The effects of the soil tillage and the fertilization on the NDVI values of the maize plant

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Introduction

In our time, determination of optimal fertilizer doses is becoming more and more important (*Széles et al*., 2012). Proper dosages during the growth period can be ensured via instrumental measurements, as maize utilizes different nutriments at a variable rate in the course of its growth.

Materials and methods

The aim of our research is to monitor the NDVI values of the maize in different soil tillage and fertilizer treatments in non irrigated conditions with 80.000 plants ha^{-1} by using handheld Trimble Greenseeker. The measurements was carried out in the polyfactorial long-term maize field experiment at the trial site of the University of Debrecen (Hajdúság loess plateau, 47° 30' N, 21° 36' E, 121 m elevation) in 2017. The statistical analysis was carried out in R statistical environment (R Core Team, 2016) RStudio (RStudio Team, 2018) graphical interface, with the "agricolae" (de Mendiburu, 2017) package. For the analysis of correlation between tillage, fertilization and NDVI values, a repeated measurement model was created based on the example of Huzsvai and Balogh (2015), while the multiple mean comparison was carried out by means of the Student-Newman-Keuls test. The example code of the repeated measurement model in the R statistical environment:

*model<- aov(NDVI~soil_tillage*fertilizer*phenologycal_phase+Error(plot_id/phenologycal_phase), data=database))*

summary(model)

Results and discussion

Based on the repeated measurement model, tillage had no statistically verifiable effect at 5% level of significance. Fertilization significantly increased the NDVI values of maize compared to the control plots, but there was no difference between the two fertilizer treatments. The interaction between tillage and fertilization influenced the NDVI values measured in maize. In the average of every measurement date, autumn ploughing, strip tillage and the subsoiling did not differ on the control plots. In the case of the 80 kg N ha^{-1} + PK fertilizer treatment, there was no verifiable difference amongst the three tillage treatments. There was statistically verifiable difference in the average of the three measurement times between the winter ploughed control and the subsoiled 160 kg N ha^{-1} + PK plots. All three measurement times were statistically different from each other. After the NDVI value measured during the 4 leaf stage, an increase was observed, and then the

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highest value was measured before the second cultivation, followed by a decline. The lowest NDVI value was measured at the first measurement date in the autumn ploughed treatment; strip tillage and subsoiling treatment did not differ from each other. There was no difference between the autumn ploughed and the strip tillage treatment at the second measurement date; the highest NDVI value this time was measured in the subsoiling treatment. At the time of silking, larger NDVI values were measured on ploughed plots; both the strip-tillage and subsoiled plots were below that. At the time of the first measurement, fertilization was statistically proven to increase the NDVI values compared to the control plots. At this time, there was no difference between the two fertilizer levels. At the second measurement time, the highest NDVI values were measured with the 80 kg N ha^{-1} + PK treatment. At this time, there was no significant difference between the control and 160 kg N ha^{-1} + PK plots. At the time of silking, there was a significant decline in all three fertilizer treatments compared to the previous date. At this time, NDVI values measured on the control plots were statistically below the fertilized plots, and no statistically verifiable difference was found at this time.

Conclusions

The measured agrotechnical parameters as well as the timing of the measurement influenced the manually measured NDVI values. Due to its measurement principle, the device also measures soil in small plant stocks, therefore it greatly influences the received data. At the time of silking, the decline can be explained by the large amount of pollen.

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