#7445 A CHEAP ALTERNATIVE TO DATA MANAGEMENT AND CREATING OF YIELD MAPS OF SMALL-PLOT FIELD EXPERIMENTS

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ABSTRACT

Due to the effects of climate change, the spatial and temporal distribution of precipitation is currently extremely variable. Long-term field trials provide an opportunity to examine the long-term effects of crop production factors and the effect of different crop years can also be analysed. In the long-term field trial, spatial representation of the data belonging to each plot might be necessary for the purpose of soil heterogeneity analysis, working hypothesis, or even presentation.

The long-term field trial included in the analysis is located in the eastern part of Hungary, east of Debrecen. The long-term experiment was founded in 1989 by Prof. Dr. János Nagy. The long-term experiment consists of 3 tillage 3 fertilizer treatments 2 forecrop 2 irrigation 3 genotype 2 plant number treatments in 4 repetitions. In the present article, the 2015-2019 period of the long-term trial is examined.

In the average of the 5 examined crop years, there is no statistical difference between the ripped (10.64 t/ha) and winter ploughed (10.58 t/ha) cultivation. The yield of strip tillage was statistically 8.57% lower than that of the winter ploughed treatment.

The statistical evaluation confirmed that the crop year clearly influenced the maize yield in the average of primary tillage.

INTRODUCTION

Due to the effects of climate change, the spatial and temporal distribution of precipitation is currently extremely variable. Long-term field trials provide an opportunity to examine the long-term effects of crop production factors and the effect of different crop years can also be analysed. In the long-term field trial, spatial representation of the data belonging to each plot might be necessary for the purpose of soil heterogeneity analysis, working hypothesis, or even presentation. Researchers dealing with long-term field trials usually store the measurement data for a given experiment in MS Excel or in a database of a statistical software and perform statistical analyses by means of them. However, in long-term trials, possible treatment modifications or plot mergers make it difficult to standardize the database. It is difficult to retract a database of several crop years from the lines of the database for each plot, and it is also difficult to display the measurement data even for a given year. Yield mapping using GPS is now an available option, however, a plot harvester equipped with a robotic steering wheel and a GPS-based RTK (real time kinematic) system requires a large investment. Spatial data originated from yield mapping also require the application of GIS.

MATERIALS AND METHODS

The long-term field trial included in the analysis is located in the eastern part of Hungary, east of Debrecen. The long-term experiment was founded in 1989 by Prof. Dr. János

Nagy. The long-term experiment consists of 3 tillage 3 fertilizer treatments 2 forecrop 2 irrigation 3 genotype 2 plant number treatments in 4 repetitions. In the present article, the 2015-2019 period of the long-term trial is examined. As of 2015, the trial includes the traditional winter ploughed, a ripping tillage treatment without ploughing, and the RTK-based modern strip tillage treatment introduced by a company engaged in agricultural trade and services in Hungary. Satellite or UAV-based remote sensed data or field measurements can also be used to generate the yield map. In the present article, the experimental plots were digitized based on UAV footage using the open source, free Quantum GIS software. The longer time series numerical statistical database and the plot yield data of the given year were integrated into a GIS database.

According to the storage method used in GIS, the layer (*.shp) files in Quantum GIS store the outline, there are additional 5 files, one of which is the database (*.dbf) file, which stores attribute table belonging to the layers. This no longer meets the criteria for a proper database for long-term experiments over several years (Huzsvai, 2012). The input interface of the Quantum GIS attribute table provides relatively few options for simple data entry. It sorts the attribute line for the selected element in the given layer to the first position, but it is difficult to enter large amounts of data one by one for the given parcels. The Open Office Calc software handles .dbf files easily and correctly, and the column and decimal separators can be specified individually when opening files with a .csv extension. With the help of the above, the lines of data filtered from the original database were attached to the lines of the .dbf database belonging to the parcel outlines in the appropriate order. Bypassing the QGIS data entry interface with this procedure, a large amount of data can be attached to each plot outline, and no separate data entry is required other than creating a database for basic statistics.

RESULTS AND DISCUSSION

The GIS database created in Quantum GIS, with its large amount and relatively easy to attach data, offers a solution for the proper spatial and temporal identification of each plot, which is a practical problem in long-term experiments (Figure 1). This makes it easier to track the experiment, or even any change that might occur in it. The existing GIS database can be exported in a number of formats, including *kml*, which can be displayed using Google Earth.

Another solution to display the previously created *kml* files is to import them into Google My Maps that is available under Google Drive, where it is possible to view the map using a browser. With Google Drive and My Maps, these maps can be shared even within a research group, as well as outlines can be edited, and blank columns that already exist within the attribute table can be filled with measurement data.

In addition to the GIS visualization, the data of the long-term experiment were processed by numerical statistical method and RStudio. The yield results of the experiment were examined using a repeated measurement model and the method of least significant difference (LSD). In the scope of the evaluation, the yield results of the non-irrigated, monoculture maize, 80 kg N/ha 60 kg P_2O_5/ha 90 kg K_2O/ha nutrient levels were examined in the 2015-2019 crop years. There was no statistically significant difference between the columns marked with the same letter in the figures.

In the average of the 5 examined crop years, there is no statistical difference between the ripped (10.64 t/ha) and winter ploughed (10.58 t/ha) cultivation. The yield of strip tillage was statistically 8.57% lower than that of the winter ploughed treatment.

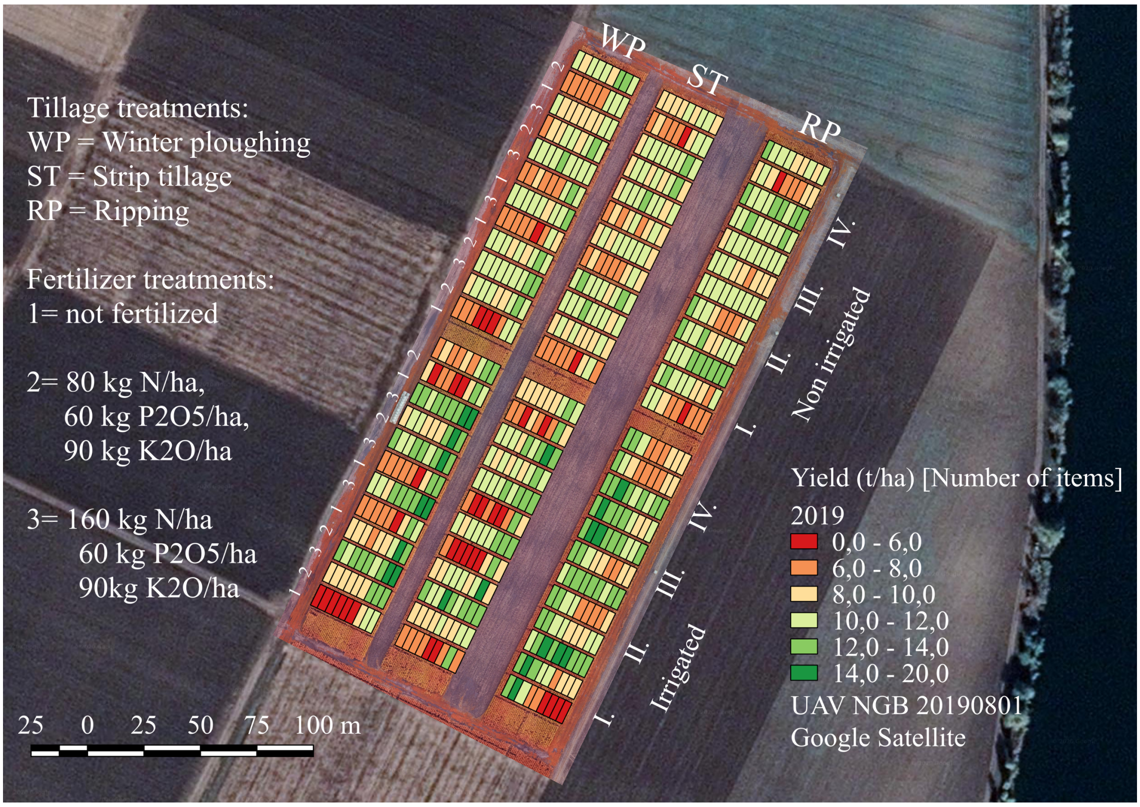

Figure 1. Analog measured and digitized maize yield map of the long-term experiment (Debrecen-Látókép, Hungary, 2019)

The statistical evaluation confirmed that the crop year clearly influenced the maize yield in the average of primary tillage. According to Gombos and Nagy (2019), the average temperature of the experimental space is 10.4 °C, the average annual precipitation is 550 mm. The lowest yield (8.96 t/ha) in the average of tillage was measured in the warmer and drier year of 2015. Then, the yield of the 2016 crop year (12.97 t/ha), which was 0.89 °C warmer than average but 267.8 mm more precipitation, was significantly higher than the other crop years included in the study. It was 4.01 t/ha (+144.8%) higher than the average yield in 2015 and 2.71 t/ha (+126.4%) higher than the average yield achieved in 2019. The second lowest yield of the study period (9.58 t/ha) was measured in the 2017 crop year, which was 0.98 °C warmer than the average and had 91.1 mm more precipitation. In this crop year, maize produced 3.39 t/ha less than before. The yield of the 2018 crop year with an average rainfall but warmer than average (+1.34 °C) was 2.83 t/ha lower than the 2016 average yield. The last year of the study (2019) was 2.74 °C warmer than average and 191.7 mm less precipitation fell, however, the yield did not differ statistically from the yield of 2018.

Primary tillage and crop year influenced maize yield together. The lowest yield results of the examined period were observed in 2015 (+1.45 °C, -32.5 mm), in this crop year there was no significant difference in yield between the three tillage variants. In the year 2016, which provided an outstanding yield (+0.89 °C, 267.8 mm), the three tillage variants differed statistically. The highest yield of the examined period was 13.77 t/ha with the winter ploughed primary tillage, while the second highest yield was achieved in the same year (2016) with the ripped (13.01 t/ha) tillage. The peak yield of 12.13 t/ha of strip tillage was also measured in the 2016 crop year. In 2017 (+0.98 °C, +91.1 mm) there was no statistical difference between the yields of winter ploughed and ripped tillage, of which the maize yield of strip tillage was 0.73 t/ha less. In 2018, which was warmer than average (+1.34 °C) but came with average rainfall

(+1.5 mm) there was no statistical difference between winter ploughed (9.93 t/ha) and strip tillage (9.68 t/ha). In this crop year, the highest yield was achieved with ripping (10.81 t/ha). In the dry 2019 (+2.74 °C, -191.7 mm) crop year, there was no statistical difference between the yield of ripped (10.51 t/ha) and winter ploughed (10.31 t/ha) treatments. In this crop year, there was no difference between strip tillage (9.95 t/ha) and winter ploughing (Figure 2).

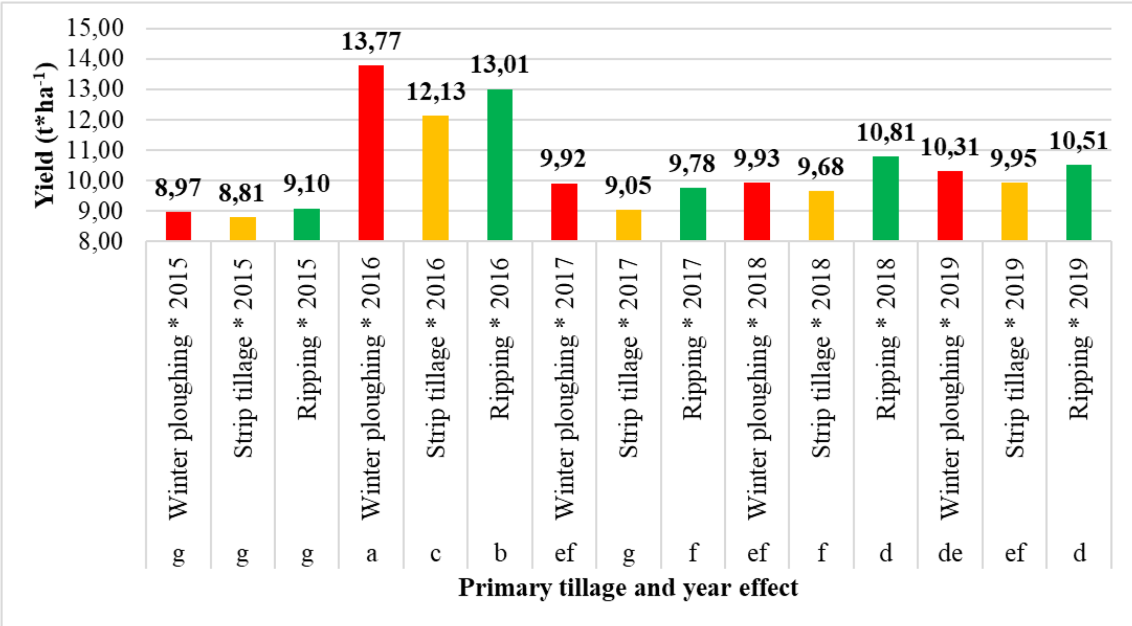

Figure 2. The effect of primary tillage and crop year on maize yield (Debrecen-Látókép, Hungary, 2015-2019)

The applied GIS method is suitable for the spatial display of data from small-plot long-term experiments, for the management and storage of long time series data. Based on the results of the study, the yield of the winter ploughed primary tillage exceeded the strip tillage only twice in the 5 years examined. This also supports the spread of non-ploughing tillage among farmers. The strip cultivator disturbs only 30% of the soil surface and is therefore more energy efficient than the other two studied tillage variants.

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