Spatio-temporal patterns of crop signals: is UAV-based multispectral imagery a suitable tool to detect soil compaction at field scale?

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Soil compaction due to heavy machinery is one of the major soil degradation threats in modern agriculture. Field traffic under unfavorable weather conditions can increase bulk density and penetration resistance, reduce soil hydraulic conductivity and plant growth. An increased surface runoff caused by a decreasing infiltration further grows the effects of nutrient leaching and the eutrophication of adjacent water bodies. For soil compaction prevention, it is necessary to know where soil compaction occurs. The detection of this issue is, however, cost, time and labor intensive.

The aim of this study is to evaluate the use of UAV-based multispectral imagery analyses to detect soil compaction pattern at field scale. Therefore, UAV imagery of two sugar beet (Beta vulgaris L.) fields were captured in April, June, July and November of 2019 to analyze different crop signals. The crop surface model and the NDVI were used as a predictor to reflect plant and biomass status. The k-means clustering algorithm was used to combine plant height and NDVI to detect spatial-temporal patterns of low crop performance. Sites with lower crop performance were assumed as potential sites of soil compaction; here, further measurements (penetration resistance, infiltration rate) were conducted and soil and yield samples were taken.

First results show that (1) spatio-temporal patterns of crop performance can be found; (2) sites with low crop performance have a lower infiltration rate and lower crop yield; (3) the measurements of penetration resistance are inconclusive.

As soil compaction reduces infiltration rate and yield, this study shows first indications that it is possible to detect soil compaction via plant signals using UAV. This has a big potential for practical use as costs for drones are declining and they are gaining popularity under farmers. Thus, the use of UAV may enable farmers to monitor their fields, identify areas of soil compaction and in the following implement measures against soil compaction.