Soil apparent conductivity measurements for planning and analysis of agricultural experiments: A case study from Western–Thailand

Sebastian Rudolph (1,2), Chalermchart Wongleecharoen (3,4), Richard Murray Lark (2), Ben Paul Marchant (2), Sarah Garré (5), Michael Herbst (1), Harry Vereecken (1), and Lutz Weihermueller (1)

(1) Forschungszentrum Jülich GmbH, Agrosphere Institute (IBG–3), Jülich, Germany , (2) British Geological Survey, Environmental Science Centre, Keyworth, England, (3) Institute of Plant Production and Agroecology in the Tropics and Subtropics, University of Hohenheim, Germany , (4) Department of Soil Science, Kasetsart University Bangkok, Bangkok, Thailand, (5) Université de Liège, Gembloux Agro–Bio Tech, Gembloux, Belgium

In agricultural experiments the success or failure of a potential improvement is generally evaluated based on the plant response, using proper experimental designs with sufficient statistical power. Because within-site variability can negatively affect statistical power, improvements in the experimental design can be achieved if this variation is well understood and incorporated into the experimental design, or if some surrogate variable is used as a covariate in the analysis. Apparent soil electrical conductivity (ECa), measured by electromagnetic induction (EMI) may be one source of this information. The objective of this study was to investigate the effectiveness of EMI–derived ECa measurements for planning and analysis of agricultural experiments. ECa and plant height measurements of maize (the response variable) were taken from an agricultural experiment in Western Thailand. A statistical model of these variables was used to simulate experiments with different designs and treatment effects. The simulated data were used to quantify the statistical power when testing three orthogonal contrasts. The following experimental designs were considered: a simple random design (SR), a complete randomized block design (CRB), and a complete randomized block design with spatially adjusted blocks on plot means of ECa (CRBECa). According to an analysis of variance (ANOVA) the smallest effect sizes could be detected using the CRBECa design, which suggests that ECa survey measurements could be used in the planning phase of an experiment to achieve efficiencies by better blocking. Also, analysis of covariance (ANCOVA) showed that larger power improvements could be achieved when ECa was used as a covariate in the analysis. We therefore recommend that ECa measurements should be used to describe subsurface variability and to support the statistical analysis of agricultural experiments.