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SK Thakur
M. Tech Student, Department of Soil and Water Engineering, College of Agril. Engg, J.N.K.V.V, Jabalpur, Madhya Pradesh, India

Rishi Pathak
M. Tech Student, Department of Soil and Water Engineering, College of Agril. Engg, J.N.K.V.V, Jabalpur, Madhya Pradesh, India

Ajay Ahirwar
Research Scientist NIH, Roorkee, Uttarakhand, India

RK Nema
Professor and Head, Department of Soil and Water Engineering, College of Agril. Engg, J.N.K.V.V, Jabalpur, Madhya Pradesh, India

Corresponding Author:
SK Thakur
M. Tech Student, Department of Soil and Water Engineering, College of Agril. Engg, J.N.K.V.V, Jabalpur, Madhya Pradesh, India

Spectral response of Wheat and Mustard crops

SK Thakur, Rishi Pathak, Ajay Ahirwar and RK Nema

Abstract

Every natural and synthetic object on the earth surface and near surface reflects and emits EMR (Electromagnetic Radiation) over a range of wavelengths in its own characteristics way according to its chemical composition and physical state. The brightness or reflectance of vegetation varies across the electromagnetic spectrum. Actively growing plants show a strong contrast between strong absorption in the red and high reflectance in the near-infrared regions of the spectrum. This property can be used to demarcate the area under different crops in a synoptic manner. Remote sensing satellite gathers data on reflectance in different wavelength bands. It has to be analyzed in light of ground information and response of a particular crop in different wavelength bands. This study was conducted to evaluate the spectral response of *rabi* crops namely as mustard and wheat. For this study experimental crop plots were considered. Weekly observations were recorded with hand held spectro radiometer at different stages of crop growth. The observations were taken from 21st Jan to 26th March 2010 till the harvest of crops. The results obtained show that in all the treatments incident energy is measured 12.5 to 191.7 W/cm^2/Sr-micron. The soil is reflecting from 40 to 70 percent of it in all the four bands. It behaves in similar way in all the bands. The average reflectance of all crops was obtained 22 to 99 percent. The average reflectance from mustard and wheat increases with crop growth till vegetative growth and reduced to minimum at the time of maturity because of composition of crop and structure of leaf due to lowering of moisture content. The spectral response of different crops is helpful to demarcate and monitor the crops and for further planning.

Keywords: Remote sensing, electromagnetic radiation, spectral response, spectral signature

1. Introduction

Remote Sensing is defined as process or technique of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device without being in contact with the object, area, or phenomena being studied (Reddy, 2001) [1]. It consists of the interpretation of measurements of electromagnetic energy reflected from or emitted by a target from a vantage-point that is distant from the target.

In remote sensing it is most common to categorize electromagnetic waves by their wavelength location within the electromagnetic spectrum. The most prevalent unit used to Measure wavelength along the spectrum is the micrometer (1µm=10-6m).

Spectral reflectance and colour readability gives the proportions of energy reflected, absorbed, and transmitted will vary for different earth features, depending upon their material type and conditions. These differences permit us to distinguish different features on an image. The wavelength dependency means that, even within a given feature type, the proportion of reflected, absorbed, and transmitted energy will vary at different wavelengths.

Background soil/water is an important influencing factor. Each crop has its own architecture, growing period, etc. thus enabling discrimination through remote sensing data. If there are two crops with similar spectral signatures on a given date (confusion crops), multidate data may be used to discriminate them. Vigour of the crop is responsible for high absorption in the red and reflectance in the near infrared. It has been observed that the ration of near infrared to red radiance is a good indicator of the vigor of the crop. (Chandra, and Ghosh, 2007) [2].

The temporal data acquired at different growth stages increases the dimensionality information content and have advantage over single date data for crop classification. Amongst the single date data, February data was found to be better for wheat classification in comparison to November, January, March and April data. Combination of first two principal components each derived from IRS LISS-I four band data acquired in January and February was found to be the best set. Wheat classification accuracy achieved was 94.54 percent found (Dutta et al. 1998) [3].

For IR radiation, increases in LAI, increased the canopy reflectance, but relative changes in absorption and transmittance were inconsistent between crop species. Changing atmospheric conditions such as sun angle and cloud cover will also introduce significant amounts of variability in crop canopy reflectance. The effect of changing source incident angle and view angle has been studied for crop canopies and for individual leaves in a laboratory setting (Walter – Shea and Biehl, 1990) [4].

This study was conducted to evaluate the spectral response of *rabi* crops namely as mustard and wheat. For this study experimental crop plots were considered. Weekly observations were recorded with hand held spectro radiometer at different stages of crop growth. The observations were taken from 21st Jan to 26th March 2010 till the harvest of crops.

2. Material and Methods

The study area consist of a Experimental plots having two crops namely as Mustard (Terri Uttam) and Wheat (JW 273). Both plots were regularly observed through hand held radiometer for the spectral signature of crops. Spectro radiometer is used for taking spectral reflectance of mustard and wheat crops and soil at their various growth stages. There are four band in spectro radiometer and these bands operates in the invisible and near infra red region (i.e. from 0.4 nm to 0.9 nm) to meet these requirements. The instrument is useful for quantitative measurements of visible and near IR radiations. For interpretation of remote sensing data was also collected. Both the crop were constantly observed through spectro radiometer for spectral signatures.

3. Results and Discussions

The energy reflectance of crop and soil with respect to calibration plate was observed in band 1(0.4-0.5 µm), band 2(0.5-0.6 µm), band 3 (0.6-0.7 µm), and band 4(0.7-1.1 µm) using ground truth specrtro radiometer. The observation of plate, crop and soil through spectro radiometer were taken at different interval till the harvesting of crop. The energy reflectance of Mustard (Terri Uttam) and Wheat (JW 273) were recorded from the experimental plots. The spectral response of both crops is discussed under each crop separately.

Table 1: Average reflectance of Mustard crop

DAS	B1	B2	B3	B4
86	66.1	72.3	72.4	76.1
93	60.9	66.6	75.6	74.7
101	71.2	64.4	63.8	69.9

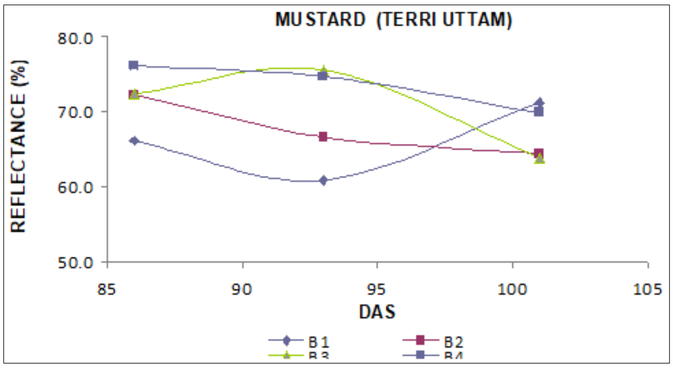

Fig 1: Average reflectance of mustard crop.

Table 2: Average reflectance of wheat crop

DAS	B1	B2	B3	B4
66	70.2	78.5	79.2	82.6
73	69.2	73.7	77.8	83.1
81	79.2	68.7	82.1	84.2
110	79.5	83.9	83.3	89.2
117	73.6	81.0	80.4	87.5
130	79.0	76.5	75.6	85.5

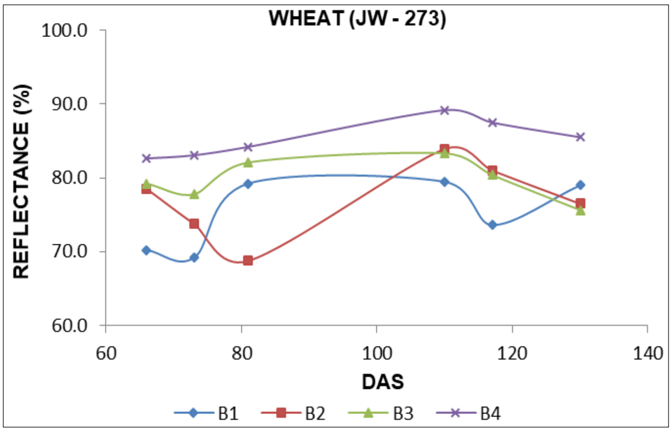

Fig 2: Average reflectance of wheat crop

3.1 Mustard (Terri Uttam)

The observations recorded on reflectance of Mustard crop at various growth stages are presented in table 1. The readings were taken from 21st Jan to 26th February 2010 till the harvest of crop. There were 3 plots for each replication with four replications. The value depicted in table 1 is average reflectance of each band on 86th, 93rd and 101th DAS, in band 1 (0.4-0.5 µm), band 2 (0.5-0.6 µm), band 3 (0.6-0.7 µm) and band 4 (0.7-1.1 µm). In general the peak reflectance occurred on 93rd day in all bands. The average reflectance of mustard crop in all four bands i.e., 76.1 in fourth band was found maximum at 86th DAS and decreases with more no. of days i.e., 69.9 at 101 DAS. To understand the variation in reflectance in each band the observation plotted with respect to days after sowing are depicted in Fig 1. It was found that as the no. of day's increases the blue colour of band 1 was also increases and the others are decreases due to the crop colour and composition. The reduced level of incoming energy has caused lower reflectance value from 21st January date of observation. The peak reflectance was occurred on 93rd DAS in band 3 at 75.6 % and the band 1 and band 4 intersect at point 101th DAS which means both the values increases or decreases at maximum no of days. Finally it was found that at maturity stage the crop shows lower value of reflectance because of change in pigment, composition of crop and structure of leaf due to lowering of moisture contain.

3.2 Wheat crop (JW 273)

Table 2 and Fig. 2 present the reflected energy from wheat crop. The average reflectance in all four bands and plots with wheat crop. The reflectance of crop and soil shows similar degree of variation. The average reflectance was maximum in band 4 i.e., 89.2% and minimum reflectance was found 68.7% at 81 DAS. So by these observations it was found that the reflectance is lower at maturity stage of wheat crop. The differences of reflectance in wheat crop shows that all the bands i.e, blue, green, red and near NIR from the maturity stage in greenary condition are found lower and increases with no. of days. In all the bands the NIR are more responsive than the other bands. So on crop curve it can be seen that maximum changes occur in NIR band after 110th days of sowing. The figure 2 shows the almost similar trend in band 1, band 3 and band 4 and band 2 shows the less responsive as compare to others. The changes of reflectance which shows that the more responsive band 4 which may be attributed to change in crop leaf structure, soil reflectance of all bands shows lower values as compared to the crop. The reflectance of wheat as compare to the other crops are more and reflectance is maximum during the time of observation.

Finally it can be observed that the percentage reflectance of both mustard and wheat crop from the table that the reflectance values were higher in initial reduced in the second weak. First month attained a peak during the last week of January and then again reduces to minimum during the harvest in mustard crops and in wheat crop the increases of no. of days of sowing in which the reflectance regular pattern decreases the crop maturity and attains a maximum value at harvest period.

4. Conclusion

The spectral response of mustard and wheat crops are reduced at the increases of no. of days of sowing. Spectral responses of various both rabi crops during January to march 2010. it can be concluded that the observation recorded in mid January has maximum energy incident and reflected. It is capable of giving information of the crop growth and its performance. Percentage reflectance in Band 1 to Band 4 gives more reliable assessment of mustard and wheat. For better results, monitoring of both crops the observation should be taken near after time of sowing.

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