Can Calcium acetate be used as an alternative to gypsum for improving oilfield, brine impacted soils

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Introduction

North Dakota has been a leading producer of oil and natural gas since horizontal drilling and fracking methods were implemented. Along with the production of oil and natural gas comes the by-product of brine. The primarily constituents of brine are sodium and chloride which pose threats to soil and plant health and groundwater safety.

Historically, gypsum has been a popular calcium based amendment used to remediated brine impacted soils as it's able to supply enough calcium to replace sodium on clay surfaces, but it is a sparingly soluble amendment (~2 g L^{-}). Other, more soluble calcium sources, often contain chlorides and nitrates which are highly regulated in North Dakota groundwaters.

This prompted the idea as using calcium acetate (Ca-ac) for remediating brine impacted soil. Ca-ac has about the same amount of calcium as gypsum, but is over 100x more soluble. We also hypothesize the acetate may serve as an available carbon source for soil microbes.

Fig. 1: Brine impacted site near Glenburn, ND

Ksat Methods

To determine if calcium acetate is a good substitute to gypsum, Ca-ac, flue gas gypsum (FG Gyp) and pelletized gypsum (Pel Gyp) were mixed with a brine impacted soil at rates of 1T, 5T, 10T and 20T per acre.

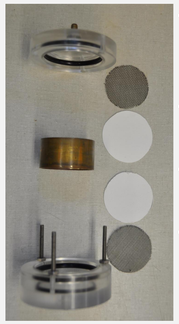

Fig. 2: Tempe cell parts

- Tempe cells assembled using methods similar to those by Sommerfeldt et al. 1984
- Water was supplied from a 20 cm head
- Leachate collected increments
- Ksat determined based on time and volume of water moved through soil

Fig. 3: Ksat setup

Fig. 4: Ca-ac

Fig. 5: Pel Gyp

Fig. 6: FG Gyp

Results

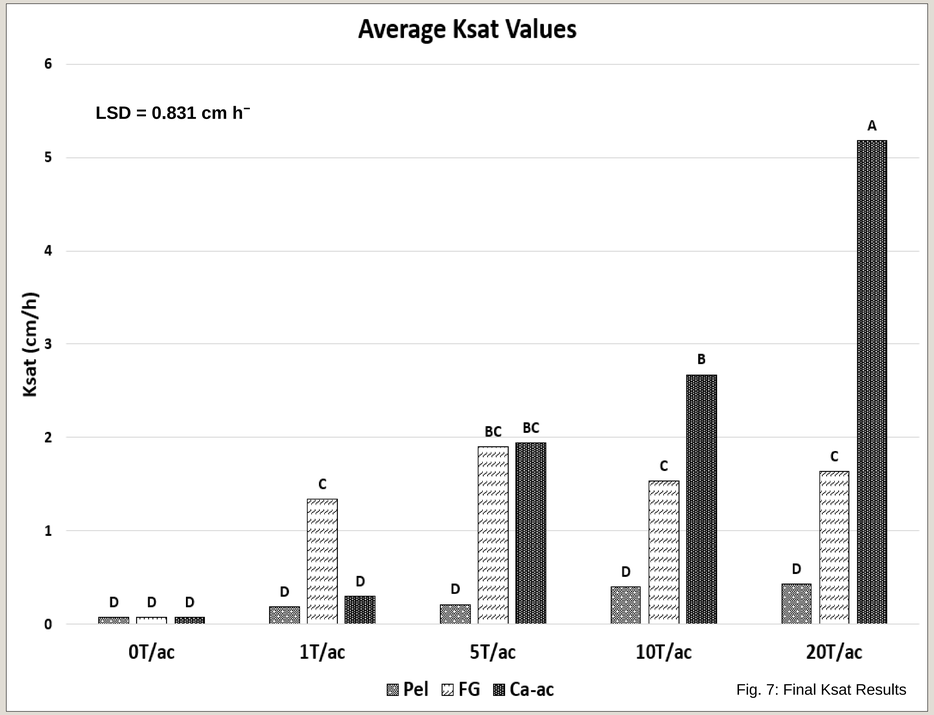

Fig. 7: Final Ksat Results

- For Ksat rates to differ from each other, rates had to differ by 0.831 cm h^{-}
- The final Ksat of soils with any rate of Pel Gyp did not significantly differ from the control which had no amendments added
  - Increasing rates of Pel Gyp did not significantly increase Ksat
- The final Ksat of soils with any rate of FG Gyp did not significantly differ from each other, but were significantly different than the control and any rate of Pel Gyp
  - Increasing rates of FG Gyp did not continuously significantly increase Ksat
- The final Ksat of soils with increasing rates of Ca-ac proved to be significantly different than each other and from Pel Gyp and FG Gyp amendments

Discussion

Next Steps:

- Conduct this experiment in a field setting with tile drainage to safety collect and dispose of leachate
  - Apply Ca-ac on soil surface then irrigate
  - Solubilize salts (NaCl and Ca-ac)
  - Ca^{2+} will replace Na^{+} and prevent dispersion
  - Ksat will increase with improved flocculation
  - Na^{+} and Cl^{-} collected via tile drainage
  - Acetate serves as available carbon source

- Economically produce calcium acetate on a large scale ($CaCO_3+2CH_3COOH \rightarrow H_2CO_3+Ca(CH_3COO)_2$)
- Further look into acetate being an available carbon source for soil microbes

References

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Acknowledgments

Special thanks to the co-authors as well as Kevin Horsager, Jarrett Lardy, Beverly Alvarez-Torres, Chantel Mertz and Aaron Ostlund for their willingness the help and expertise.

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