The Effect of Soil Amendment with Glycerol on the Growth of Pea Plants

Fahad AL Otaibi and Jeff Schoenau

Department of Soil Science, University of Saskatchewan

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Introduction

Different options may exist for effective utilization of crop processing by-products. Land application as a fertililizer / conditioner is one option, but any amendment product should be tested and evaluated carefully to document benefits and ensure environmental quality and safety. Glycerol is a by-product of the bio-diesel fuel industry. It may be useful as potential organic soil amendment and conditioner because it is a ready available source of organic matter (39 % C). Application of an organic carbon source could improve several soil chemical, physical, and biological properties. However, application of an amendment that contains only carbon, hydrogen and oxygen creates the possibility of N and P deficiencies due to N and P immobilization by the soil decomposer population. To remedy this limitation, especially N, N_2 fixing legumes could be used since they can derive their N from the atmosphere. Little previous work has been conducted on amendment of soil with glycerol and its interaction with crops. A combination of amendment with glycerol and N_2 fixing microorganisms, and growing a legume, could allow for improved production. The objectives of this study were to determine the effect of addition of glycerol at three different rates in combination with *Rhizobium leguminosarum bv. viciae* on pea yield and N, P uptake.

Materials and Methods

Soil, Glycerol, and Rhizobium sources:

- Soil was an Orthic Brown Chernozem (0-15cm) sampled from a cereal stubble field in the fall of 2007 with the following characteristics: pH 7.8, E.C. 0.26, O.C 1.8 %, NO3-N 5.4 mg/kg, and MK extractable P 5.0 mg/kg)
- *Rhizobium leguminosarum bv. viciae* was obtained from culture collection of the Soil Microbiology laboratory of the Soil Science department of the University of Saskatchewan.
- Methanol stripped glycerol was obtained from a local bio-diesel manufacturer.

Treatments:

- A control without any additive;
- A rhizobial strain alone;
- Three treatments including application of glycerol at three different rates (100, 1000, and 10,000 kg/ha respectively); and

- Three treatments including application of glycerol at three different rates (as above) in combination with rhizobial strain.

The Controlled Environment Experiment:

- Approximately 1 kg of air-dried soil was placed in each pot and water was added to bring to field capacity. After 48 hours of equilibration, 200 ml of glycerol mixed with water to provide the appropriate rate was added. After 48 hours, four pre-germinated pea seeds were sown into each pot. Then, 1 ml of rhizobial strain, grown on YMB for 96 h, was added to each seed in the corresponding treatment. The experiment was carried out as a completely randomized design with 3 replicates per treatment.
- Pea plants were kept in a growth chamber for 8 weeks with 16/8 hours day/night cycles, respectively.
- After 8 weeks, plants were harvested and shoots were oven-dried, weighted and analyzed for N and P concentration using acid digest and colorimetry.

Results

Effect on Pea Yield:

Higher pea yields were obtained with combined treatments of glycerol and rhizobia. Yield response to glycerol suggests a beneficial effect on soil conditions for pea growth (Fig.1).

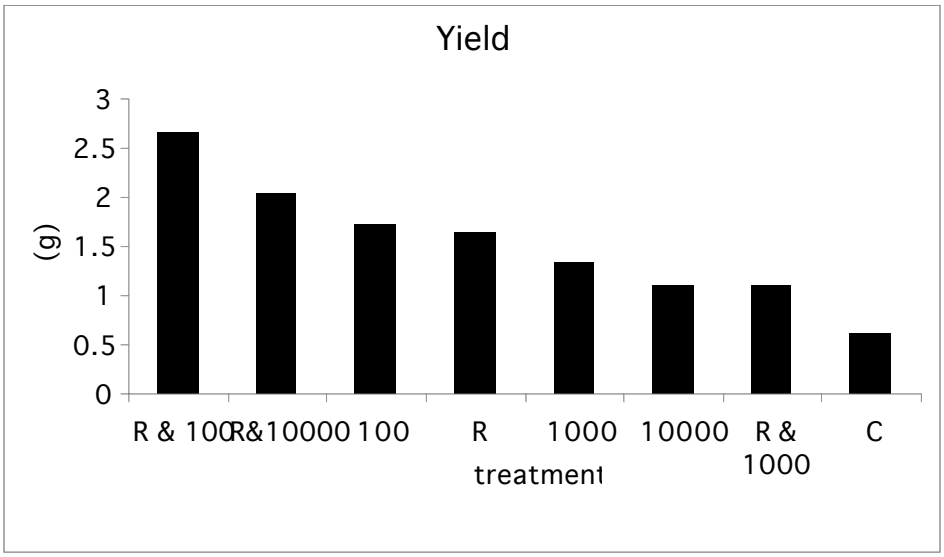

Fig. 1. Effect of glycerol alone and in combination with rhizobial inoculant on pea yield. R on the X axis indicates rhizobial inoculation, and 100, 1000, and 10000 are application rates of glycerol in kg/ha. C denotes unamended control.

Effect on plant N:

Plant N concentration decreased slightly with glycerol application (Fig. 2). Also, rhizobium and glycerol application at rate of 1000 kg/ha was not significantly different from control treatment. It appears that nitrogen fixation can help compensate for N immobilization.

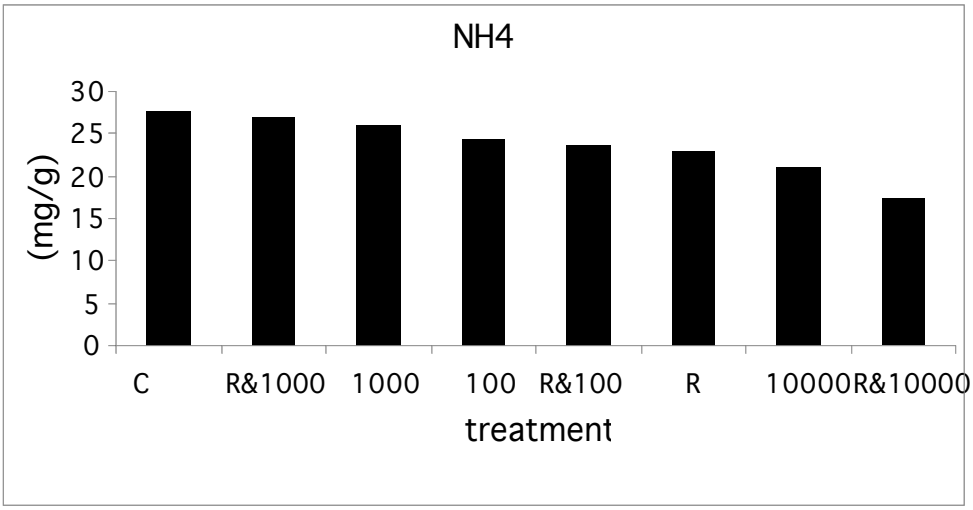

Fig.2. Effect of glycerol treatments alone and in combination with rhizobial inoculant on N concentration in pea shoots. R on X axis indicates rhizobia and the numbers 100, 1000, 10000 are application rates of glycerol in kg/ha. C denotes unamended control.

Effect on plant P:

Application of glycerol at 10000 kg/ha significantly decreased P concentration (Fig. 3). However, rhizobium treatment had some positive effect on shoot P concentration.

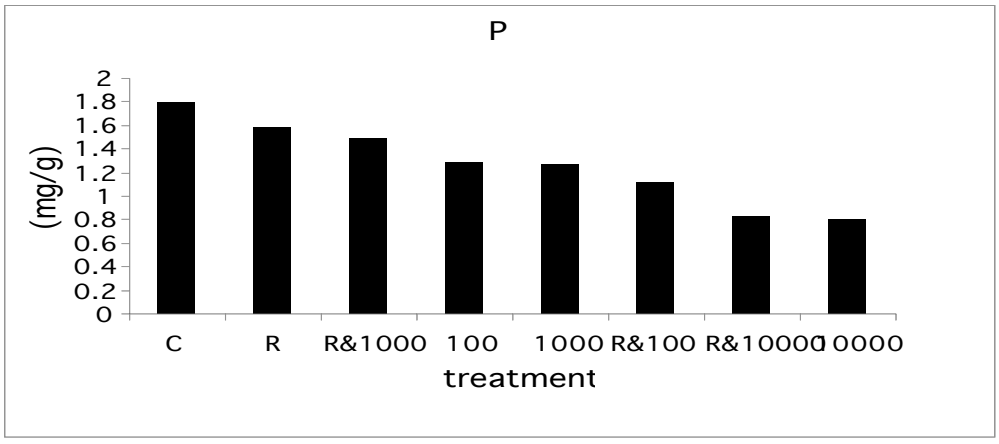

Fig. 3. Effect of addition of glycerol alone and in combination with rhizobial inoculation on P concentration in pea plants. R on X axis indicates rhizobia and the numbers 100, 1000, 10000 are application rates of glycerol in kg/ha. C denotes unamended control.

Effect on soil organic carbon:

Application of glycerol at different rates increased the soil organic carbon concentration (Fig. 4). As expected, the highest application rate (10000 kg glycerol/ha) resulted in the highest organic carbon concentration.

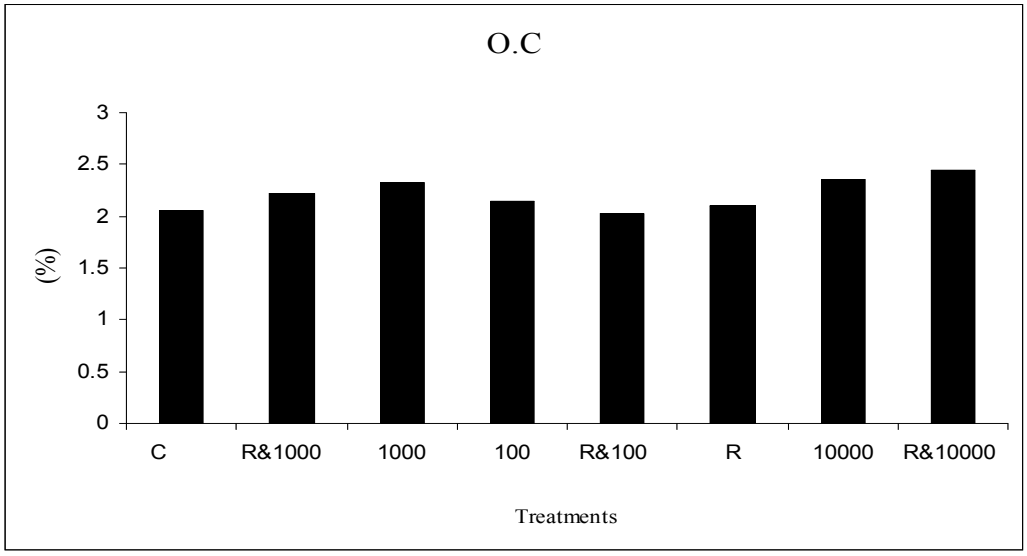

Fig. 4. Effect of applying Glycerol alone and in combination with rhizobial inoculant on soil O.C. content. R on X axis indicates rhizobia and the numbers 100, 1000, 10000 are application rates of glycerol in kg/ha. C denotes unamended control.

Conclusion

- Utilization of glycerol as organic amendment could improve some soil conditions to enhance growth.
- Glycerol application at high rates can lead to immobilization of N and P in soils.
- Use of N fixing rhizobia-legume symbiosis can be of benefit in overcoming N limitations.
- Glycerol can increase soil organic matter content which has subsequent benefits to soils.
- Glycerol and microbial biofertilizers could be used together to enhance plant growth. Efficient inoculants that are superior in N-fixation should be selected and used.

Acknowledgment

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