicilliumbilaiae*+ 100 kg N ha^{-1}**
10. **Wood ash $_{\text{(Fly Ash)}}$ @ 2 Mg ha^{-1}**
11. **Wood ash $_{\text{(Fly Ash)}}$ @ 2 Mg ha^{-1} + 100 kg N ha^{-1}**
12. **Wood ash $_{\text{(Fly Ash)}}$ @ 2 Mg ha^{-1} + 100 kg N ha^{-1} + 20 kg P ha^{-1}**
13. **Alfalfa pellets** **@ 3.5 Mg ha^{-1}**
14. **Compost** **@ 8 Mg ha^{-1}**
15. **Thin stillage** **@ 20,000 L ha^{-1}**
16. **Distiller grain dry wheat** **@ 2 Mg ha^{-1}**
17. **MykePro @ 10 kg ha^{-1}**
18. **MykePro @ 10 kg ha^{-1} + 100 kg N ha^{-1}**
19. **Bone meal ash** **@ 154 kg ha^{-1}**
20. **Bone meal ash** **@ 154 kg ha^{-1} + 100 kg N ha^{-1}**

Summary of Results

- Compared to unfertilized control, N only treatment did not increase seed yield, and application of P alone increased seed yield significantly in 2012 and 2013 but it was much less than when both N and P fertilizers were applied together (Figures 1 and 2).

- Rock phosphate did not produce any seed yield benefit, even when it was applied along with N fertilizer.

- Wood ash fine alone tended to increase seed yield, and increased seed yield significantly in the presence of N fertilizer but the highest seed yield was obtained when it was applied along with N + P fertilizers.

- Thus, suggesting not enough supply of available P from wood ash for optimum seed yield.

- Seed yield increased slightly/moderately with alfalfa pellets, moderately/significantly with compost, considerably with distiller dry grain of wheat (DDG-wheat), and the highest seed yield with thin stillage which was similar to or slightly more than N + P fertilizer combination.

- There was no seed yield benefit from MykePro alone or bone meal ash alone applications. Application of N to MykePro or bone meal treatments increased seed yield only slightly, suggesting lack of available P for optimum seed yield.

- Trends of total N uptake and total P uptake in seed (Figures 3 and 4) and seed + straw (Figures 5 and 6), and straw yield (data not shown) were generally similar to seed yield.

Conclusions

- Compared to N alone, there was a substantial increase in seed yield of barley with triple superphosphate (TSP) when applied along with N fertilizer on this P-deficient soil.

- However, rock phosphate did not produce any seed yield benefit, and there was only slight seed yield increase from MykePro or bone meal ash, even when these amendments were applied along with N fertilizer.

- In treatments where amendments were applied alone without any chemical fertilizers, thin stillage provided balanced nutrition and produced maximum seed yield among all organic and inorganic amendments, which was closely followed by DDG-wheat, with some benefit from compost.

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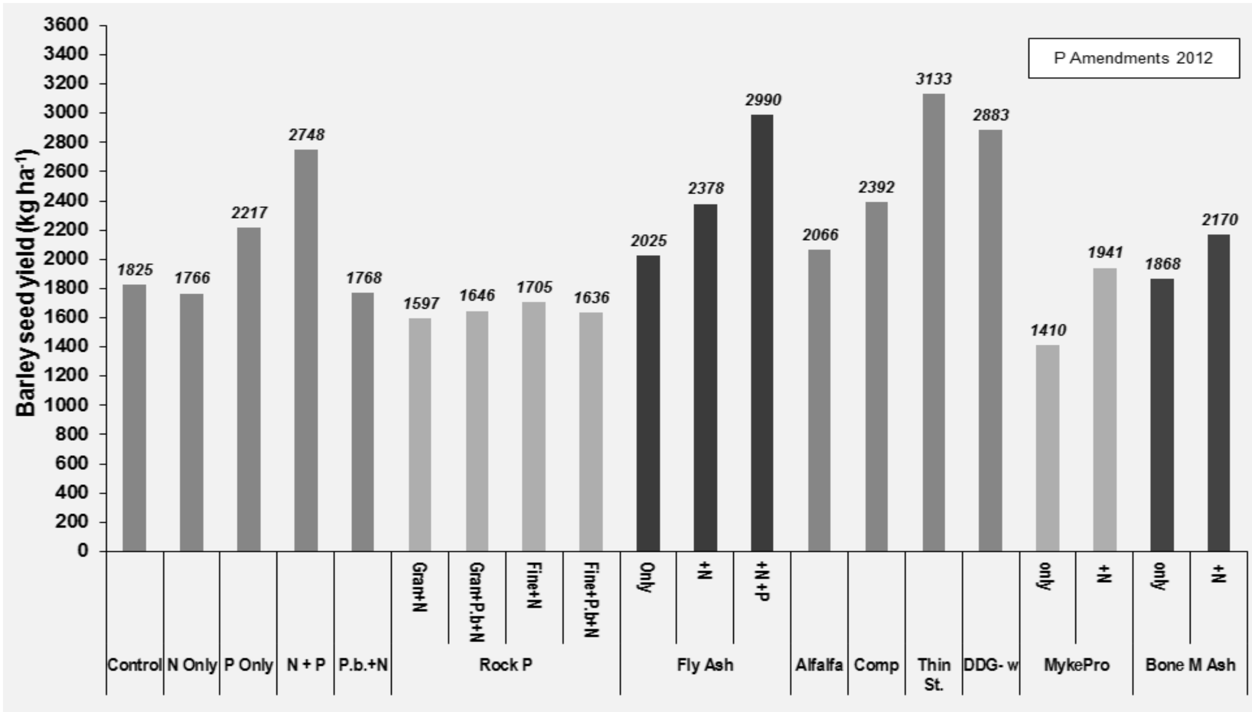

Figure 1. Seed yield of barley with various amendments applied annually in 2012 at Kelvington, Saskatchewan (LSD = 297).

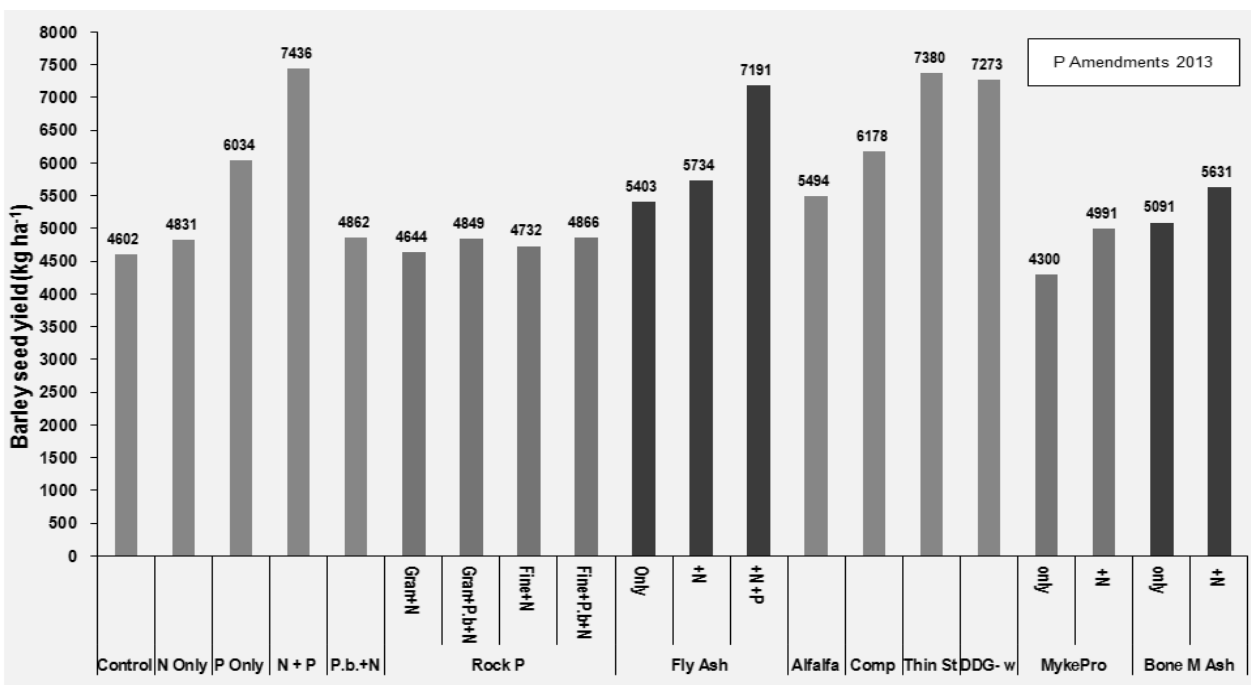

Figure 2. Seed yield of barley with various amendments applied annually in 2013 at Kelvington, Saskatchewan (LSD = 691).

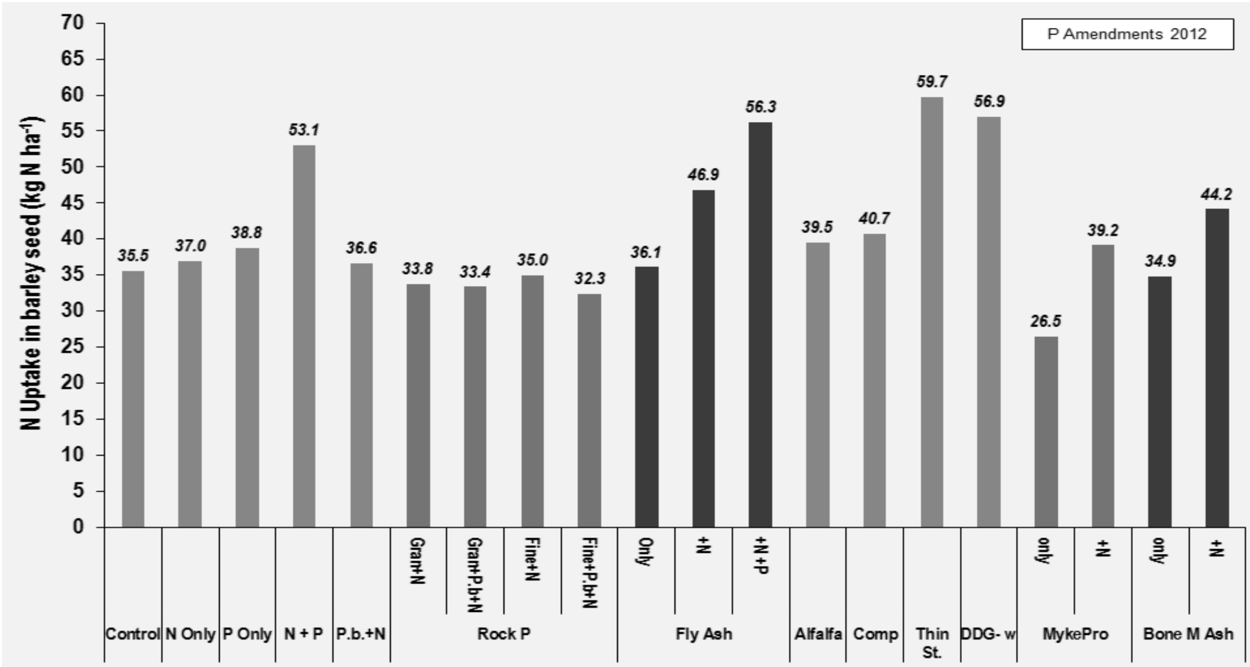

Figure 3. Uptake of N in barley seed with various amendments applied annually in 2012 at Kelvington, Saskatchewan (LSD = 6.4).

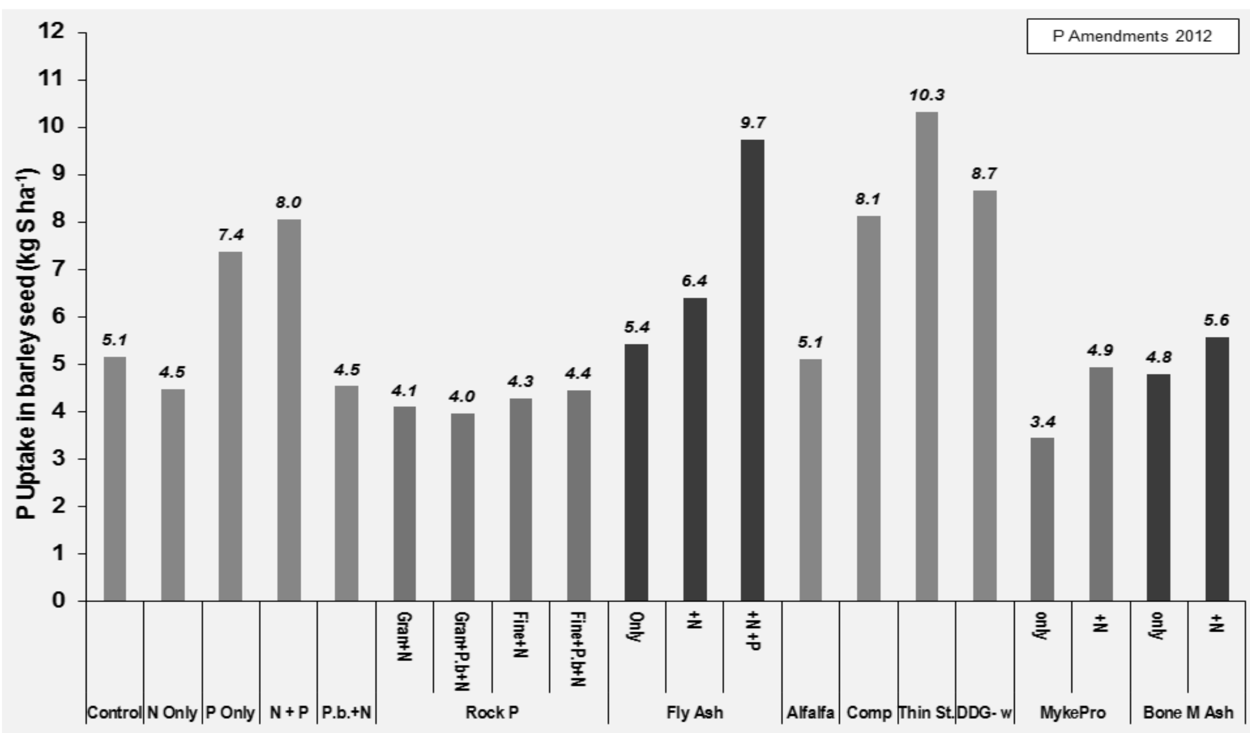

Figure 4. Uptake of P in barley seed with various amendments applied annually in 2012 at Kelvington, Saskatchewan (LSD = 1.2).

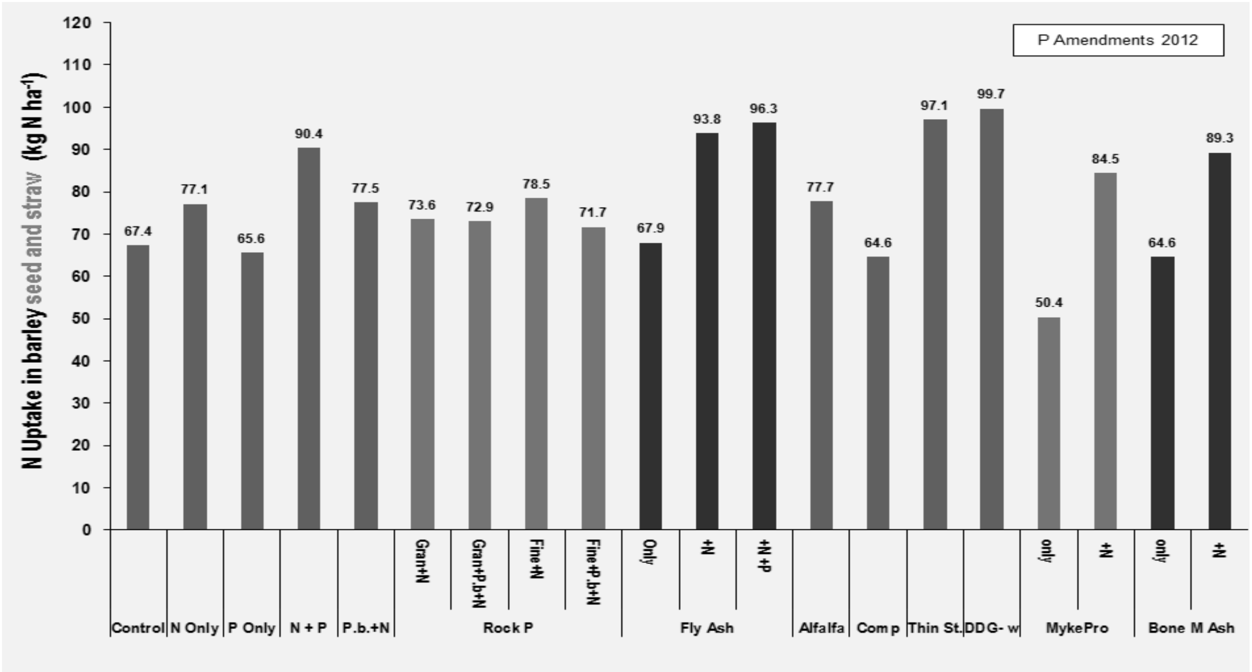

Figure 5. Uptake of N in barley seed + straw with various amendments applied annually in 2012 at Kelvington, Saskatchewan (LSD = 14.4).

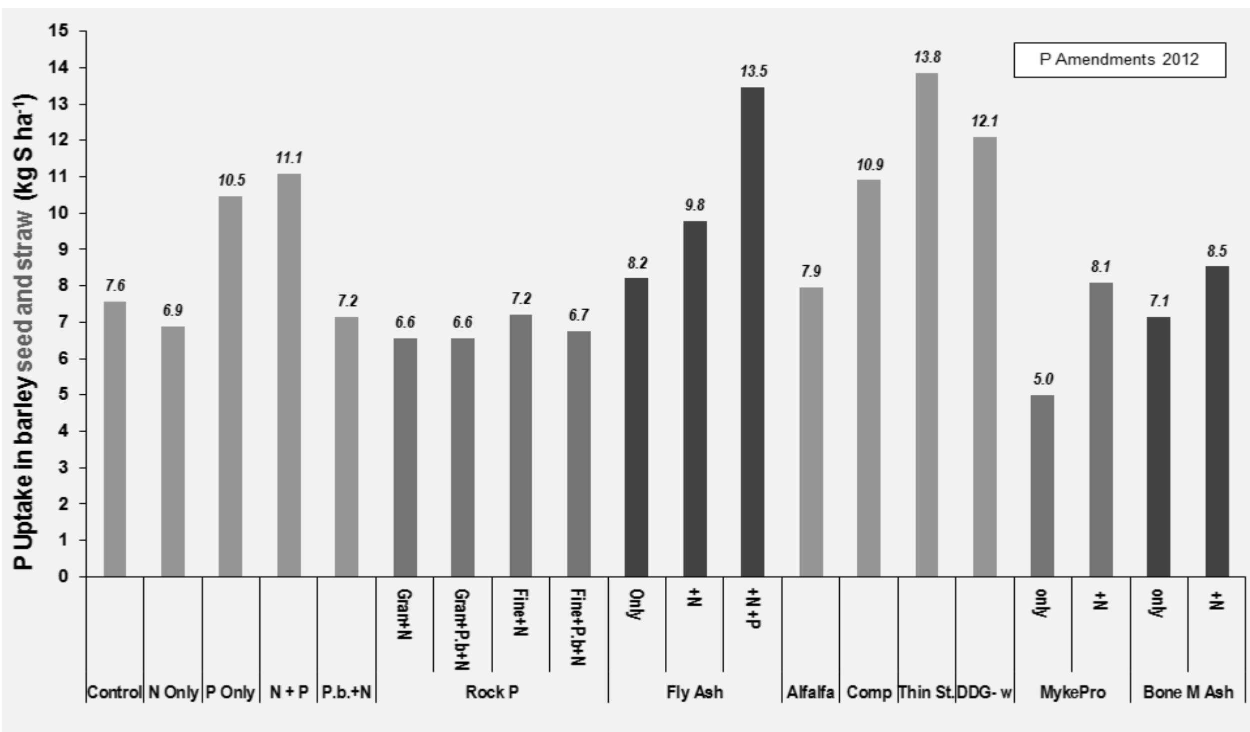

Figure 6. Uptake of P in barley seed + straw with various amendments applied annually in 2012 at Kelvington, Saskatchewan (LSD = 1.9).