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USE OF THE CROP CIRCLE ACS-430 DEVICE FOR IDENTIFYING THE NDVI GREEN INDEX IN A CORN CULTURE IN SIBIU COUNTY, ROMANIA

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Abstract. The present study is part of a much larger research that took place over two years in a corn crop in the commune of Apoldu de Jos (Sibiu, Romania), starting from the idea that the same production can be obtained, only by fertilizing with urea in the preparation of the germination bed, and not when ammonium nitrate is applied in two passes, sowing and during the growing season of the crop. The present paper aimed to determine the green index by performing measurements in different phases of crop vegetation, correlated with the administration of urea and ammonium nitrate fertilizers, to the two experimental plots of corn V_1 and V_2, using the device Crop Circle ACS-430, held by the Faculty of Agricultural Sciences, Food Industry and Environmental Protection within the Lucian Blaga University of Sibiu.

Keywords: measurements, corn cultivation, Crop Circle ACS-430.

Rezumat. Utilizarea aparatului Crop Circle ACS-430 pentru identificarea indicelului de verde NDVI, într-o cultură de porumb din județul Sibiu, România. Studiul prezent face parte dintr-o cercetare mult mai amplă ce s-a desfășurat pe parcursul a doi ani într-o cultură de porumb din comuna Apoldu de Jos (Sibiu, România), ce a pornit de la ideea că aceeași producție poate fi obținută, doar prin fertilizarea cu uree la pregătirea patului germinativ, și nu când se aplică azotatul de amoniu în două treceri, la semănat și în timpul perioadei de vegetație a culturii. Prezenta lucrare, a avut ca scop determinarea indicelui de verde prin efectuarea de măsurători în diferite faze de vegetație a culturii, corelată cu administrarea fertilizanților pe bază de uree și azotat de amoniu, la cele două parcele experimentale de porumb V_1 și V_2, prin utilizarea aparatului Crop Circle ACS-430, aflat în dotarea Facultății de Științe Agricole, Industrie Alimentară și Protecția Mediului din cadrul Universității Lucian Blaga din Sibiu.

Cuvinte cheie: măsurători, cultură de porumb, Crop Circle ACS-430.

INTRODUCTION

Precision agriculture is increasingly applied worldwide, but it has begun to be practiced in Romania on large areas of land. Studies and research on this topic have been carried out over time by groups of researchers from different countries of the world on different agricultural crops. (PARNES, 1990; VITOUSEK et al., 2002; WARD et al., 2009; CABEZA et al., 2011; UDERT & WÄCHTER, 2012; NANZER et al., 2014; CAO et al., 2015; GROSZYK et al., 2015; LU et al., 2015; QUEBRAJO et al., 2015; SHEN et al., 2015.) A peculiarity of this type of agriculture is the precision equipment that can be attached to agricultural machinery and which consists of sensors that allow remote scanning of the soil, and, in the case of our research, to determine the green index of plants (NDVI).

Studies in the field have shown a close correlation between NDVI values determined by sensors in the composition of the Crop Circle ACS-430 and the N content in different crops. NDVI readings give us valuable information about the variability of N content in the field and thus production estimates can be made after sampling and calculating NDVI values. (BARNES et al., 2000; CAO et al., 2015; LU et al., 2015; QUEBRAJO et al., 2015; SHEN et al., 2015).

The Crop Circle ACS-430 has a built-in light sensor that works on the basis of its own polychrome technology and with which we performed measurements in different vegetation stages of the corn crops analysed on sunny days. The device was used manually by scanning the corn plants in the two plots, by repeated passes over the crop, but it can be mounted on almost any type of machine at the desired distance from the analysed crop or the target plants. The sensor consists of a light source to illuminate and detect the green part of plants. Light source technology simultaneously emits both visible and near infrared (NIR) light from a single LED light source. The major benefit of this new technology is the light source that can detect on the surface of the plants under analysis both visible light spectra and infrared light bands. Crop Circle ACS-430 can perform measurements in three bands simultaneously: 670 mm, 730 mm and NIR bands.: 670 mm, 730 mm and NTR bands.

MATERIALS AND METHOD

The measurement of the green degree with the help of the Crop Circle ACS-430 device (Fig. 1), was made in two stages of the evolution of the corn culture. The obtained NDVI values were compared with the result of the soil analyses and with the observations made on the plants, regarding their development stage.

The first determination with the sensor was made on 06.06.2017 on the day of application of the second dose of N. At that time the corn was in the phase of 7-8 leaves and it could be seen that the plants fertilized with urea (V_1) were more developed than those fertilized with ammonium nitrate V_2 (MOISE, 2019). The degree of vegetation cover of the soil is less than 40% and because of this the calculated values of the NDVI index were very low. The values obtained for the two variants were close, with a difference of 2.6% in favour of the V_1 variant, fertilized with urea. For a correct interpretation of them we used the calculation formula with a correction coefficient SAVI (soil adjusted vegetation index). SAVI was developed as a modification of NDVI to correct the influence of light reflection on the soil surface when the degree of vegetation cover is less than 40%. SAVI is structured as NDVI to which the ground reflection correction factor is added.

Figure 1. Crop Circle ACS-430 (*device user guide*).

NIR waves represent the value of near-infrared reflection, RED and indicate the value of reflection in the visible spectrum and L is the correction factor for ground reflection. Following the research, 3 optimal correction factors were used depending on the degree of soil cover with vegetation. Thus, for very low density of vegetation we used L = 1, for the average degree of land cover L = 0.5 and for the high degree of land cover L = 0.25. If the value of L = 0 then SAVI was equal to NDVI. In our case the degree of vegetation cover of the land is low, therefore we would use L = 1.

$$SAVI = \frac{NIR - RED}{NIR + RED + L} \cdot (1 + L)$$

RESULTS AND DISCUSSIONS

The data measured with the Crop Circle ACS430 allowed us to calculate the classic vegetation index of maize plants, NDVI but also the SRI index. This allowed us to use dozens of vegetation indices detected for measurements made in the corn crop and which were transmitted via satellite using GPS by remote sensing.

Serial data recorded by the sensor was then processed using a laptop. In the analysed corn culture, the NDVI index varied according to the vegetation stage of the corn plants, the level being very low in the first phases of vegetation, then it gradually increased when the panicle appeared, after which it decreased for a period, stabilizing after panicle development.

During the two years of studies, research was performed to determine the accuracy of sensors in the analysed corn crop, the object of the study was to determine the correlation of NDVI readings with corn nitrogen content and grain production, depending on the nitrogen standards applied. The sensors performed well in determining the variability of the nitrogen in the crop and helped us to calculate the fertilization norms with N.

Compared to the level of nitrogen in the soil, the NDVI value increases in direct proportion to the increase in nitrogen content. The increase of the NDVI value is constant up to a supply level of 300 kg / ha N after which it is capped. To estimate the production potential, the best results were obtained with NDVI values from the phase preceding the onset of panicle (MOISE, 2016).

The first observations on the plants were made on June 6, 2017 (Fig. 2), before administering the second dose of ammonium nitrate to variant V_2 (Fig. 3). We found that in variant V_1 fertilized with urea, the culture was well developed.

In variant V_2 fertilized with ammonium nitrate, the plants were less developed than those fertilized with urea. Although the difference was very small, the information from the literature shows that in winter wheat a difference of 8-10% of NDVI values corresponds to a difference in crop fertilization with 111 kg of nitrogen per hectare. The amount of nitrogen administered at V_1 until the time of determination was 42 kg / ha higher than the amount applied at V2 (Figs. 4; 5).

Figure 2. Development stage V_1 on 6th of June 2017 (original).

Figure 3. Development stage V_2 on 6th of J 2017 (original).

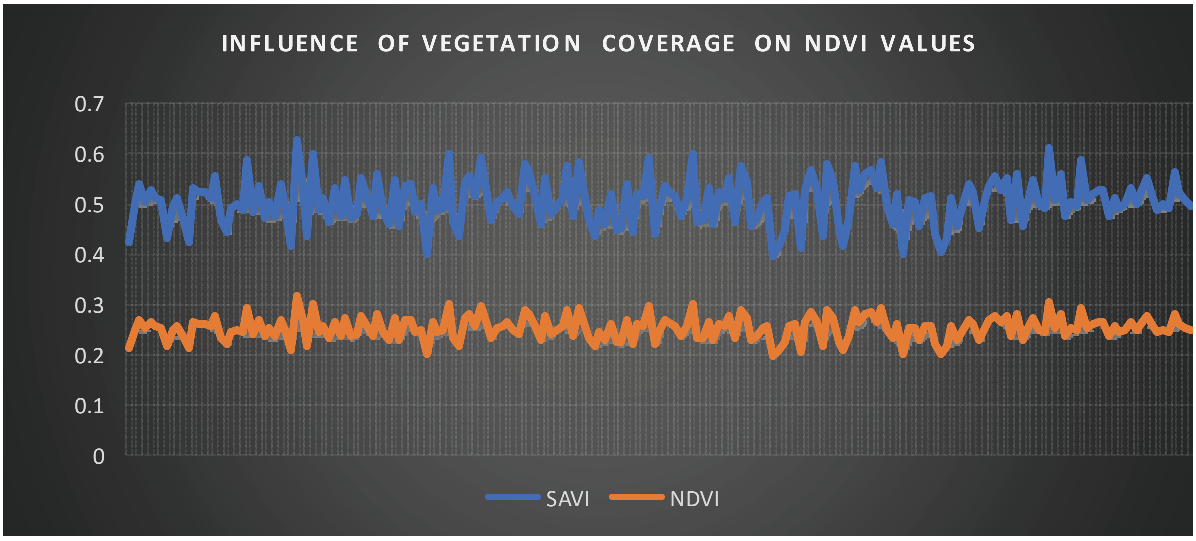

Figure 4. Graphical representation NDVI/SAVI for the variant of V_1 (original).

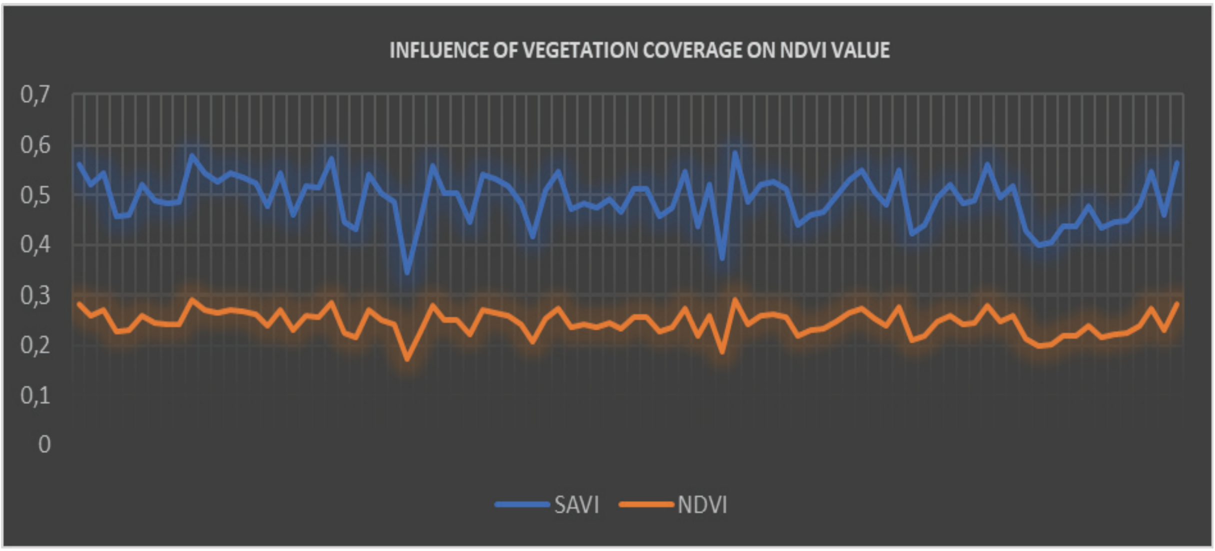

Figure 5. Graphical representation NDVI/SAVI for the variant of V2 (original).

The second determination was made on June 23, 2017, 17 days after the application of the second dose of ammonium nitrate to V_2. The plants were in the phase of 11-12 leaves and visually no differences were observed between them. Following the scans with the Crop Circle sensor, the values obtained for NDVI are the following: 0.7064 for V_1 fertilized with UREA and 0.7086 for V_2 fertilized with NH4NO3. There is a slight increase in the values obtained for variant V_2, fertilized with ammonium nitrate, which exceed by 0.31% the average of the values obtained for variant V_1 fertilized with urea. The conclusion we can draw from the interpretation of these values is that in the version fertilized with urea the supply of N of the plants was at least as good as in the version fertilized in two passes with ammonium nitrate (Figs. 6; 7).

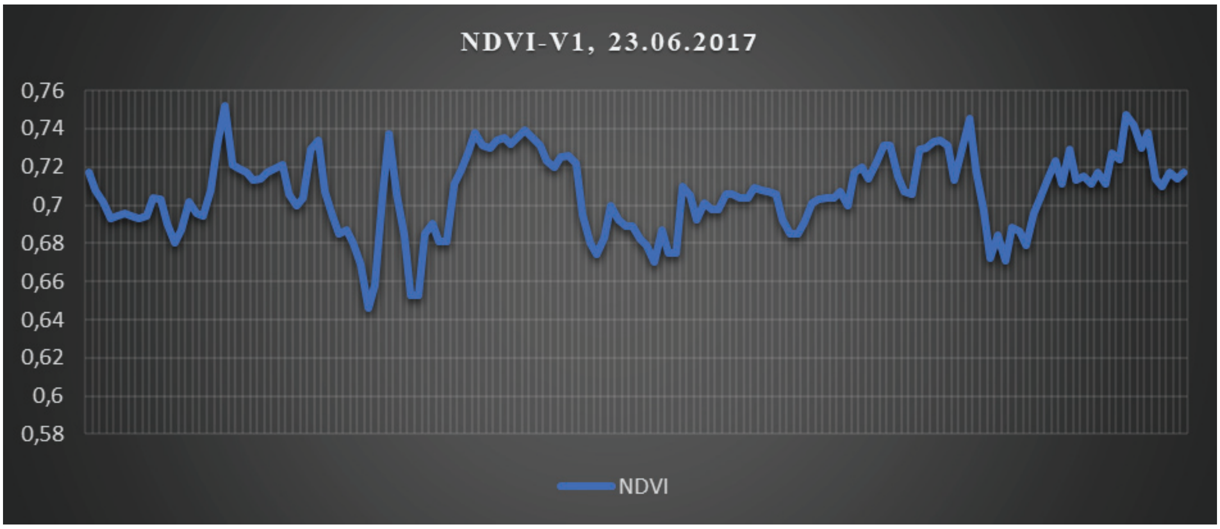

Figure 6. Graphical representation NDVI for the V1 variant (original).

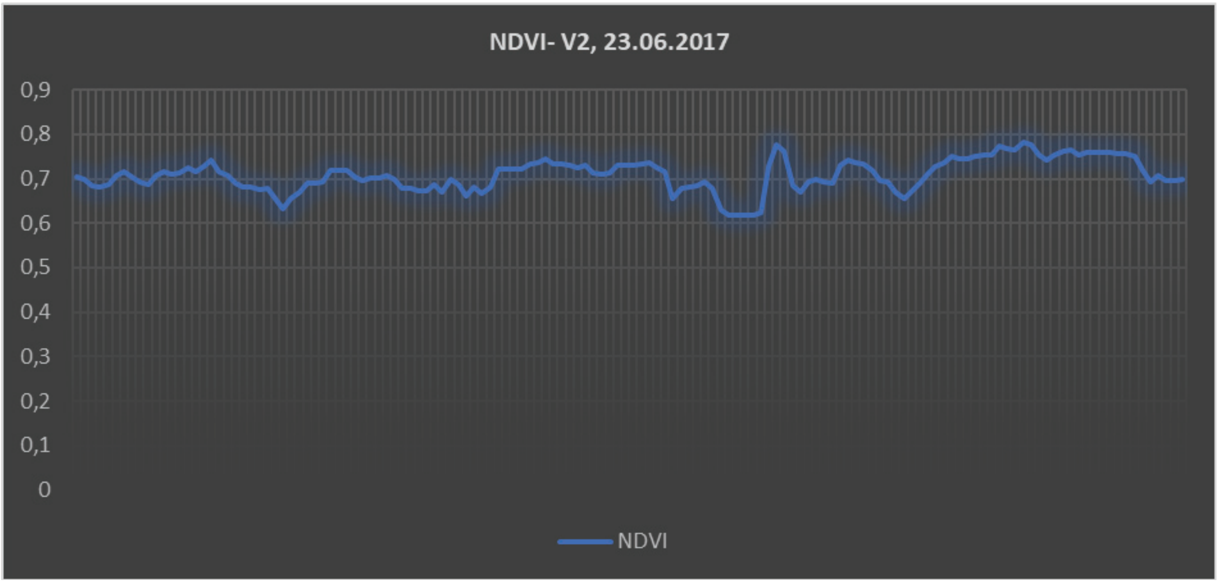

Figure 7. Graphical representation NDVI for the V2 variant (original).

Following the observations made on-site, we found a gap in the development of plants in the two experimental groups only in the first phases of vegetation. On June 6, 2017, 28-29 days after being sown, plants fertilized with urea V_1 were better developed than plants fertilized with ammonium nitrate V2. Until that moment, 92 kg / ha of active substance nitrogen were applied to V_1, respectively 50 kg / ha of active substance nitrogen for V_2. We did not notice any colour differences that indicate the existence of a deficiency or excess of N in either variant, but after scanning the two batches with the Crop Circle device, we obtained an average value of the SAVI index by 2.6% higher at V_1 compared to V_2 (Fig. 8).

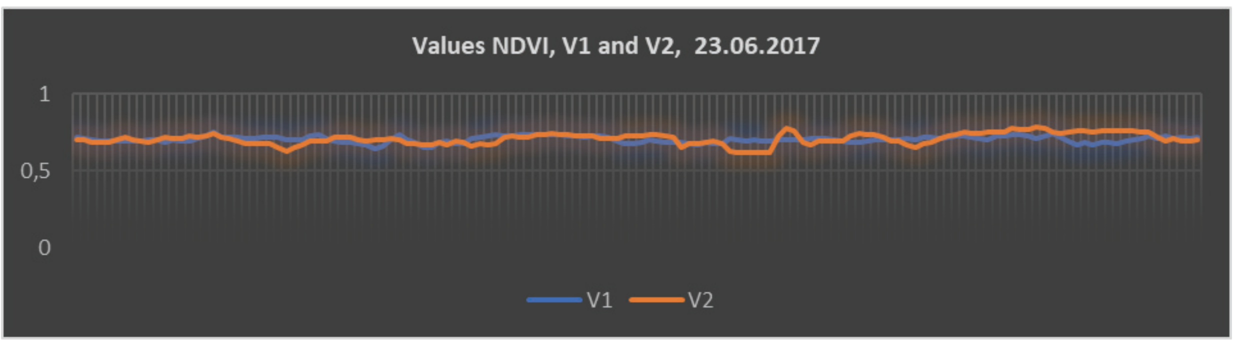

Figure 8. Graphical representation NDVI on the 23th of June 2017 (original).

On June 23, 2017, 17 days after the application of the second tranche of 42 kg/ha of active substance nitrogen to V_2, the plants in this group recovered and no differences were observed between V_1 and V_2. At this date, both lots benefited from an intake of 92 kg / ha of active substance nitrogen. And the values of the NDVI index obtained by scanning with Crop Circle are very close, the difference between the averages of the NDVI values of the two variants is 0.31% in favour of V_2 (Fig. 9).

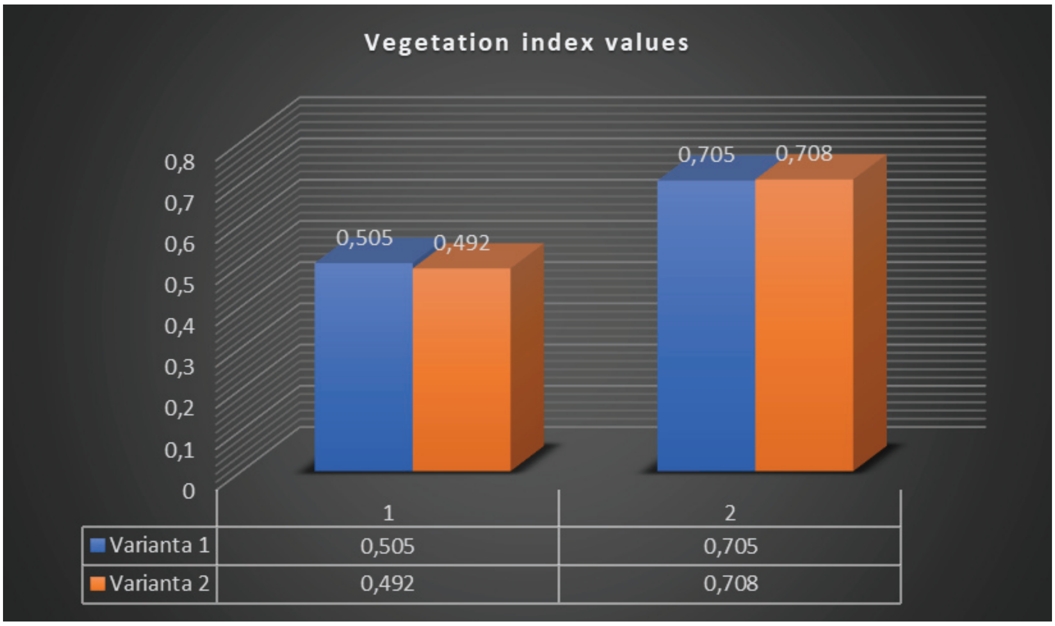

Figure 9. Comparison of vegetation index values in the two phases (original).

CONCLUSIONS

Following the observations made in the field, we found a gap in the development of plants in the two experimental groups only in the first phases of vegetation. On June 6, 2017, 28-29 days after being sown, the plants fertilized with urea V_1 were better developed than the plants fertilized with ammonium nitrate V_2. Until then, 92 kg / ha of active substance nitrogen and 50 kg / ha of active substance nitrogen for V_2 were applied to V_1. We did not notice any colour differences that indicate the existence of a deficiency or excess of N in either variant, but after scanning the two batches with the Crop Circle device, we obtained an average value of the SAVI index by 2.6% higher at V_1 compared to V_2.

Following the analyses we can say that there was a good correlation between the sensor readings collected during 2015 and 2016 in the development stages of the two experimental groups V_1 and V_2 and the corn productions. Vegetation production estimates were used to calculate the optimal dose of maize facial fertilization by 21% and 34% lower depending on soil type and water availability, compared to the farmer's fertilization dose of 226 kg / ha. N, no production losses. This method of identifying the green index with the help of the Crop Circle device, widely applied, allows farmers in our country to administer nitrogen fertilizers if necessary, in the optimal dose, to reduce production costs, increase farm profitability and reduce environment pollution with nitrites.

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