Research Article

An approach for site specific nutrient management in paddy growing soils

Abstract

The average productivity of rice grown in Sri Lanka is very low. One of the main reasons for the low productivity is poor soil nutrient management. However, there is a potential to maximize productivity through Site Specific Nutrient Management (SSNM). To apply SSNM, information of within field variability of soil is important. Objective of this study was to find the within field variability of soil texture and selected soil chemical properties in a paddy growing land of the dry zone of Sri Lanka, mapping the spatial variability of the selected properties using Geographic Information Systems (GIS) and find out the possible correlation between the soil properties in the studied paddy land. Sixty seven soil samples were collected from a paddy field (2.5 ha) of CIC Seed Farm, Pelwehera, Sri Lanka. Soil texture, soil pH, exchangeable Ca, exchangeable Mg and available soil P were measured. There is a considerable within field variability of soil texture and other chemical properties. Variability of the soil chemical properties mainly attributed to the variability of soil texture. Continuous map of soil texture has similar spatial distribution patterns with exchangeable Ca, exchangeable Mg and soil pH. There are significant positive correlations of soil clay content with exchangeable Ca, exchangeable Mg and soil pH at p‹0.01 level. Also significant negative correlations can be found between clay content and available P.Spatial distribution maps produced during the study showed that within field variability in paddy soils are significant enough to support SSNM.

Keywords: paddy soils, within field variability, site specific nutrient management, soil texture, exchangeable Ca, exchangeable Mg, available P, soil pH, inverse distance weighting

Volume 2 Issue 5 - 2015

Haputhantri TR, Vitharana WAU

Department of Soil Science, University of Peradeniya, Sri Lanka

Correspondence: Haputhantri TR, Department of Soil Science, University of Peradeniya , Jeswel Place, Mirihana, Nugegeoda, Sri Lanka, Tel+94772344718, Email taru.pera@gmail.com

Received: September 18, 2014 | **Published:** September 08, 2015

Abbreviations: ASI, agro services international; CV, coefficient of variance; GIS, geographical information systems; IDW, inverse distance weighting; SSNM, site specific nutrient management

Introduction

Deficiencies of conventional management practices largely are contributed to the lack of productivity of rice in Sri Lanka. One of the main reason for having the productivity below the potential productivity is neglecting the within field spatial variability of soil properties in rice fields. This management strategy is broadly known as the Site Specific Nutrient Management (SSNM). The original concept of SSNM to manage among farm nutrient variability was developed in Asia in 1996.[1]

They defined SSNM as a dynamic, field-specific management of nutrients in a particular crop or cropping system to optimize the supply and demand of nutrients according to their differences in cycling through soil–plant systems. After studding about the spatial variability of soil chemical and physical properties, different management units (zones) can be developed.

Then the fertilizer recommendations can be defined separately for each and every management zone. Thus the productivity of the rice fields can be increased by satisfying the exact crop requirement. However, studies have not been conducted in Sri Lanka to explore the within-field variability of soils of paddy growing soils. Government has introduced only one fertilizer recommendation for thousands of hectares of paddy lands in dry zone of Sri Lanka without considering the huge spatial variability of the soils.

Objective of this study is to find the within field variability of soil chemical and physical properties in a paddy growing land of the dry zone of Sri Lanka , mapping the spatial variability of those chemical and physical properties using Geographic Information Systems (GIS) and find out the possible correlation between the soil properties in the studied paddy land.

Materials and methods

The study site was a 2.5ha paddy field at Palwehera (central coordinates 753.4614 N, 8040.3573), Sri Lanka. The study area is situated in the dry zone of Sri Lanka, which receives a mean annual rainfall less than 1750mm. The soil belongs to the great group Rhodustalfs. Soil samples were taken at 67 geo referenced points. Half of the sampling points were located on the nodes of a 25m regular grid and the other half was selected as random pairs associated with each grid cell. Air dried samples were analyzed for soil texture using the pipette method soil pH (1:2:5 Soil: Water mixture: exchangeable Ca) exchangeable Mg and available P using ASI extraction methods. An exploratory data analysis was performed for all measured properties and Pearson’s correlations were determined between studied properties. Inverse Distance Weighting (IDW) methodology was used to interpolate data to create continuous maps of the soil physical and chemical properties.

Results and discussion

Table 1 shows the results of the exploratory data analysis. The range and coefficient of variation values (CV= 11.7%-66.7%) indicated a considerable variation of the selected fertility parameters. Available P content showed the largest variability. Soil texture is the relative proportion of sand, silt and clay content. High soil clay content can be observed in the orange coloured region of the spatial distribution map of soil clay content (Figure 1).

The green coloured region is having relatively low soil clay content than the orange coloured region. In the studied land the slope is situated towards North and North East directions. Therefore migration of clay particles with the runoff water and accumulating them in the lower slope can be the reason for the observed distribution pattern of soil clay content (Figure 2). Soil exchangeable Ca (Figure 3) and Mg (Figure 4) are almost similar in their spatial distribution pattern and follow a similar pattern with soil texture. The correlation between Ca and clay percentage (r=0.780) and the correlation between Mg and clay percentage (r=0.770) are significant at 0.01 probability level.

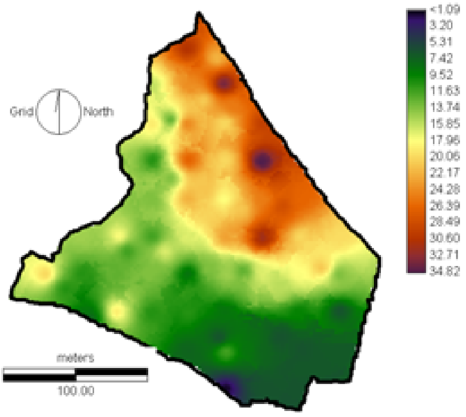

Figure 1 Spatial distribution of soil clay content .

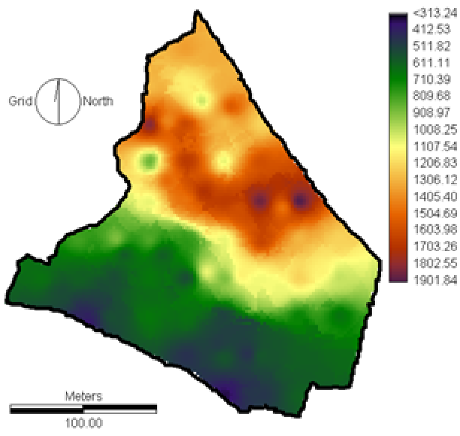

Figure 2 Spatial variability of exchangeable Ca.

Soil pH also varies with the slope with the same pattern. Even though there was small CV for pH, there is a structured spatial variability of the soil pH where large pH values can be observed in the Northern region of the map and small pH values can be observed in the Southern region (Figure 2). When clay content is increased the pH also has increased. That may be due to the increasing of the concentration of the exchangeable Ca and exchangeable Mg with the increasing of clay content. There are significant correlations between soil pH and exchangeable Ca (r=0.734), soil pH and exchangeable Mg (r=0.676) and Soil pH and clay percentage (r=0.623).

Significant positive correlations with soil exchangeable Ca, exchangeable Mg and soil clay content with soil pH have been found by Ige et al.[2] Soil available phosphorus showed a significant negative relationship with soil clay percentage (r=-0.329) at 0.01 probability level. However, the correlation coefficient is not large but the spatial distribution pattern of phosphorus (Figure 5) indicates that the phosphorus is relatively more deficient in high clay area. Several studies have shown significant effect of soil clay content on phosphorus sorption.[3–5] High surface area and presence of various P sorbing minerals that results in the common observation that high clay soils often adsorb more P compared with coarse-textured soils.

Table 1 Results of exploratory data analysis

Variable	Minimum	Maximum	Mean	CV
Clay (%)	1.5	34.87	16.3	46.6
Sand (%)	55.2	91.5	72.6	11.7
P (ppm)	2	35	9.59	66.7
Ca (ppm)	353.51	1905.17	1007.1	43.1
Mg (ppm)	74.31	322.88	193.64	34.5
p^H	4.97	6.94	6.04	8

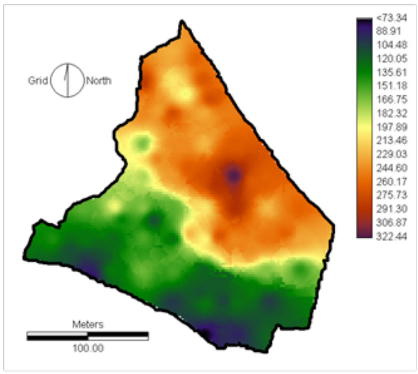

Figure 3 Spatial variability of exchangeable Mg.

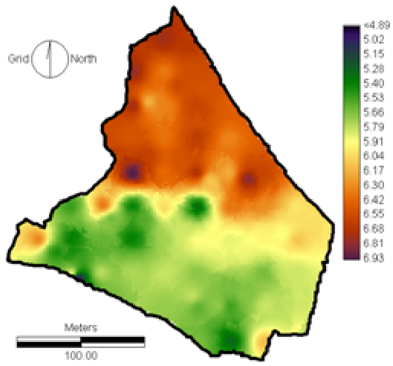

Figure 4 Spatial distribution of Soil pH.

Citation: Haputhantri TR, Vitharana WAU. An approach for site specific nutrient management in paddy growing soils. *Adv Plants Agric Res.* 2015;2(5):227–229. DOI: 10.15406/apar.2015.02.00066

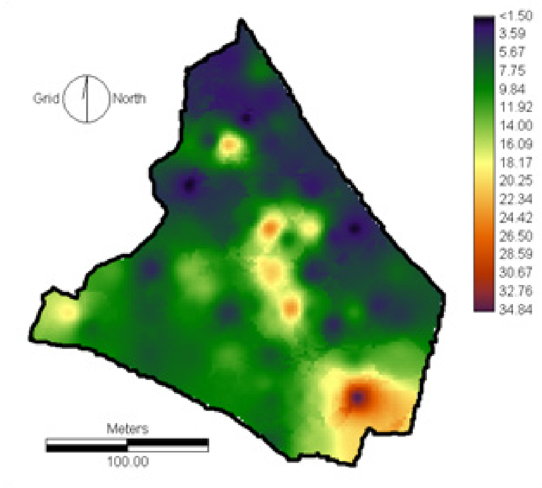

Figure 5 Spatial variability of available P.

Conclusion

There is a considerable with-in field variability of soil texture and other chemical properties. Variability of the soil chemical properties is mainly attributed to the variability of soil texture. Continuous map of soil texture has similar spatial distribution patterns with exchangeable Ca, exchangeable Mg and soil pH. Study showed that within field variability in paddy soils are significant enough to support SSNM. The studied paddy field can be divided into different management zones using the spatial distribution pattern of different soil properties.

Acknowledgements

First and foremost I express my sincere thanks to Dr. W.A.U. Vitharana, Senior Lecturer, Department of Soil Science, Faculty of Agriculture, University of Peradeniya, for giving me an invaluable guidance and encouragement throughout the period of my research. I wish to express my deep sense of gratitude to Mr. Priyanga Dematawa, General Manager, CIC seed farm, Pelwehera, for his guidance, useful suggestions as well as the laboratory facilities given.

Conflict of interest

The author declares no conflict of interest.

References

1. Dobermann A, Witt C, Dawe D. Performance of site specific nutrient management in intensive rice cropping systems of Asia. *Better Crops International*. 2002;16(1):25–30.
2. Ige DV, Akinremi OO, Flaten DN. Direct and indirect effects of soil properties on phosphorus retention capacity. *Soil Sci Soc Am J*. 2007;71(1):95–100.
3. Kang J, Hesterberg D, Osmond DL. Soil organic matter effects on phosphorus sorption:a path analysis. *Soil Sci Soc Am J*. 2009;73(2):360–366.
4. Maynard JJ, Geen ATO, Dahlgren RA. Spatial relationships of phosphorus sorption in a seasonally saturated constructed wetland soil. *Soil Sci Soc Am J*. 2009;73(5):1741–1753.
5. Zhang H, Schroder JL, Fuhrman JK, et al. Path and multiple regression analyses of phosphorus sorption capacity. *Soil Sci Soc Am J*. 2005;69(1):96–106.

Citation: Haputhantri TR, Vitharana WAU. An approach for site specific nutrient management in paddy growing soils. *Adv Plants Agric Res*. 2015;2(5):227–229.
DOI: 10.15406/apar.2015.02.00066