DO 1:1 SOIL EXTRACTS FOR SALINITY UNDERESTIMATE LEACHING FRACTIONS?

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ABSTRACT

Soil test laboratories often include 1:1 pH and salinity measures as part of their routine analysis. The saturated paste method is also a choice but may not be selected due to a higher cost associated with the procedure. Historical crop response to salinity has been largely carried out using the saturated paste extract procedure. Plant response estimates to salinity are based on the saturated paste method. Leaching fractions are determined from the saturated paste extract as well. Recommendations made from 1:1 extracts appeared to be falling short of helping overcome the effects of salinity both in crop choice and the amount of water needed to leach. Making salt tolerant crop recommendations and estimating leaching fractions did not appear to be working as good as it should. Soils were collected from 2011-2015 from various locations within New Mexico. The soils were tested for pH, salinity and SAR using both the 1:1 and saturated paste extract. Soil pH was usually overestimated with 1:1 extract and electrical conductivity and SAR were generally underestimated. Regressions demonstrated that 1:1 pH and ECe can be mathematically adjusted to improve recommendations. SAR_e, on the other hand, did not lend itself well to interpretation from $SAR_{1:1}$.

INTRODUCTION

Saline and sodic soils are present in New Mexico agriculture and in much of the west. Soil testing is used to identify saline and/or sodium affected soils. There exists a discrepancy in pH, Electrical Conductivity (EC), and Sodium Adsorption Ratio (SAR) between soil tests that use saturated paste (SP) extracts versus those that use 1:1 extracts. Leaching fractions, crop tolerances, and reclamation recommendations are based on SP. Clients seldom know that there are differences between the two methods and may not be able to adequately address any reclamation that may need to occur. The 1:1 extracts are less expensive and would be the first choice for clients.

The saturated paste method (Gavlak et al., 2005) requires that soil samples are ground and passed through a 2-mm sieve, then just enough water is added to make a paste that glistens but does not flow from a cup. Soil texture greatly influences the amount of water that can be added to make it “saturated.” Soils with high amounts of clay often take 24 hours to fully absorb the added water. Once 24 hours have passed and the sample is saturated, the soil is placed under suction and the liquid is removed for further testing. This sample is known as the saturated paste extract and most closely resembles conditions after an irrigation. Soil pH, EC, and SAR (relative amount of calcium, magnesium, and sodium) are determined from the saturated paste extract as well.

Unfortunately, leaching fractions are determined using the saturated paste ECe and salt tolerant crops are chosen according to their salinity tolerance. Making a good recommendation on salinity control hinges on understanding potential crop response. The question was posed to the authors of whether or not leaching fractions, crop tolerances and reclamation recommendations could be sufficiently estimated from 1:1 extracts after mathematical transformation to better estimate reclamation needs?

METHODS

Soil samples were taken to a depth of 8-inches across New Mexico over a period of time from 2011 – 2015. Samples were air dried and sent to Ward Laboratories, Kearney, NE, for analysis. The same samples received both 1:1 extract (EC1:1) and saturated paste extract (ECe) for salinity assessment. Soils used for this evaluation were limited to New Mexico but not one geographic location within the state. The same samples were also analyzed for Na, Ca, and Mg using the standard ammonium acetate extract in addition to the saturated paste extract to determine SAR.

Step-wise regression analysis and linear regression routines found within the SigmaPlot® statistics package were utilized to evaluate relationships between the two extracts methods. Gypsum recommendations were calculated for the routine versus estimated salinity and compared to the lab's salinity assessment. Leaching fractions calculations were made using NRCS equations for both 1:1 and saturated paste results. Soil pH was also compared between the two methods.

RESULTS AND DISCUSSION

Soil extracts for determining salinity when using 1:1 extracts generally underestimated the saturated paste salinity. Since leaching fractions were developed from soil saturated paste extracts it became apparent that the leaching fraction was underestimated. An equation was developed to better estimate-e saturated paste EC from soils using the 1:1 extracts.

Soil pHe can be estimated using the equation:

$pHe = 4.293 + 0.429(pH_{1:1}) - 0.0942(EC_{1:1}) + 1.19^{-5}(Ca_{1:1}) + 4.06^{-4}(Na_{1:1})$ $[R^2_{adj}=0.726]$ (Figure 1).

If only the pH is given the saturated paste could be estimated using the equation:

$pHe = 3.335 + 0.552(pH1:1)$ $[R^2_{adj}=0.622]$ (Figure 1).

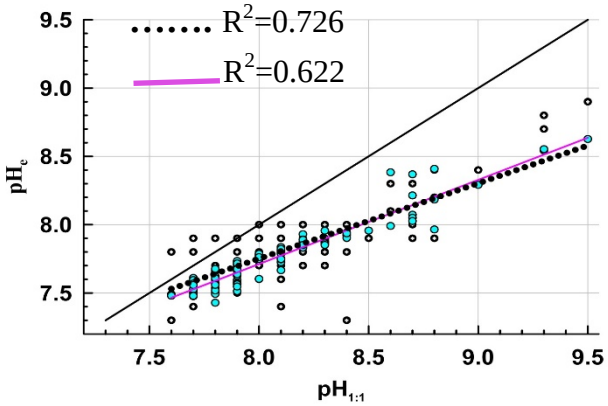

Figure 1. Soil pHe vs pH1:1 with a 1:1 relationship line

Soil ECe can also be estimated from the equation using the 1:1 extract:

$ECe = 0.0705 + 2.269(EC_{1:1}) - 1.51^{-3}(Mg_{1:1}) + 2.57^{-3}(Na_{1:1})$ $R^2_{adj}=0.892$

Alternatively, if Mg and Na levels had not been tested for then it can be estimated from the 1:1

$ECe = 3.335 + 0.552(EC1:1)$ $R^2_{adj}=0.851$

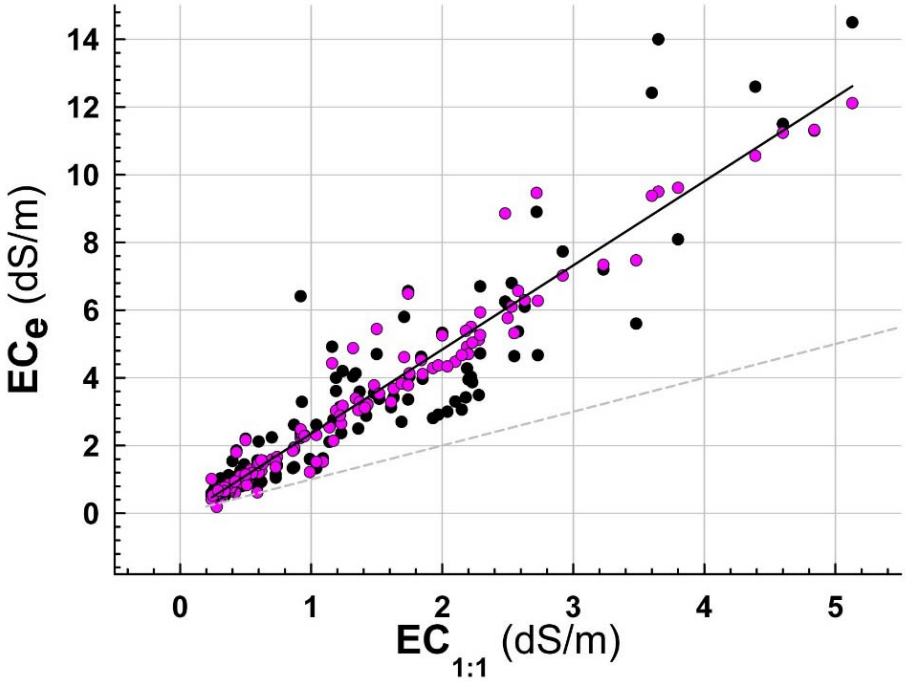

Figure 2. ECe calculated from EC1:1. Solid line is an estimate from only the EC1:1 extract while the circles represent calculated ECe from EC1:1, Ca1:1 and Na1:1.

SUMMARY

EC_e can be adequately predicted from EC1:1. This aids in calculating potential yield loss as well as estimating an appropriate leaching fraction. While it may not be necessary to adjust the pH it does lend itself to better conversations about pH control. There were not relationships that could be derived to predict the SARe from SAR1;1.

REFERENCES

Gavlak, R.G., D.A. Horneck, and R.O. Miller. 1994. Plant, soil and water reference methods for the Western Region [WREP 125]. Fairbanks, AK: University of Alaska.