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Calcium Aluminum Balance (CAB) as new concept for liming materials application to arable soils

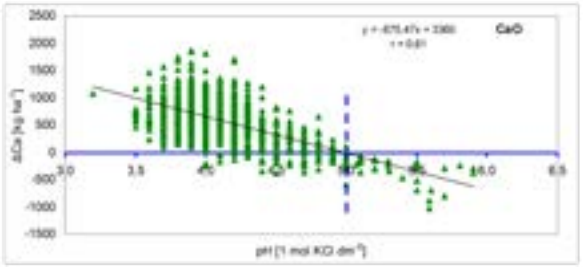
Jean Diatta[1], Witold Grzebisz[1] and Radosław Witczak[2]
[1]Poznan University of Life Sciences, Poland
[2]K+S Polska , Poland

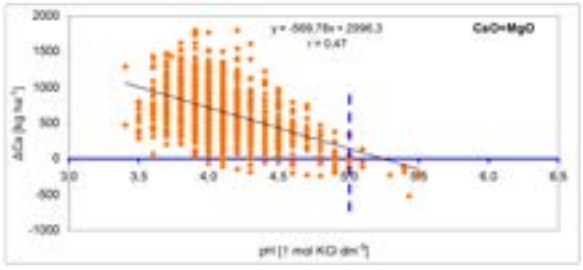
1. Concept Outline: The amounts of Ca currently in the soils, i.e., „in situ" and Al as well as H+ are the core factor that regulates soil pH. Therefore the efficiency of soil pH improvement and stabilization should be based mostly on the real amounts of Ca incorporated into the soils, than the aglime rates, as currently practiced in agriculture. It is assumed that, the Ca saturation of the cation exchange maintains soil reaction at a given pH. Below this level the situation worsens and beyond, therefore improves. The difference (ΔCa) between the steady state (initial pH) and the predicted one is the real amount of Ca (and not liming materials) to incorporate for improving and maintaining soil pH. The concept is briefly illustrated below (Fig. 1).

Fig. 1: Concept of soil borne Ca *versus* pH and Ca incorporation for acidification and agrochemical prediction

2. Theoretical and experimental considerations: The elaboration of the concept was performed on the basis of the following assumptions: -Are pH measurement and acidity determination (Al + H+ mainly) enough for effective regulation of soil pH? - Is the consideration of Ca instead of aglime rates helpful for full control and stabilization of pH of very acid soils? - May CAB (Calcium-Aluminum-Balance) and PGC (Proton Generation-Capacity) indices be applied for calibrating biomass and yields of crop plants? A 3-year study was performed for evaluating acidification impact, and simultaneously predicting agrochemical response of two crop plants (winter wheat and sugar beet). The following parameters/factors were considered: very acid arable land (pH0–60cm 3.8 – 4.4); three (3) aglimes (CaO – 80%, CaO/MgO – 60/20, CaCO3 – 52%) and four (4) rates 0, 500, 1000, 1500 kg as CaO ha-1). Next, nitrogen was applied as NH4NO3 at the rates 0, 60, 120, 180, 240 kg N ha-1.

3. Data validation and quantification:





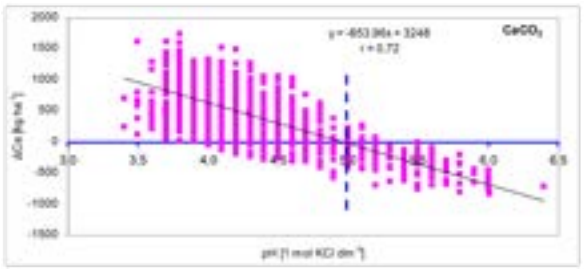


Fig. 2: Relationships between pH and calcium levels (ΔCa) for the tested aglimes (CaO, CaO/MgO, CaCO3)

Results of ground calculations for aglime application:

- 660 kg Ca ha-1, i.e. 925 kg CaO ha-1;
- 720 kg Ca ha-1, i.e. 1010 kg CaO ha-1 (as CaO/MgO),
- 632 kg Ca ha-1, i.e. 885 kg CaO ha-1 (as CaCO3)

were required (on average) for shifting pH from 3.8-4.4 to 5.0

Recent Publications

1. Kidd P.S., Proctor J. (2001): Why plants grow poorly on very acid soils: are ecologists missing the obvious. Journal of Experimental Botany, 52(357):791-799.
2. Pannatier E., Walthert L., Blaser P. (2004): Solution chemistry in acid forest soils: Are the BC:Al ratios as critical as expected in Switzerland. Journal of Plant Nutrition and Soil Science, 167, 160-168.
3. Hazelton P., Murphy B. (2007): Interpreting soil test results. What do all the numbers mean? Australia: CSIRO Publishing; p. 169.
4. Diatta J., Walkowiak R., Grzebisz W., Witczak R. (2012): Aluminum-based winter wheat biomass and grain yield spatial variability in arable soils: concept and field test. Journal of Elementology, 17(2): 215-229.
5. Diatta J., Borowiak K., Szczepaniak W. (2018): Evaluation of fertilizers solubility and phosphate release in slightly acidic arable soil. Archives of Agronomy and Soil Science, 64:8, 1131-1141

Biography

Jean Diatta is a professor (Agriculture and Environmental Protection) at Poznan University of Life Sciences (Faculty of Agriculture and Bioengineering), Poland. Engaged as Lecturer and Scientist. Head of the Environmental Biogeochemistry Division. He has been working on nitrogen kinetics and carbon dioxide release from plant residues (PhD). Soil acidification/degradation and remedial practices particularly in agroecosystems have been for long time his research challenges. Next, he was involved in environmental investigations dealing with urban ecosystems as well as industrial-based degradation/pollution of lands. He is currently involved in innovative recycling of anthropogenic/agricultural/industrial wastes, where he holds a patent pending and some are in finalization. He has published more than 200 peer reviewed papers/book chapters and supervised at least 120 BSc and MSc students. Three PhD students have been also supervised. He has being cooperating with several institutions among others: K&S (Kali und Salz) – Germany; Environmental Institute of Scientific Networks (EISN-Institute, Germany); ZALF, Leibniz Centre for Agricultural Landscape and Landuse (Germany); University of KwaZulu Natal (South Africa); Central Mining Institute (GIG, Poland); Institute of Experimental Biology (Adam Mickiewicz University, Poland); Expert at the Polish Committee for Standardization (Section: Soil Chemistry / Physics and Fertilisers)

jeandiatta63@yahoo.com