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Spatial and Temporal Variability of Macronutrients in a Lime-amended Acid Paddy Field

E. Vidal Vázquez (1), L. A. Morales (2), and A. Paz González (1)

(1) Soil Science, University of Corunna, Zapateira sn, 15005 Coruna, Spain (tucho@udc.es), (2) Soil Science, University of Corrientes, Sargento Cabral, sn, Coorientes, Argentina

Soil spatial variability is a natural occurring and or management induced feature that is important for site-specific management practices such as variable rate fertilization. Since rice paddy fields are flat and flooded, apparently they should be homogeneous and subsequently it could be thought that spatial variability in yields and soil attributes might be negligible. However, significant levels of variability in soil general properties, soil nutrients and rice yields have been observed even in small paddy fields. Describing spatial variability of within-field properties is a fundamental first step toward determining management strategies. The aim of this study was to analyze patterns of spatial variability in available macronutrients (NH_4^+-N, P and K) from an acid rice soil submitted to lime amendment.

The experimental site was located at Corrientes province, Argentina. The climate is warm, subtropical with abundant rainfall the whole year round. The study soil was typic Plintacualf. Field trials were set up involving three treatments: control, without lime addition, plus two different dolomite doses of 625 and 1250 kg.ha^{-1}. Before lime addition, soil pH was 3.7; organic matter content was 2.14 % and cation exchange capacity (CEC) was 21.7 Cmolc kg $^{-1}$. Soil was sampled at three different stages, first before sowing in aerobic conditions and them two more times in anaerobiosis, i.e. by bunch formation and flowering. Ninety-six soil samples per treatment were taken during each of the three sampling periods. NH_4^+-N, P and K were routinely determined. Spatial variability was assessed through the analysis of semivariograms. Next, kriging maps were constructed and compared for successive sampling dates.

The statistical variability of NH_4^+-N, P and K over the study period was low to medium, depending on treatment and sampling dates. Lime application produced a positive effect on the NH_4^+ availability at sowing time. Increased Olsen-P availability during sowing and tillering could be also attributed to lime addition, but a negative effect of liming on P availability was observed during flowering. Mehlich I extractable K was in general low to very low and decreased from sowing to flowering, irrespective of lime treatment.

Semivariogram analysis showed a rather strong spatial dependence of NH_4^+, P and K concentrations and this all over the three study periods and for the three lime treatments. Empirical semivariograms could be adjusted quite well by a nugget component (C_0) plus a spatial structure (C_1), which was described by spherical or exponential models with a correlation range between 40 and 85 m. Geostatistical analysis provided insight into possible processes responsible of the observed spatial variability patterns within the rice soil. Kriging was useful in mapping macronutrient variability allowing identifying microrregions with high or low values of the target soil properties clearly showing the presence of small scale variability for the study soil attributes within each liming treatment and during each of the three sampling dates. Also the position of patches with maxima and minima values changed between successive sampling dates illustrating the lack of temporal stability of the pattern of spatial distribution for the study soil attributes. Results illustrate the potential for applying the principles of precision agriculture to control spatiotemporal variability in rice fields.