Predicting variations in the glyphosate sorption coefficient across two loamy agricultural fields

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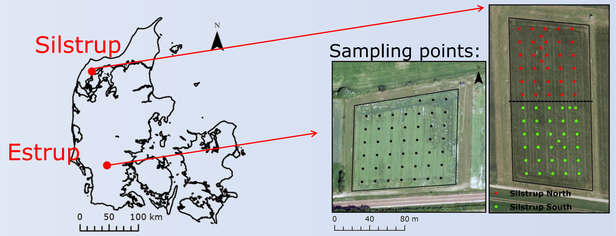
Introduction

Pesticide leaching is highly variable across field scale due to heterogeneities in soil properties and the mechanisms affecting pesticide leaching. Leaching of the strongly sorbing pesticide glyphosate requires increasing attention as the use increases worldwide and glyphosate is detected to a greater extent in drains and groundwater. Sorption highly controls glyphosate mobility and leaching. Predictions of the glyphosate sorption coefficient are needed for reliable risk assessments of groundwater contamination.

Objectives

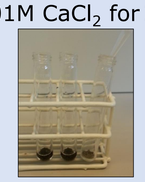
- Estimation of the glyphosate sorption coefficient (K_d) from easily measurable soil properties
- Identification of soil parameters related with glyphosate sorption in multiple linear regression (MLR) analyses for future field-scale screening of glyphosate mobility

Locations and methods



Three replicates of 0.5 g soil

Hydrated with 0.5 mL 0.01M $CaCl_2$ for 24 h



9 mL 0.23 µg L^{-1} glyphosate solution

> End-over-end for 24 h at 20°C
> Centrifugation for 1 h
> 3 mL supernatant + 17 ml scintillation cocktail
> Scintillation counts

Glyphosate sorption coefficient (K_d): $K_d = \frac{C_s}{C_e}$

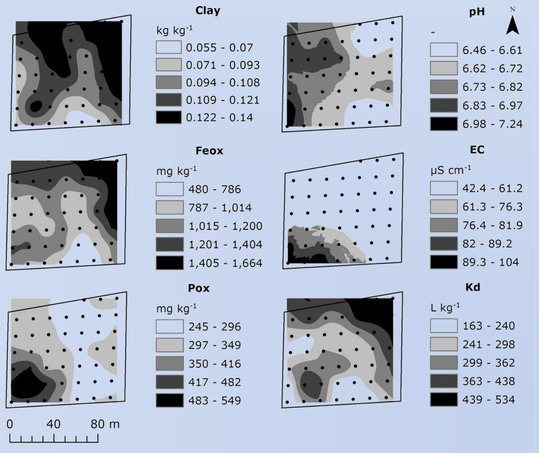
C_s: amount of glyphosate sorbed by the soil (g kg^{-1});
C_e: glyphosate concentration in solution at equilibrium (g L^{-1})

Soil properties: Clay, silt, sand, OC, EC, pH, Olsen P (available phosphorus), olaxate-extractable aluminum (Al_{OX}), iron (Fe_{OX}) and phosphorus (P_{OX}).

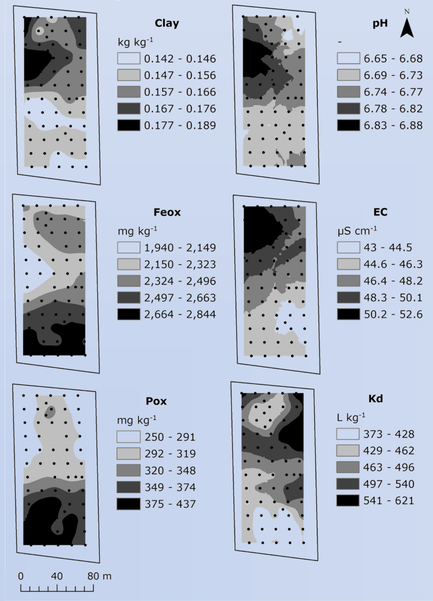
Field scale variations

Geographical scenarios: (i) each field separately, (ii) both fields together, and (iii) Silstrup North and South separately.

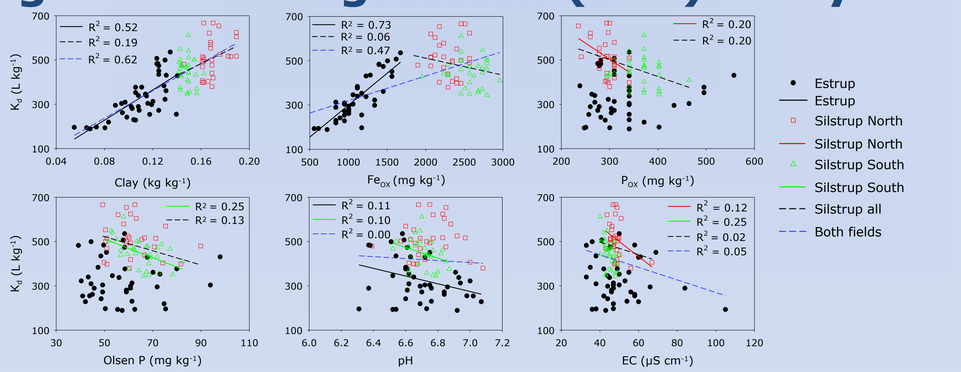
Estrup:



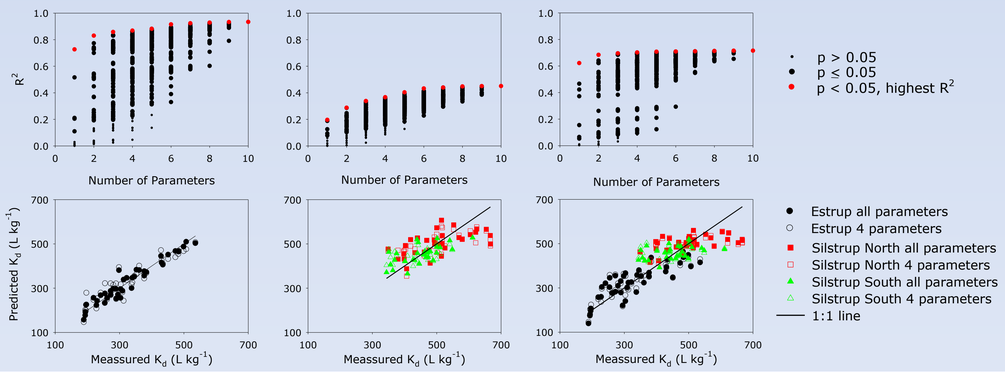
Silstrup:



Single Linear Regression (SLR) analyses



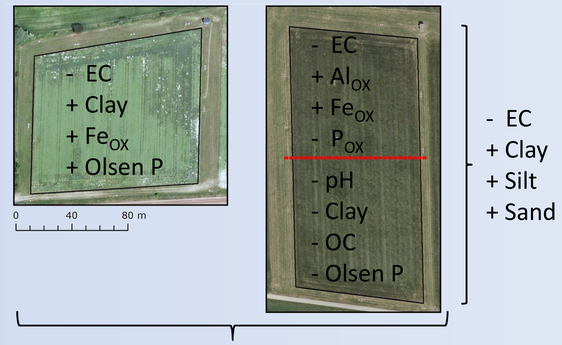
Multiple Linear Regression (MLR) analyses



Best four sets – Towards field scale screening and risk assessment models

	Estrup	Silstrup all	Silstrup North	Silstrup South	Both fields
R^2 single analyses	0.73	0.20	0.17	0.25	0.62
R^2 4 parameters	0.87	0.37	0.43	0.54	0.70
R^2 all parameters	0.93	0.45	0.50	0.69	0.72

– Best single predictor change with the geographical scenario (Fe_{ox} for Estrup, P_{ox} for Silstrup)
– MLR predictions improved from SLR. Diminishing effect of MLR with more than 4 parameters



Conclusions & Perspectives

Considering correlations with all possible sets of measured parameters, a best-four set of parameters was identified for each field. The composition differed for the geographical MLR scenarios, suggesting that different properties control glyphosate sorption in different locations. The most common parameters in the best-four sets included clay and pH, together with Fe_{OX}, EC and phosphorous. These have been reported before as important drivers of glyphosate sorption previously.

References

Paradelo, M., Norgaard, T., Moldrup, P., Ferré, T.P.A., Kumari, K.G.I.D., Arthur, E., and de Jonge, L.W. 2014. Prediction of the glyphosate sorption coefficient across two loamy agricultural fields. Submitted to Geoderma.

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