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Geophysical Research Abstracts
Vol. 19, EGU2017-19631, 2017
EGU General Assembly 2017

Refine phosphorus stratification caused by long-term tillage and P fertilisation in maize -soybean rotation in eastern Canada

Noura Ziadi (1) and Christian Morel (2)

(1) Quebec Research and Development Centre, Agriculture and Agri-Food Canada, Quebec, QC, G1V 2J3, Canada , (2) INRA, UMR 1391 ISPA INRA Bordeaux Sciences Agro, F-33140 Villenave d'Ornon, France

The use of conservation tillage for crops production worldwide has increased markedly over recent years. Nutrient distributions under no-till (NT) compared with conventional moldboard tillage (CT) management in the cold, humid region of the eastern Canada need to be assessed for future placement, quantity, and type of fertilizers to efficiently match crop demands. We determined soil-profile distributions of soil total C (TC), total N (TN), and phosphate ions concentration (CP) in soil solution to a depth of 0.4 m after 23 years of continuous CT and NT management at different P fertilization rates on a clay loam soil in eastern Canada cropped with grain maize – soybean rotation. The experimental site was initiated in 1992 in southern Quebec, Canada. In August 2014, soil samples were collected at five profiles: 0 to 5, 5 to 10, 10 to 20, 20 to 30 and 30 to 40 cm under CT and NT fertilized at three P fertilizations (0 (P0), 17.5 (P0.5), and 35 (P1) kg P ha^{-1} applied as triple superphosphate on maize at 5 cm depth). To refine CNP stratification analysis for NT-P0 and NT-P1, supplemental soils of the 0-5 cm layer were sampled in P0 and P1 and then cutting into 5 layers of 1 cm. Different patterns for CP in relation to P fertilization under CT and NT were observed at the five profiles. The CP values did not differ significantly within ploughed layer but increased with P fertilization, e.g. 0.031, 0.066, and 0.075 mg P L-1 for P0, P0.5 and P1, respectively. Significant decline was observed in deeper depth beyond the plough. The Cp results in NT-P0 did not differ significantly to those of MP-P0. By contrast, highly significant P stratifications were observed in NT-P0.5 and NT-P1, especially marked in NT-P1 for which the CP value in 0-5 cm layer (0.35 mg P L-1) was 50 times greater than that in 30-40 cm layer (0.007 mg P L-1). To refine the C, N, and P stratifications, supplemental sampling was carried out in the 0-5 cm to cut this layer every 1 cm depth for P0 and P1. Most dramatic changes occurred within the 0-5 cm depth. The CP value in the first cm of soil (0.20 mg P L-1) was four times greater than that in the 4-5 cm layer (0.049 mg P L-1) of soil. The main reason for the large P accumulation in the first centimeter of soil is the annual return of plant residues to the soil surface. The stratification of TC and TN within the 0-5 cm layer showed similar trends irrespective of P fertilization. Under NT, the magnitude of CNP stratifications within the 0-1 cm layer to the 4-5 cm layer is equivalent to that observed in the 0-5 cm layer to the 30-40 cm layer.