

DETERMINATION OF ELECTRICAL CONDUCTIVITY OF TWO MAJOR RICE GROWING SOILS USING 1:5 SOIL WATER SUSPENSIONS AND SATURATED EXTRACTION

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INTRODUCTION

Rice growing soils in the coastal belt of Sri Lanka become salinized every year when sea water intrusion occurs due to tidal waves, and these lands are converted into conditions where rice growing is difficult. On the other hand, irrigated rice soils in the dry zone of Sri Lanka carries a risk of salinization due to internal drainage as the soil profile is insufficient to drain off salts brought in with the irrigation water (Handawela, 1982). Salinization of the root zone may also occur due to capillary rise of salts from salinized water table (Ceuppens *et al.*, 1997). Since salt content of irrigation water is high in many places, this process is accelerated. As such large scale crop failures are experienced due to accumulation of salt in the rice fields. To overcome this situation, farmers are advised to check their soils for salinity before starting the cropping season. Salinity can be estimated by different methods; however, but plant response was much more related to the salt concentration of the soil solution than to the total salt content of the soil, as expressed in the weight basis (Rowel, 1994). Hence, Electrical Conductivity (EC) of soil solution is determined worldwide to assess the salinity. Currently, two methods are practiced in research laboratories to determine electrical conductivity. They are; 1:5 soil water suspension and saturated soil extraction (USDA, 1954; Rhoades, 1996, Rowell, 1994). Of the two methods, results from saturated extractions are thought to be the best predictor of plant response to salinity (Rhoades *et al.*, 1989b) because saturated soil extractions attempt to simulate the environment of naturally occurring moisture-saturated soil.

Since electrical conductivity and soil pH both are estimated from one solution, of the 1:5 soil water suspensions (EC_w), it is widely used in many of our soil science laboratories to determine electrical conductivity. In such occasions it is difficult to understand the real salinity levels of the soils since there is no comparison between EC values of 1:5 water suspensions and EC values of saturated extraction.

This paper reports the results of a study conducted to find out the relationship of electrical conductivity between 1:5 soil water suspensions and saturation extraction in two major rice growing soils in Polonnaruwa, Sri Lanka.

MATERIALS AND METHODS

Soil samples were collected from Reddish Brown Earth (RBE: Rhodusalfs) and Low Humic Gley (LHG; Endoaqualfs) soils of Kalingaela Yaya of Parakrasamudraya irrigation scheme in Polonnaruwa. Topographical maps and irrigation block out maps were used to decide sampling positions and the soil group and samples were collected from 0-15 cm layer and composited to make one sample for each sampling point. Twenty samples from each soil group were collected from a sixty acre land. Samples were air dried and ground to pass a 2 mm sieve. Sub samples from each soil sample were taken and texture, Cation Exchange Capacity (CEC) and organic matter content were determined. Soil samples weighing 150g were saturated through capillary action until it reached a condition of complete saturation, as described by USDA Handbook 60 (USDA, 1954). Saturated pastes were stirred and allowed to equilibrate for 30 minutes and extract from the saturated paste was taken using a low-pressure vacuum pump. Electrical conductivity of the extract was measured with a calibrated EC meter. To prepare 1:5 soil to water suspension of the same sample, 150 ml of de-ionized water was added to 30 g of sieved soil (2-mm sieve), stirred and the suspensions were allowed to equilibrate for 30 minute and electrical conductivity was determined in the water suspension. EC_e values were plotted against EC_w and regressions equations were obtained. Generated regressions were used to validate the relationships between EC_e , and EC_w . To allow for direct comparisons of electrical conductivity, regressions lines were forced zero by omitting the y intercept.

RESULTS AND DISCUSSION

Physical and chemical properties varied between LHG and RBE soils: LHG soil had higher clay content (15.8 %), higher CEC (11.4) and higher organic carbon content than RBE (Table 1).

Table 1. Properties of the RBE and LHG soils collected from rice fields at Kalingaela Yaya (average of 20 soil samples).

Soil property	Soil group			
	LHG		RBE	
	Mean	Range	Mean	Range
Sand (%)	70.5	83.1 – 68.3	74.0	82.0 – 68.9
Silt (%)	13.7	14.0 – 8.4	16	12.2 – 18.5
Clay (%)	15.8	16.4 – 8.5	11	5.8 – 18.5
pH (1:2.5)	6.5	6.1 – 6.8	5.50	5.8 – 5.1
CEC meq/100g	11.4	11.0 – 15.5	10.7	7.5 – 12.0
Organic carbon (%)	0.68	0.09 – 2.0	0.74	0.3 – 1.1

Electrical conductivity values of RBE ranged from 50 to 280 $\mu\text{s}/\text{cm}$ when measured as EC_w and from 100 to 504 $\mu\text{s}/\text{cm}$ when measured as EC_e . In LHG soil it ranged from 50 to 230 $\mu\text{s}/\text{cm}$ as EC_w and 150 to 560 $\mu\text{s}/\text{cm}$ as EC_e (Table 2). Therefore, a wide range in salinity levels could be obtained for comparing the EC_e with EC_w for both soils. As usual EC_e values were always greater than the EC_w values. The significant difference between the EC_w and EC_e is due to dilution effect that has been suggested by other researchers (Reitemeier, 1946; Schofield 1947; USDA, 1954). As suggested by Handawela (1982), EC values of LHG are higher than RBE due to high salt seepage through irrigation water applied to RBE soils. This phenomenon is seen when EC was measured as EC_e (Table 2).

Table 2. EC values of 1:5 soil water suspensions (EC_w) and saturated soil extraction (EC_e) of the two soils.

Soil type	EC values $\mu\text{s}/\text{cm}$		
	EC range EC_w	EC range EC_e	Mean of 40 samples
RBE soil	50-280	100-504	257 (3.1*)
LHG soil	50-230	150-560	214 (3.3*)

*variance

Electrical conductivity of the saturated extraction (EC_e) was highly correlated with EC_w for both soils ($r^2 = 0.83$ for RBE and $r^2 = 0.96$ for LHG $P < 0.05$) (Fig. 1 and Fig. 2). The slope of the regression is 1.92 for RBE and 3.43 for LHG. According to Rowell (1994) to get EC_e from EC_w , EC_w should be multiplied by 6.4 for many soils. According to the results of this study, the multiplication factor for RBE and LHG are 1.92 to 3.43 respectively. According to the above results, electrical conductivity of RBE soils measured in 1:5 water suspension can be converted into saturated extraction by multiplying the above values by 1.92. On the other hand for LHG, soil multiplication factor is 3.44. This difference in the converting factor may be due to differences in physical characteristics of the two soils used in the experiments (Rhoades *et al.*, 1989b). As such, it is learned from these results that the multiplication factor differs from soil to soil and preliminary investigation should be done to ascertain the conversion factors.

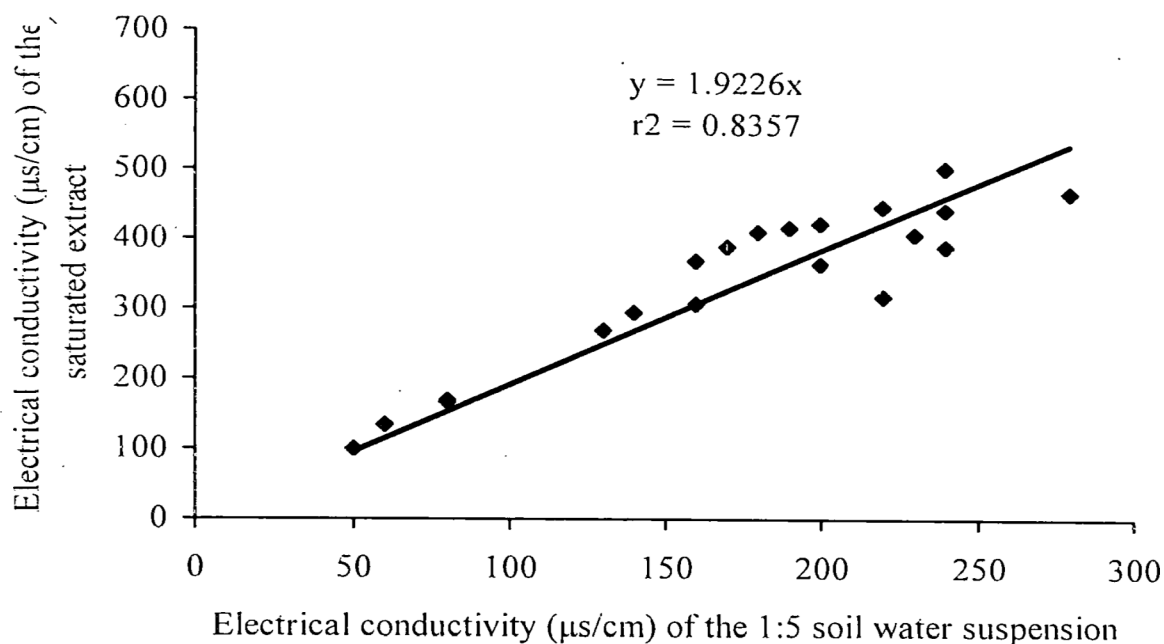


Figure 1. Relationship between electrical conductivity of 1:5 soil water suspension (ECw) and conductivity of the saturation extract (ECe) of RBE soil.

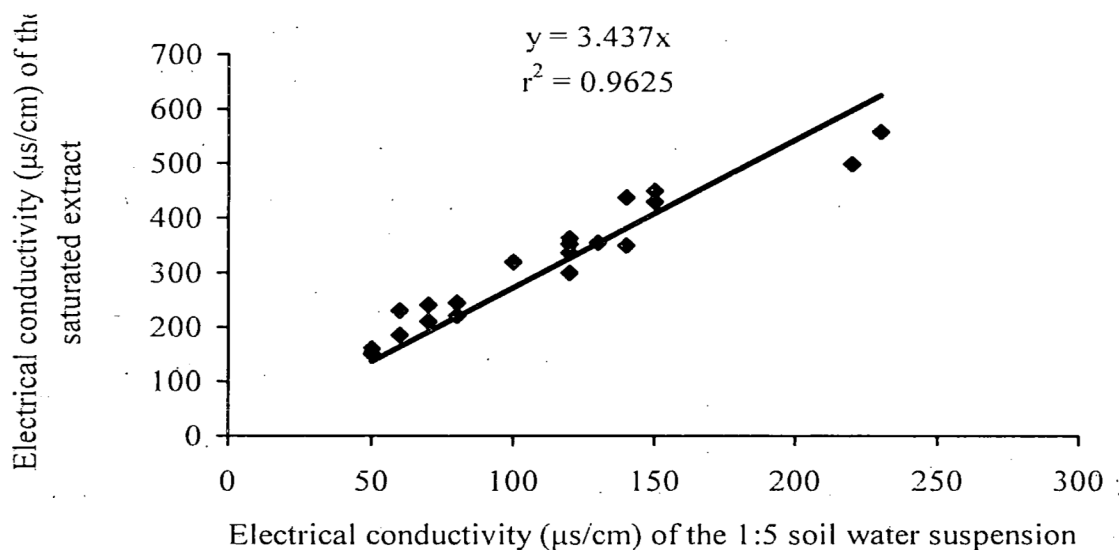


Figure 2. Relationship between electrical conductivity of 1:5 soil water suspension (ECw) and conductivity of the saturation extract (ECe) of LHG Soil.

CONCLUSIONS

The benefits of converting electrical conductivity of soil water suspension to saturated extraction equivalents are potentially large, as laboratories can minimize the cost and time associated with soil salinity analysis by using the less expensive 1:5 soil water suspensions. Since the

relationship was linear, it is possible to convert electrical conductivity values obtained as 1:5 soil water suspensions to their saturated extract equivalents using the regressions generated. Due to the wide range of EC obtained from this study, the derived equations have the potential to be used in a similar soil conditions available elsewhere. Further investigation using soils from a variety of soil types across the country could allow for a more accurate characterization of soil salinity using the EC values of 1:5 water suspensions.

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