Field heterogeneity as a crucial factor for improving crop growth simulations

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Introduction

Heterogeneity in crop growth, often caused by contrasting soil properties (Fig. 1), is difficult to measure and to model not least due to limited data availability. Measurements of apparent electromagnetic conductivity (ECa) have been proposed to obtain spatially consistent information about soil heterogeneity but have rarely been set into relation to plant measurements. Little work has also been done in validating crop models with respect to their ability to characterize the effect of field heterogeneity on crop growth. This study was to relate the ECa method with measurements of the green leaf area index (GLAI) and to validate a crop model with respect to its ability to reproduce the spatial variability of GLAI of two crops during two different years in Germany.

Materials and Methods

Field experiments

Field experiments for identifying heterogeneous spatio-temporal patterns on field scale were carried out in Selhausen in the central western part of Germany (Fig. 2D).

GLAI was measured destructively in winter wheat and sugar beet during 2011 and 2012 in three different fields (Figs. 2A-C). Up to eight sample points were established within each field which represent the range of different soil types in the fields. Measurements of ECa indicating soil water holding capacity were carried out in March 2012 on these test sites (Figs. 2A-C) for obtaining variabilities in soil conditions. The ECa data shown in Figs. 4 and 5 refers to a soil depth of up to 0.5 m.

Crop modeling

The Light INTerception and UtiLization simulator (LINTUL2) (van Ojen & Leffelaar 2008), successfully used in earlier crop modeling studies, was validated with respect to its ability to reproduce the spatial variability of GLAI within a field. The soil model SLIM (Solute Leaching Intermediate Model) (Addiscott et al. 1986, Addiscott & Withmore 1991), coupled with LINTUL2, was parameterized for the different soil types measured at the sample points.

Results

Correlations between measured LAI and ECa for different sample points in fields with winter wheat and sugar beet in Germany in 2011 and 2012. Sugar beet shows a stronger relation to ECa than the LAI of winter wheat.

Conclusions and Future Work

- GLAI correlates with ECa for winter wheat and sugar beet crops, indicating thereby that differences in soil properties affect GLAI (Figs. 3, 4).
- Crop models applied to heterogeneous fields need to be validated for different parts of the field as shown in Fig. 5.
- Sources of inaccurate simulations need to be further investigated. To which extent more detailed soil and crop physiological models, like GECROS, improve the model accuracy should be tested.

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References


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