# MONITORING THE VEGETATION STATUS OF POTATO

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**Abstract.** *Optimization of production processes requires knowledge, monitoring, calculation and interpretation of involved factors in plant growth and production formation. Paper presents experimental results of measurements of chlorophyll, foliage reflectance and NDVI vegetation index performed at the National Institute of Research and Development for Potato and Sugar Beet of Brasov, in potato Desiree variety. It was investigated the possibility of using the values of physiological parameters of potato plants to monitor crop vegetation status and estimation, finally, the production capacity.*

**Keywords**: precision agriculture, chlorophyll, reflectance, NDVI

## INTRODUCTION

In arable farming to optimize crop production timely and accurate information on crop and soil status is important for management actions.

Continuous monitoring of crops and soils is laborious and tedious, if aimed at monitoring every square meter of a field at regular time intervals. Jongschaap and Booij (2004) found that new monitoring techniques, such as remote and near sensing can easily be applied at field scale, have become available at affordable costs.

Monitoring crop N status during the growing season accomplishes little unless it is possible to correct N deficiency before it reduces yield. Using a chlorophyll meter as an N management tool is especially appropriate where additional N can be applied through the irrigation system.

The crop vegetation status can be monitored with a chlorophyll meter SPAD 502 and a multispectral radiometer CropScan. Measurements with the SPAD 502 meter produce relative SPAD meter values that are proportional to the amount of chlorophyll present in the leaf (Qihua et al., 2011). The CropScan multispectral radiometer is useful as an objective and efficient means of estimating the effects of any condition that affects plant health, yield, or quality of the crop (CropScan Inc., 2009).

The objectives of this study are to monitoring the status of crop vegetation and find the methods that improve the potato management.

## MATERIAL AND METHOD

The research has been carried out at the National Institute of Research and Development for Potato and Sugar Beet, Brasov, in field production of potato seed material on Desiree variety.

Were follow the dynamics of growth the vegetative mass and production capacity. Were performed by 6 measurements of 3 repetitions at five different times in the period 06.06.2011 - 08.08.2011. The measurements were made in several stages of growth: plant

establishment, tuber initiation, tuber bulking and tuber maturation. Timing of these growth stages varies depending upon environmental factors, such as temperature, soil type, availability of moisture, cultivar selected and geographic location.

The measurements were conducted between 11 am and 2 pm and focused on:

- The dynamics of leaf chlorophyll content (measured by SPAD 502 Plus Chlorophyll Meter, see fig.1);
- The dynamics of canopy reflectance on 8 different wavelengths (measured by CropScan multispectral radiometer, see fig.2)
- Statistical interpretation on NDVI vegetation indices.


Fig.1 The leaf chlorophyll content monitoring with SPAD 502 Plus Chlorophyll Meter

Fig.2 The canopy reflectance monitoring with CropScan multispectral radiometer

The crop potato fall in plants group with high requirements for nutrients. Therefore Desiree was fertilized with NPK complex (15:15:15) – 510 kg/ha.

The preparatory work of land were performed when the soil was dry so do not adhere to aggregates wheels to avoid compaction and soil ball formation which damage the production and tubers quality. For planting potato the preparatory work of land were carried out with the cultivator.

The planting period was choose according to soil moisture and minimum soil temperature. The temperature condition refers to minimum soil value which the tubers continue their physiological processes, higher temperatures than 5-6$^0$C at a depth of 10 cm in the soil. The potato planting in an area with high humidity lead to compaction effects which is serious consequences on production. The potato planting were made in 20 April.

From the late works of potato planting to emergence, interval which varies depending on the evolution of temperatures and precipitations on that period, were destroyed the weeds, were recovered the billon on proper dimensions for a good coverage of potato tubers. For combating and preventing the weeds from potato crop it has been herbicide with SENCOR 1 kg/ha. The emergence was in 30.05.2011.

## RESULTS AND DISCUSSION

**Determination of leaf chlorophyll content.** In table 1, are presented the average values of chlorophyll content of potato leaves at different times. As can be seen in table,

the mean value of chlorophyll at Desireé variety determined in the period 6 June – 8 August 2011 was 50.55 SPAD units, with 9,54% coefficient of variation. In the study period the mean values of chlorophyll content of potato leaves varied between 55,58 and 49,60 SPAD units.

The highest value of 55,58 SPAD units measured in the first decade of June when the potato plants was young and the canopy were the least developed.

The Duncan test presented in table 1 indicates that the value from 06.06.2011 was significantly higher than further measurements. Once with the vegetation development the values of chlorophyll content of potato leaves decreased progressively.

The lowest chlorophyll values are between 47,54 and 49,60 SPAD units (insignificant differences), who have registered the measurements from 13 July, 28 July and 8 August when has been maximum development of foliage.

Table 1

Comparison of the average chlorophyll content of potato leaves at different times

| Time | Subset for alpha = .05 | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| 13.07.2011 | 47.54 | | |
| 28.07.2011 | 48.56 | | |
| 08.08.2011 | 49.60 | 49.60 | |
| 17.06.2011 | | 51.47 | |
| 06.06.2011 | | | 55.58 |
| Sig. | .148 | .161 | 1.000 |

Note: Means for groups in homogeneous subsets are displayed.
Uses Harmonic Mean Sample Size = 18.000.

**Foliage reflectance determination.** In figure 3, are presented in dynamics the average values of reflectance measurements for each wavelength at different time at Desireé variety. We can see that the values are decreasing once with growth and development of plants and end rows.

If we compare the average values measured at 660 nm wavelength with average values measured at 810 nm wavelength (which are used in the NDVI formula), shows that in the investigated period they have different meanings.

The measured values at 660 nm wavelength are decreasing once with growth and development potato plants from 10,34 to 2,87, with variation coefficients between 21,37 and 12,75 %. At the maximum canopy development is recorded the lowest value. Until the end of the observations period, the measurements remain around minimum value.

The measured values at 810 nm wavelength are increase strongly from 17,6 to 46,4 with variation coefficients between 14,0 and 6,7 % until 13 July. The high reflectance level is maintained at 28 July measurement. In 8 August the measured reflectance was lower, 37,7 with 10,9% variation coefficient.

From statistical analyzed shows that the highest variability of measurements is at the tuber initiation stage when the plants are small and uncovered space between them is greater.

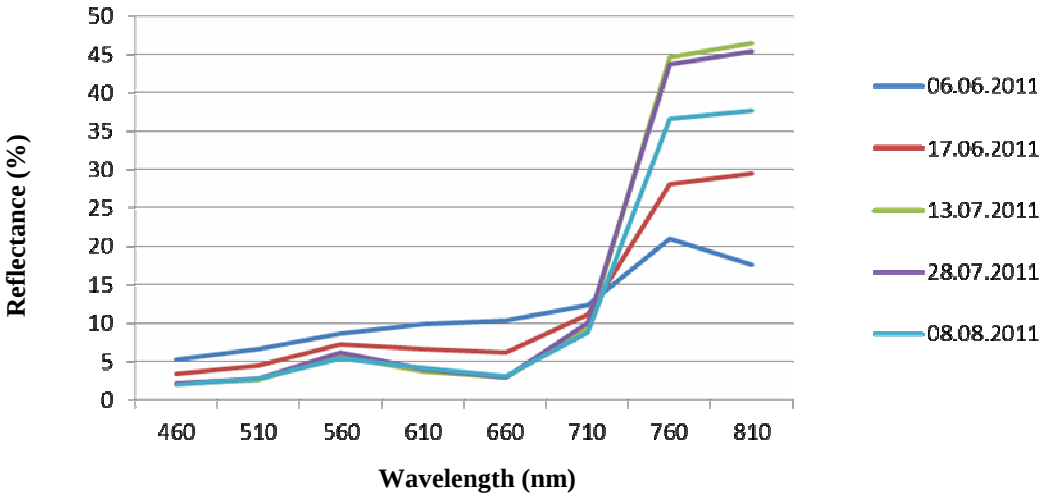


Fig.3 The average values of canopy reflectance at different time

**Determination of vegetation index NDVI**

NDVI is a vegetation index used frequently because he can separate the vegetation from uncovered soil based on satellite analysis. The NDVI formula is:

$$NDVI = \left( \frac{NIR - RED}{NIR + RED} \right) \quad (1)$$

In visible domain (460 – 700 nm), green plant pigments (especially chlorophyll) causes a strong energy absorption. The absorption is maximum in red and blue strips, resulting in characteristic green appearance of foliage plants. In NIR domain the interaction is different. So, the energy from this domain is not used for photosynthesis, she is strongly reflected from internal structure of leaves this leads to a very strong reflectance in NIR domain. This intensely contrast between the energy quantity reflected in red and NIR domains of electromagnetic spectrum represent base of quantitative indices of vegetation development used satellite images (Jensen, 2000).

Table 2

The mean average of vegetation index NDVI at different time

| Time | Mean | Minimum | Maximum | Variation coeff. (%) |
|---|---|---|---|---|
| 06.06.2011 | 0.27 | 0.19 | 0.38 | 21.74 |
| 17.06.2011 | 0.65 | 0.49 | 0.76 | 13.75 |
| 13.07.2011 | 0.88 | 0.86 | 0.91 | 1.79 |
| 28.07.2011 | 0.87 | 0.81 | 0.91 | 3.66 |
| 08.08.2011 | 0.85 | 0.81 | 0.89 | 3.21 |

In table 2 are presented the mean values of NDVI vegetation index at different time used for the status of vegetation characterization to Desireé variety. The NDVI values shows that the crop has developed normally in (06.06-13.07) period with a scroll rhythm of growth stages area characteristic. The covered soil level with foliage was maximum in the beginning of July (NDVI = 0.86). The fact that the value of NDVI vegetation index were maintained over 0,80 in July and the easy decease from August was insignificant which

shows that the technology applied have succeeded the achievement and maintaining a rich and healthy foliage.

## CONCLUSIONS

After the results obtained were following the conclusions:

- The value of chlorophyll content of potato leaves decreases progressively once with advance in time and foliage development.
- The variability of physiological parameter of foliage reflectance is the highest at the tuber initiation stage when the plants are small and uncovered space between them is greater.
- The values of NDVI vegetation index shows that the technology applied have succeeded the achievement and maintaining a rich and healthy foliage.

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