Feasibility of rock phosphate and other amendments in preventing P deficiency in barley on a P-deficient soil in northeastern Saskatchewan

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Rationale

- In the Canadian Prairies, most soils on organic farms are deficient in available N, many soils are low in available P, and some soils contain insufficient amounts of sulphate-S (mostly in the Parkland region) for optimum crop yields.
- On organic farms, the deficiency of N in soil/crop can be prevented by growing N-fixing legume crops in the rotations, and deficiency of S by applying gypsum.
- Previous research in Saskatchewan has indicated that long-term production of crops without adding adequate P can decrease available P in soil under organic system.
- Therefore, maintaining adequate levels of available P in soil to prevent P deficiency in crops can be a serious problem for organic agriculture in the Canadian Prairies.
- If soils are deficient in available P, the only alternative is to use external sources to prevent P deficiency in crops.
- Research information on the potential of these products, particularly rock phosphate, in preventing P deficiency in crops grown on P-deficient soils is lacking under prairie soil-climatic conditions and in other parts of Canada.

Objective

- The objective of this study was to determine the potential of various organic and inorganic amendments, and microbial inoculants/products in preventing P deficiency in barley on a P-deficient soil in northeastern Saskatchewan.

Materials & Methods

- 3-year field experiment was established in spring 2012 on a thin Black Chernozem (TypicCryoboroll) loam soil near Kelvington, Saskatchewan, Canada.
- In this study, a randomized complete block design was used to lay out the treatments in four replications.

The 20 treatments were:

1. Control (no fertilizer/amendment) 0 kg N ha^{-1} + 0 kg P ha^{-1}
2. N (34-0-0) only 100 kg N ha^{-1}

3. P (0-45-0) only @ 20 kg P ha^{-1}
4. N (34-0-0) + P (0-45-0) 100 kg N ha^{-1} + 20 kg P ha^{-1},
5. Penicilliumbilaiae @ 60 mg kg^{-1} of seed + 100 kg N ha^{-1}
6. Rock P Granular$_{(BC\ Mines)}$ @ 20 kg P ha^{-1} +100 kg N ha^{-1}
7. Rock P Granular$_{(BC\ Mines)}$ @ 20kg P ha^{-1}+Penicillium bilaiae+100 kg N ha^{-1}
8. Rock P Fine$_{(BC\ Mines)}$ @ 20 kg P ha^{-1} + 100 kg N ha^{-1}
9. Rock P Fine$_{(BC\ Mines)}$ @ 20 kg P ha^{-1} + Penicilliumbilaiae +100 kg N ha^{-1}
10. Wood ash (Fly Ash) @ 2 Mg ha^{-1}
11. Wood ash (Fly Ash) @ 2 Mg ha^{-1} + 100 kg N ha^{-1}
12. Wood ash (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
18. MykePro + 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}

- Alfalfa forage yield increased dramatically with P fertilizer application in 2011, suggesting that soil at this site was extremely lacking in available P.
- All plots received blanket application (surface broadcast) of K_2SO_4, to supply 50 kg K and 20 kg S ha^{-1}.
- Plots were seeded to barley with a double-disc press drill with 17.8 cm row spacing.
- All plots were tilled to incorporate surface-broadcast blanket K_2SO_4 fertilizer and amendments into the soil prior to seeding.
- In 2012 data were recorded on seed and straw yield, concentration and uptake of total P and total N in seed and straw. In 2013 and 2014 just seed yield was recorded.

Summary of Results (Figures 1, 2, 3, 4 and 5)

- In all 3 years, compared to unfertilized control, N only treatment did not result any significant increase in seed yield of barley, while application of P alone increased seed yield significantly but it was much less than when both N and P fertilizers were applied together. This suggested that soil was very deficient in available P.
- Rock phosphate (both granular and finely-ground) and/or *Penicilliumbilaiae*did not result in any seed yield benefit, even when applied along with N fertilizer.
- Wood ash fine increased seed yield of barley significantly only in the presence of N fertilizer, with the highest seed yield in the presence of both N + P fertilizers.
- Seed yield of barley increased moderately with alfalfa pellets, significantly with compost manure, and considerably with distiller grain of dry wheat, but highest seed yield was obtained from thin stillage, which was essentially similar to that obtained from N + P fertilizer combination.
- There was no seed yield benefit from JumpStart or MykePro in any year and only slight increase in seed yield from bone meal ash in 2013.
- The addition of N fertilizer to MykePro or bone meal ash treatments increased seed yield, but highest yields were obtained when both N + P fertilizers were added, suggesting lack of available P supply from these amendments for optimum seed yield.
- With few exceptions, the response trends of total N and total P uptake in seed + straw to the amendments studied were generally similar to those of seed yield.

Conclusions

- Thin stillage provided balanced nutrition and produced seed yield and nutrient uptake of barley similar to balanced N + P fertilizer treatment, and it was closely followed by DGD-wheat, with moderate benefit from compost manure and some benefit from alfalfa pellets.
- In this extremely P-deficient soil, rock phosphate was not found effective in preventing P deficiency in barley, while wood ash and bone meal ash provided moderate increase in yield, with little yield benefit from JumpStart and MykePro, when other nutrients were not limiting in the soil.

Acknowledgements

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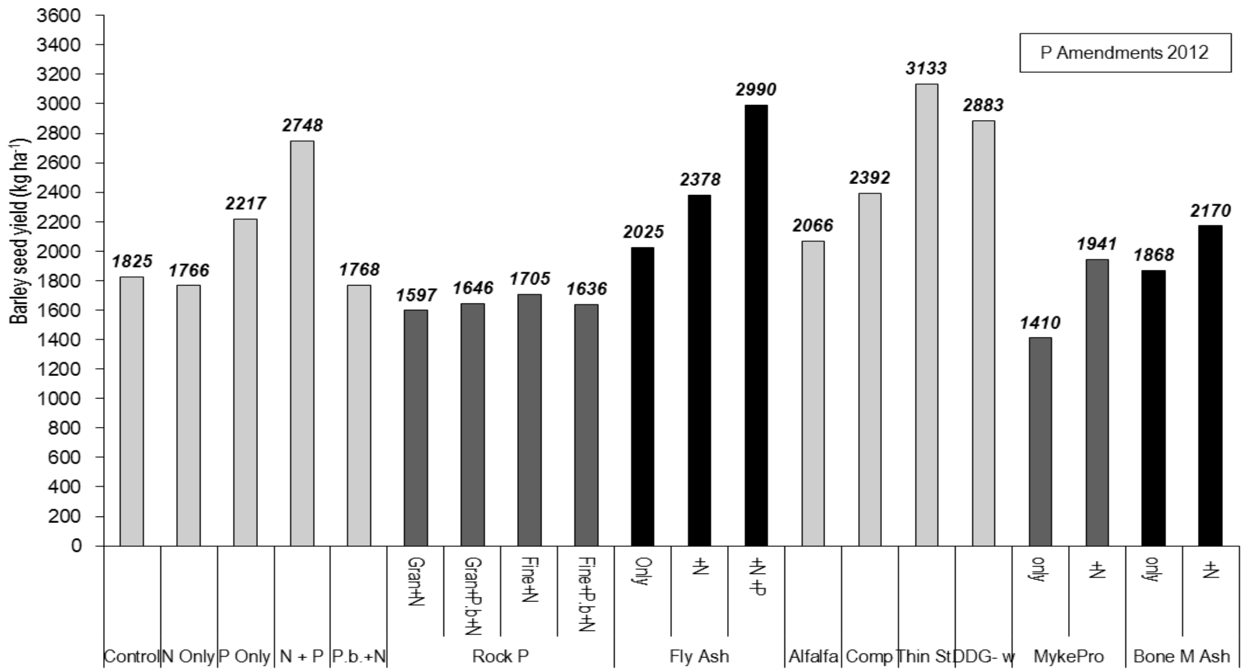

Figure 1. Seed yield of barley with various amendments applied annually in 2012 on a P-deficient soil at Kelvington, Saskatchewan.

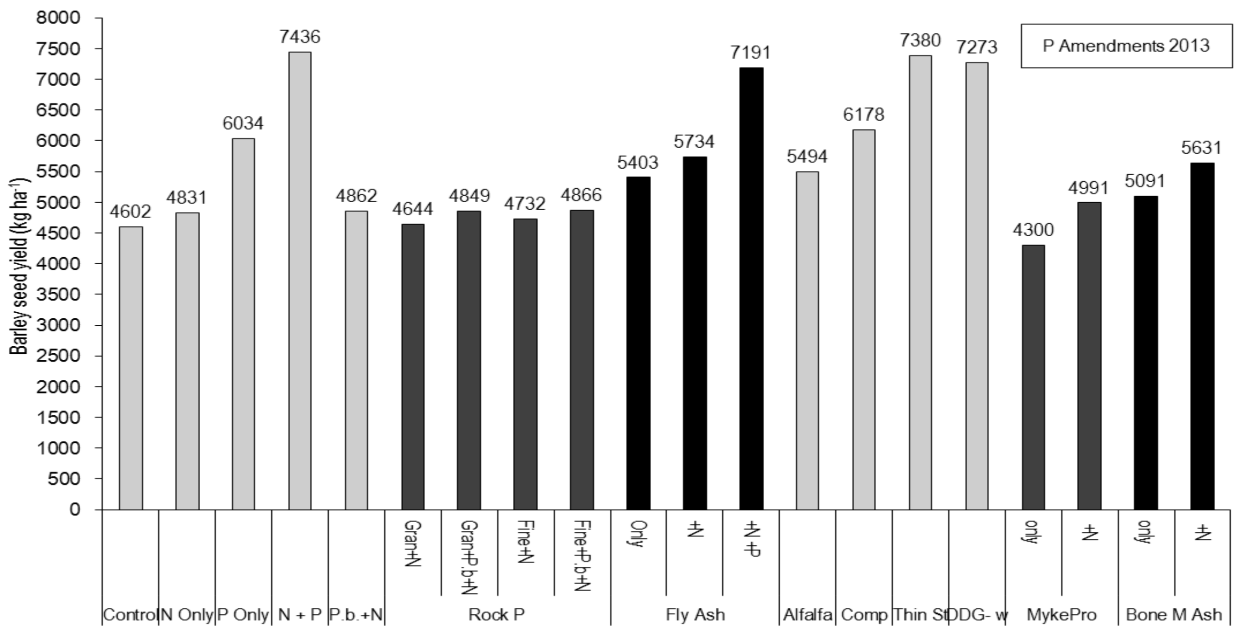

Figure 2. Seed yield of barley with various amendments applied annually in 2013 on a P-deficient soil at Kelvington, Saskatchewan.

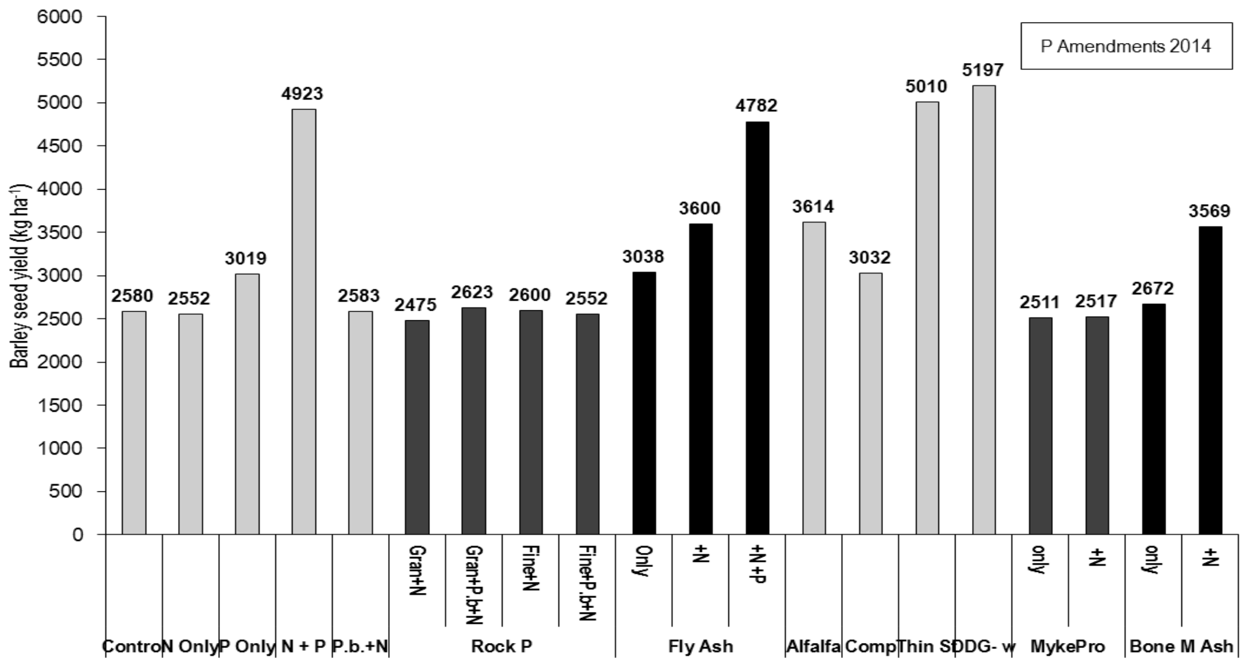

Figure 3. Seed yield of barley with various amendments applied annually in 2013 on a P-deficient soil at Kelvington, Saskatchewan.

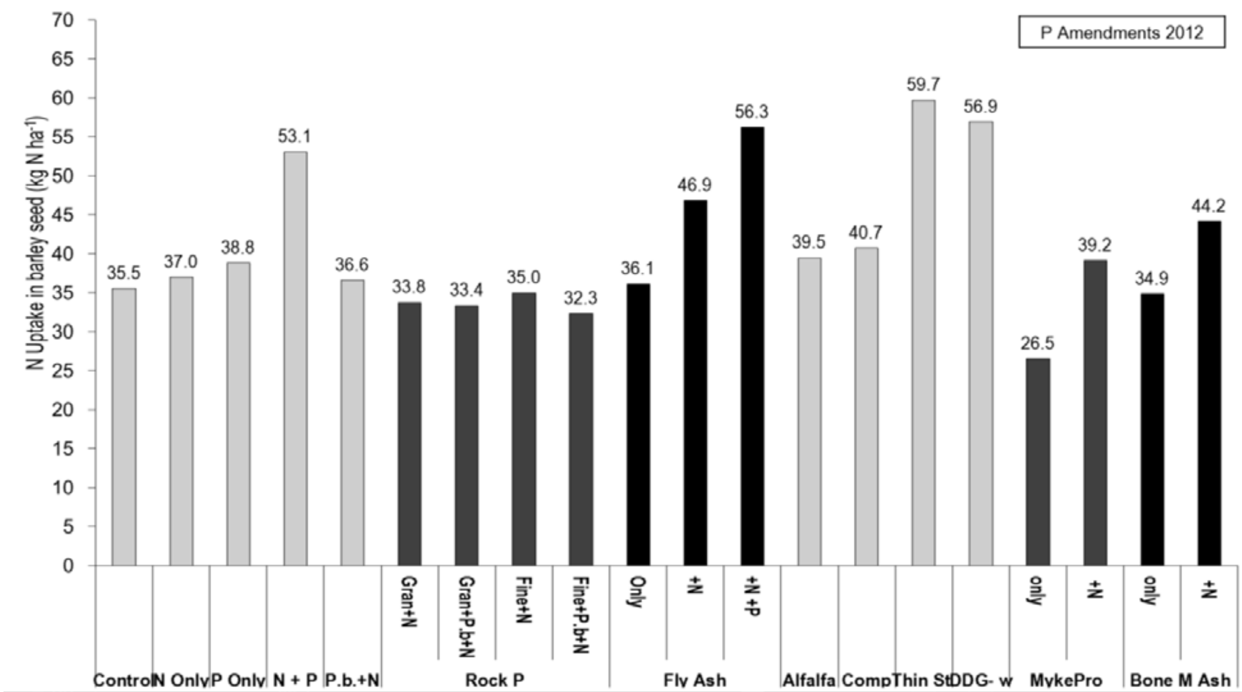

Figure 4. N uptake of barley seed with various amendments applied annually in 2013 on a P-deficient soil at Kelvington, Saskatchewan.

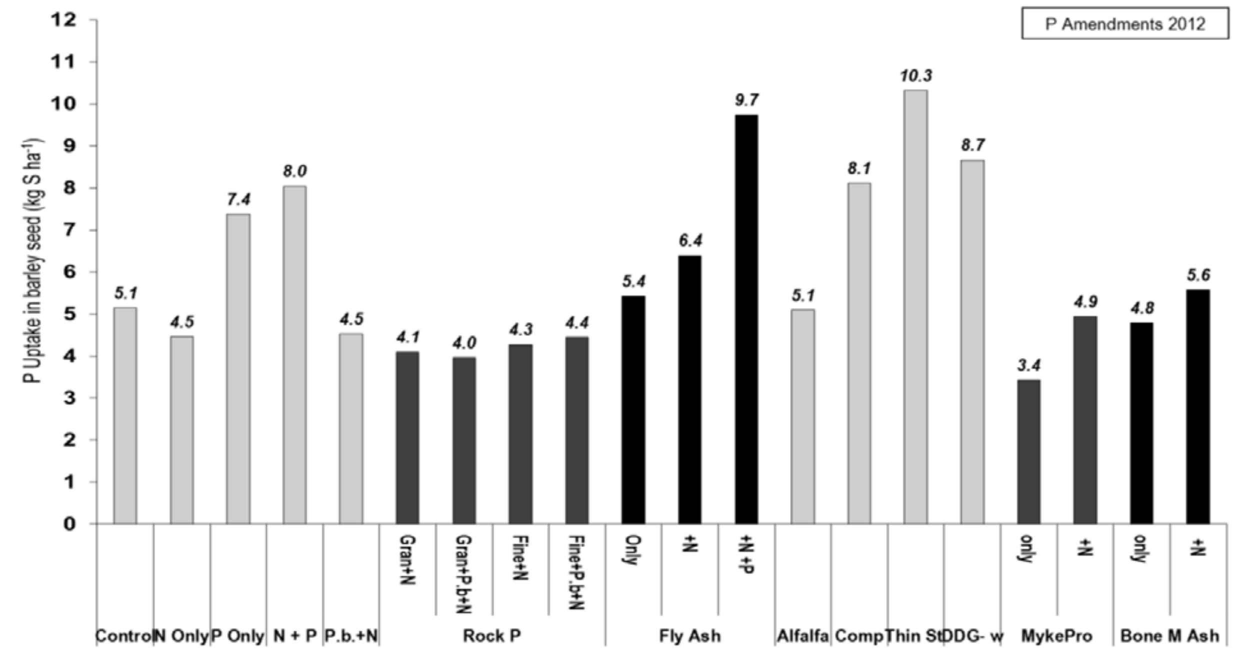

Figure 5. P uptake of barley seed with various amendments applied annually in 2013 on a P-deficient soil at Kelvington, Saskatchewan.