Relative Effectiveness of Organic and Inorganic Nutrient Sources in Improving Seed Yield and Nutrient Uptake of Canola

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Introduction

- Any nutrient (s) limiting in soil can cause substantial reduction in crop yield. In the Canadian Prairies, most soils are deficient in available N, many soils are low in available P, and some soils contain insufficient amounts of available S (but many in the Parkland region) and available K for optimum crop growth and yield, especially under organic agriculture.
- There is great interest and demand for organically-grown food and fiber products in Canada and internationally, but maintaining soil fertility is an important production issue facing organic agriculture in the semi-arid region of the Canadian Prairies.
- The N deficiency in soil on organic farms can be minimized by growing N-fixing legume crops in the rotations, but in soils deficient in available P, K, S or other essential nutrients, the only alternative is to use external sources because synthetic fertilizers/chemicals can not be applied to prevent nutrient deficiencies and increase yield in organic crops.
- Manure/compost can provide these nutrients. But often there is not enough manure to apply on all farm fields, and the cost of transporting manure to long distances is uneconomical in remote areas.
- On such soils, rock phosphate fertilizer, elemental S fertilizer, gypsum, wood ash (wood ash is a waste product of forest industry that contains lot of Ca and Mg, about 0.44% P, 4.2% K, 1% S, and small amounts of other essential nutrients) or other amendments may be used to correct deficiencies of these nutrients, and field experiments on the feasibility of these products in preventing nutrient deficiencies under organic farming are underway.
- The information on the relative comparisons of organic and inorganic nutrient sources in preventing nutrient deficiencies in the same experiment is lacking.

Objective

To determine the relative effectiveness of organic and inorganic nutrient sources (amendments/chemicals) in preventing nutrient deficiencies in canola, and increasing seed yield and nutrient uptake.

Materials and Methods

- A field experiment was established in 2009 at Star City, Saskatchewan, on a Gray Luvisol (Typic Cryoboralf).

- Soil at this site has shown severe S deficiency in canola in all previous years, and significant increase in forage yield of timothy from S application and some non-significant increase in forage yield of timothy from P application.
- Data collection includes yield, produce quality and nutrient uptake of crops, and nutrient accumulation and quality of soil.

Treatments Include:

1. Control (no amendment)
2. Compost @ 20 Mg ha^{-1}
3. Wood ash – fly ash @ 2 Mg ha^{-1}
4. Alfalfa pellets @ 2 Mg ha^{-1}
5. Alfalfa + canola meal pellets @ 2 Mg ha^{-1}
6. Distiller grain (wheat) – wet @ 2 Mg ha^{-1}
7. Distiller grain (wheat) – dry @ 1 Mg ha^{-1}
8. Thin stillage @ 20,000 L ha^{-1}
9. Glycerol @ 1 Mg ha^{-1}
10. Fish food additive @ 1 Mg ha^{-1}
11. Triple superphosphate @ 20 kg P ha^{-1} + 80 kg N ha^{-1} + 20 kg S ha^{-1}
12. *Penicillium bilaiae* + 80 kg N ha^{-1} + 20 kg S ha^{-1}
13. RP granular (IC) @ 20 kg P ha^{-1} + 80 kg N ha^{-1} + 20 kg S ha^{-1}
14. RP finely-ground (IC) @ 20 kg P ha^{-1} + 80 kg N ha^{-1} + 20 kg S ha^{-1}
15. RP granular (BCM) @ 20 kg P ha^{-1} + 80 kg N ha^{-1} + 20 kg S ha^{-1}
16. RP finely-ground (BCM) @ 20 kg P ha^{-1}+ 80 kg N ha^{-1}+ 20 kg S ha^{-1}
17. Gypsum @ 20 kg S ha^{-1} + 80 kg N ha^{-1} + 20 kg P ha^{-1}
18. MRRES @ 20 kg S ha^{-1} + 80 kg N ha^{-1} + 20 kg P ha^{-1}
19. Glycerol @ 1 Mg ha^{-1} + 80 kg N ha^{-1}
20. Wood ash – fly ash @ 2 Mg ha^{-1} + 80 kg N ha^{-1}
21. Distiller grain (corn) – dry @ 1 Mg ha^{-1}
22. Treatment 15 + *Penicillium bilaiae*
23. Treatment 16 + *Penicillium bilaiae*
24. RP + humates (gran) (BCM) @ 20 kg P ha^{-1} + 80 kg N ha^{-1} + 20 kg S ha^{-1}
25. Treatment 24 + *Penicillium bilaiae*
26. RP [powder] (BCM) @ 20 kg P ha^{-1} + 80 kg N ha^{-1} + 20 kg S ha^{-1}
27. N + S - 80 kg N ha^{-1} + 20 kg S ha^{-1}
28. Wood ash – granulated @ 200 kg ha^{-1} (side band)
29. Wood ash – granulated @ 200 kg ha^{-1}(side band)+80 kg N ha^{-1}
30. N + P - 80 kg N ha^{-1}+ 20 kg P ha^{-1}
31. N only - 80 kg N ha^{-1}

Summary

- In 2009 and 2010, application of N, P and S chemical fertilizers (NPS) produced considerably higher seed yield (and also nutrient uptake determined only in 2009) of canola compared to the unamended control.
- Among the amendments treatments without the addition of any chemical fertilizers, thin stillage produced seed yield similar to or even slightly higher than the NPS treatment in both years. This suggests a great potential of thin stillage as

an organic amendment to prevent any nutrient deficiencies and subsequently increase crop yield and nutrient uptake.

- In 2009, compared to the control, fish food, or distiller grain dry of both wheat and corn produced considerably higher seed yield, followed by moderate increase with compost, alfalfa + canola meal pellets, alfalfa pellets, or wood ash - fly ash, with little or no increase in seed yield from distiller grain wet of wheat, or wood ash granulated, and reduction in seed yield with glycerol. Nutrient uptake (measured only in 2009) showed showed responses to amendments/chemicals similar to seed yield.
- In 2010, wood ash fine, alfalfa pellets, fish food, or distiller grain dry of wheat tended to increase seed yield over the unamended control. These results also suggest the potential of fish food, distiller grain and some other amendments to improve yield of organic crops.
- In treatments where chemical fertilizers were also applied in addition to amendments, application of N fertilizer increased seed yield substantially in wood ash (especially fine), suggesting the lack of N in these treatments. Application of N also increased seed yield in glycerol treatment, but much less than gypsum + N + P, suggesting the lack of both N and S in this treatment.
- Application of N alone resulted in decline of seed yield compared to the unamended control, and N + P improved seed yield slightly. Application of RRES in combination with N + P fertilizers produced seed yield similar to gypsum + N + P treatment, but both treatments produced seed yield considerably higher than the unamended control. This suggests that deficiency of S in organic crops can be prevented by using RRES and gypsum as organic amendments.

Conclusions

- Some amendments showed potential for improvement in organic crop production, and in some other cases highest seed yields were produced when both organic and chemical amendments were applied together, or chemical N, S and P fertilizers were applied.
- These findings may help to increase the sustainability of crop production and net returns to producers by improving nutrient use and water use efficiency and soil quality through better plant and root growth, as well as minimizing environmental damage of nitrate-N (leaching to ground water and nitrous oxide emissions) by leaving less residual nitrate-N in soil under both organic and conventional farming systems.

Acknowledgements

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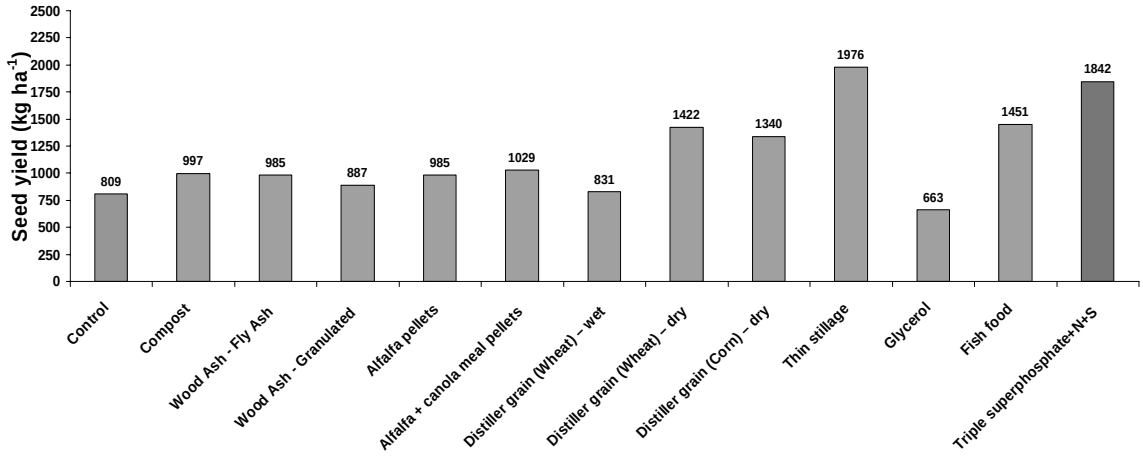

Figure 1. Seed yield of canola with organic amendments without chemical fertilizers vs. NPS fertilizer in 2009 at Star City, Saskatchewan.

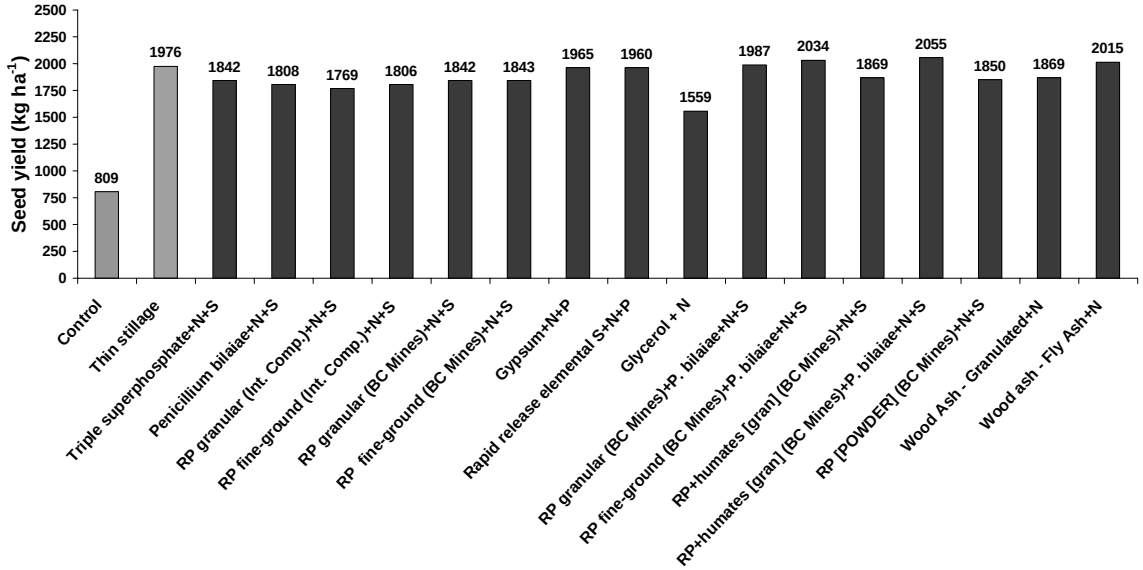

Figure 2. Seed yield of canola with chemical fertilizers and/or organic amendments applied in 2009 at Star City, Saskatchewan.

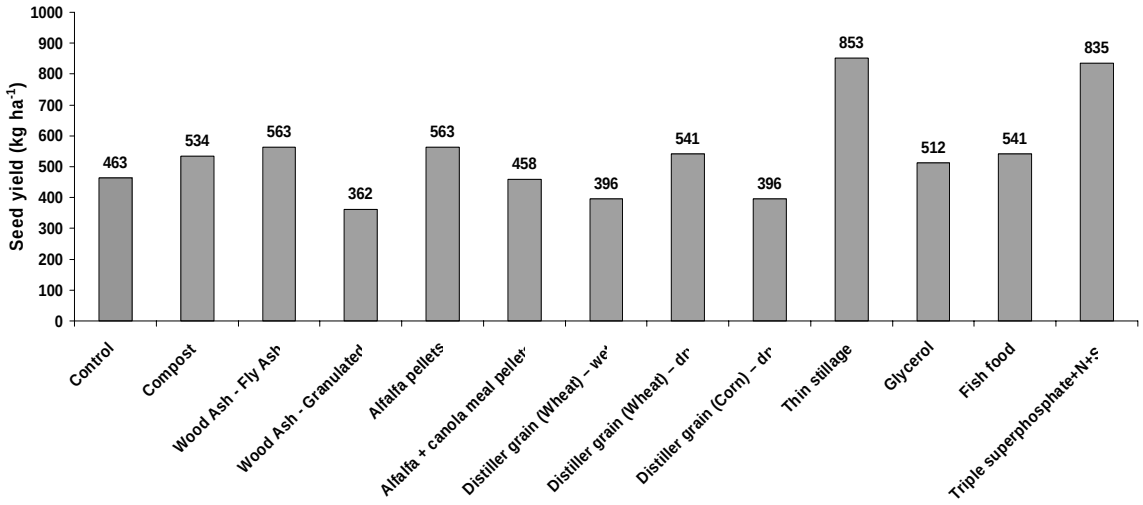

Figure 3. Seed yield of canola with organic amendments without chemical fertilizers vs. NPS fertilizer in 2010 at Star City, Saskatchewan.

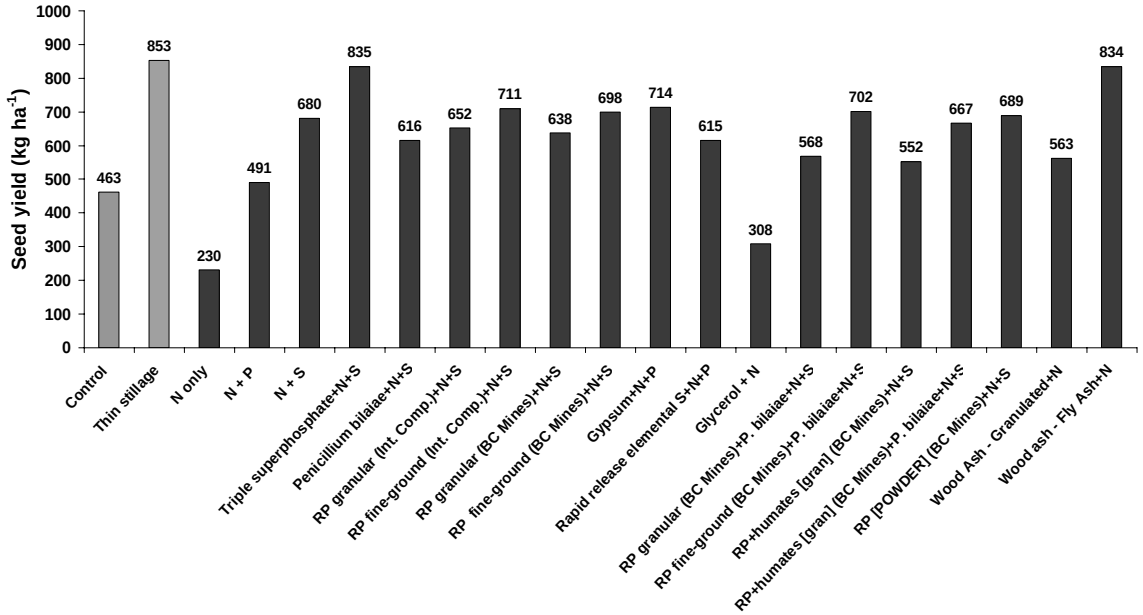

Figure 4. Seed yield of canola with chemical fertilizers and/or organic amendments applied in 2010 at Star City, Saskatchewan.