#7448 SOIL MAPPING WITH THE VERIS U3 SOIL SCANNER IN A PRECISION FARM IN HUNGARY

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ABSTRACT

Currently, field crop production faces constant challenges. Extreme climatic conditions, deteriorating circumstances on the field have a negative impact on the quantity and quality of available yields, and the ever-changing agro-economic environment makes the profitability of the sector uncertain

The examined farm is located in the eastern part of Hungary, and as of 2013, it started to gradually introduce precision farming in field crop production. The fields of the farm are heterogeneous, there are areas with low productivity on certain fields. The total area is 942 hectares, of which 230 hectares were examined. Measurement of the soil electrical conductivity (EC_a) of the upper 60 cm soil layer were performed on designated field plots of the farm with a Veris U3 soil scanner. Harvesting of the examined areas, grain moisture measurement and yield mapping were performed by means of a JD S770i type combine harvester; the data were provided by KITE cPlc. The vector point-like Veris U3 data and yield data were projected onto a 10x10 m resolution polygon grid prepared from Sentinel 2 raster satellite imagery for numerical statistical correlation analysis in the GIS database

On the examined plots there are saline spots and buried watercourses, which, depending on the crop year, also have a positive and negative effect on the yield of cultivated plants. In the average of the examined fields (230 ha), the conductivity measured by Veris U3 in 2016 showed a moderately weak ($r = 0.29$) correlation with the yield mapped by the combine.

INTRODUCTION

Currently, field crop production faces constant challenges. Extreme climatic conditions, deteriorating circumstances on the field have a negative impact on the quantity and quality of available yields (De Benedetto et al., 2013)., and the ever-changing agro-economic environment makes the profitability of the sector uncertain. Huang et al. (2017) found that an increase in the electrical conductivity (EC_a) of the soil determined between different zones of the field reduced the yields of cultivated plants at the same pH, regardless of the nitrogen supply of the soil. According to Kravchenko and Bullock (2002), the variables influencing the yield of crops, the topographic characteristics of a plot might vary from micro-topography to catchment size. Precision crop production means site-specific agricultural cultivation tied to geographical coordinates. Modern strip tillage technology based on precision technology for crops with wide row spacing is becoming more and more popular in Hungary as well. Strip tillage combines the benefits of conventional tillage systems with the soil-protecting advantages of no-tillage. Maize, sunflower and rapeseed have all been successfully strip tilled in Hungary. In Hungary, high-precision RTK (Real Time Kinematic) covers 95% of arable land in 2020.

MATERIALS AND METHODS

The examined farm is located in the eastern part of Hungary, and as of 2013, it started to gradually introduce precision farming in field crop production. The fields of the farm are heterogeneous, there are areas with low productivity on certain fields. The total area is 942 hectares, of which 230 hectares were examined. Measurement of the soil electrical conductivity (EC_a) of the upper 60 cm soil layer were performed on designated field plots of the farm with a Veris U3 soil scanner. On the 120-hectare field plot of the farm, harmful inland water was drained using a 3D RTK application, following the maize harvest in 2018. This plot was examined with a VERIS U3 soil scanner before and after water management. Agro-technical interventions, their documentation and mapping were recorded on the on-board computers of a John Deere machines. Maize, wheat, soybean and sunflower varieties were sown on the examined plots in the examined period of 2016-2019. The research was performed in cooperation with one of the largest agricultural integrators and service providers in Hungary. Harvesting of the examined areas, grain moisture measurement and yield mapping were performed by means of a JD S770i type combine harvester; the data were provided by KITE cPlc.

The vector point-like Veris U3 data and yield data were projected onto a 10x10 m resolution polygon grid prepared from Sentinel 2 raster satellite imagery for numerical statistical correlation analysis in the GIS database. A linear and multilinear regression analysis was performed from the GIS database using RStudio.

RESULTS AND DISCUSSION

On the examined plots there are saline spots and buried watercourses, which, depending on the crop year, also have a positive and negative effect on the yield of cultivated plants. In the average of the examined fields (230 ha), the conductivity measured by Veris U3 in 2016 showed a moderately weak ($r = 0.29$) correlation with the yield (Figure 1) mapped by the combine. In 2017, the correlation between electrical conductivity (EC_a) of the soil and yield (t/ha) was moderately weak ($r = 0.4$) when examined together on several plots; the correlation was the strongest from among the analysed years.

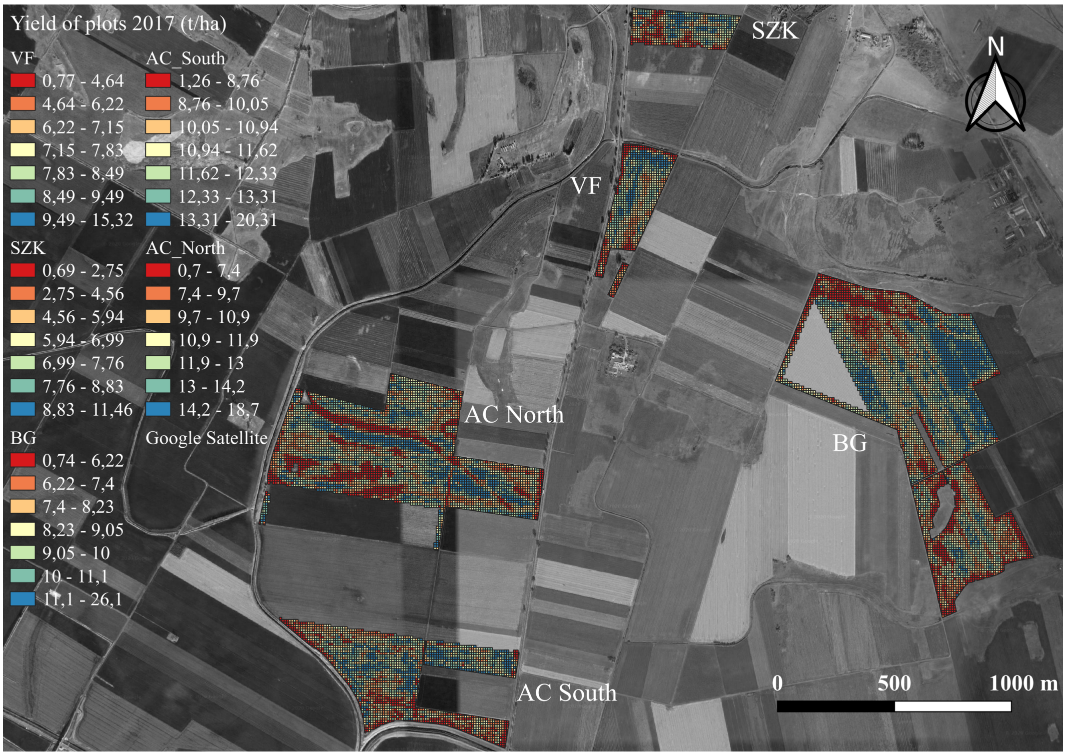

Figure 1. Yield map of the examined field plots (Hungary, Hajdú-Bihar county, 2017)

In 2018, the correlation between EC_a and yield data was weak (r = 0.29) on the examined plots, in 2019 the correlation between yield and EC_a values of the soil of the plots was negligible (r = 0.08).

Inland drainage on the 120-ha plot changed moisture conditions, however, the correlation between the two EC_a values measured by Veris remained strong (r=0.79). A moderate (r = 0.55) correlation was found between the elevation data of the soil surface determined by RTK and the EC_a values (Figure 2).

On the examined 120-hectare field, the correlation between the 2016 yield data and the EC_a data measured in 2018 was moderately weak (r = 0.38). The correlation between the 2017 harvest and the 2018 EC_a data was also moderately weak (r = 0.32). The yield data of the stock sown and harvested after the soil scan in 2018 were moderately (r = 0.53) related to the EC_a values. After the autumn harvest of 2018, the plot drainage of the plot was assessed with a 3D application, thus the Veris U3 measurements were now repeated in the spring of 2019 with the support of RTK. The link between EC_a and yield data measured this year was weak (r = 0.25). We also found a very weak (r = 0.2) correlation between the original 2018 EC_a distribution of the plot and the 2019 yield.

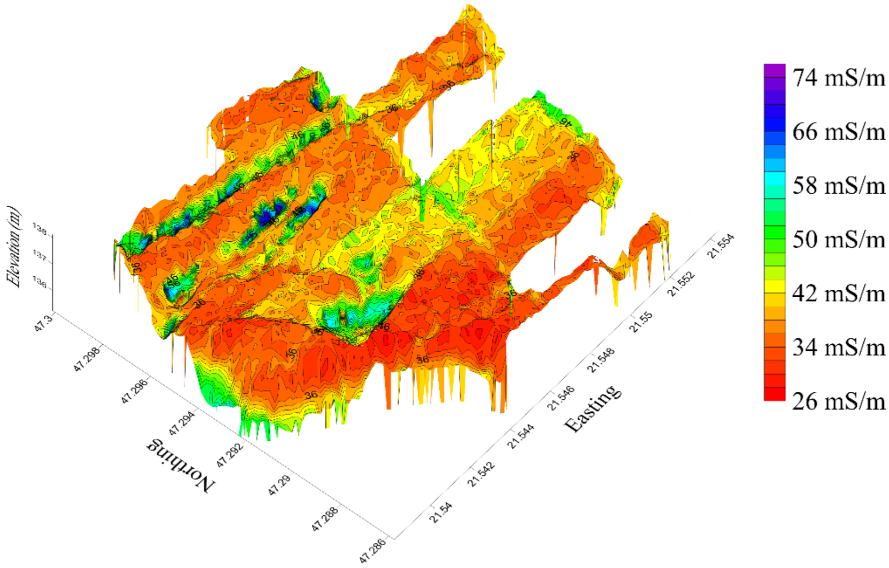

Figure 2. Surface elevation (m) and soil electrical conductivity (EC_a) values on the examined field plot (Hungary, Hajdú-Bihar county, 2019)

Examined by multilinear regression, the 2018 EC_a and elevation data were moderately (r = 0.55) correlated with the 2016 yield data. The 2017 yield data were moderately weakly (r = 0.4) correlated with the 2017 yield data. In the year of mapping, the correlation between the 2018 yield data and the altitude and EC_a data was moderately close (r = 0.57). The relationship between the 2019 EC_a, elevation, and yield data was moderately weak (r = 0.3).

Overall, it can be stated that the given crop year greatly influences the EC_a correlation between the crop and the soil, i.e. the soil patches also modify the yield of the crops within the field to a varying extent, depending on the crop year.

ACKNOWLEDGEMENTS

The research was supported by the project "Establishing a scale-independent complex precision consultancy system (GINOP-2.2.1-15-2016-00001)".

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