Progressive Research – An International Journal
Print ISSN : 0973-6417, Online ISSN : 2454-6003
Volume 11 (Special-II) : 974-976 (2016)

Society for Scientific Development in Agriculture and Technology Meerut (U.P.) INDIA

RESPONSE OF RATIO VEGETATION INDICES OF RICE CROP FOR NITROGEN AND TILLAGE RESPONSE

Shashi Bhushan Kumar, Ashok Kumar, Madhukar Kumar, M.B.B. Prasad Babu[1], Sumanth Kumar, V.V.[2] and and T. Nagender[1]

Department of Soil Science and Agricultural Chemistry, Birsa Agricultural University, Ranchi, Jharkhand

[1]Department of Soil Science and Agricultural Chemistry, IIRR, Rajendranagar, Hyderabad

[2]ICT4D, ICRISAT, Patancheru, Hyderabad

ABSTRACT

Field experiments were conducted to study the influence of nitrogenous fertilizer on the rice crop for puddle and unpuddled tillage conditions using remote sensing technique at the research farm of Indian Agricultural Research Institute, New Delhi during Kharif 1999 and Kharif 2001. Band ratio calculated with the help of spectral radiance observation of the crop canopy which were collected with the Portable Spectroradiometer, scanned from 330 nm to 1100 nm of electromagnetic spectrum range at 5nm band-width. Band ratio was calculated for the both tillage practices, puddle and unpuddled situation at different growth stages for different fertilizer treatment. Fertilized plots were observed to have a higher value of BR than controlled ones throughout the crop growth period, both in puddled and unpuddled treatments.The higher values of band ratio were observed in puddled rice compare to the unpuddled rice irrespective of growth stages and fertilizer application levels.

Key words : *Band ratio, puddle, unpuddled, rice, fertilizer, nitrogen.*

Irrigation and fertilizers are vital and costly inputs in agricultural production and are used to increase the productivity of the crop. This necessitates understanding the specific requirement of the crop and strategies for their better management. Monitoring and assessing crop growth, identifying the stress conditions are extremely important to develop strategies. Remote sensing technique can be used on large scale to monitor the crop under different stress condition. Spectral reflectance forms the basis for remote sensing.

Measurements with high spectral resolution open up new opportunities to find characteristic spectral features related to the crop status. Considerable improvements may be expected from the extension of spectral resolution down to bandwidths of a few nanometers (Gilabert *et al.*, 1996). Vegetation indices evaluated from these resolutions in the visible and infrared region, show good correlation with chlorophyll concentration, the factor most affected during crop stress.

Plant stress, which reduces chlorophyll production in leaves, will cause leaves to absorb less in the chlorophyll absorption bands; such leaf will appear yellowish or chlorotic and will have a higher reflectance, particularly in the red region. Other pigments contributing to spectral reflectance characteristics of a plant leaf are carotenes, xanthophylls (yellow pigments) and anthocyanins (red pigments). Chlorophyll masks the colour of these other pigment except during senescence when the leaf chlorophyll content is at the minimum. At the NIR, leaves typically reflect 40-50% and absorb less than 5% of the incident energy (Srivastava *et al.,* 1998). The high reflectance, as well as transmittance in the NIR "plateau" between 700 and 1300 nm are explained by multiple reflections in the internal mesophyll structure, caused by differences in the reflective indices of the cell wall and intracellular cavity. Since internal structure of leaves often differ considerably among species, reflectance differences are frequently greater in the NIR than in the visible wavelengths. Because of multiple transmittance and reflectance, there is an increase in NIR reflectance through layers of leaves with the maximum of 70-80% reflectance at about eight leaves layer (Allen and Richardson, 1986).

To reduce the stresses in crop, fertilizer acts as the major factor. Indian soils are devoid mainly of nitrogen and potash, which are incorporated physically in the field at required levels and required growth stage. Simple Ratio (SR), Normalized Difference Vegetation Index (NDVI) and Photochemical Reflectance Index (PRI) all these indices and grain yield were found greater under irrigated wheat than under rainfed conditions (Aparicio *et al.*, 2000). LAI was most closely correlated with the spectral reflectance indices, with SR and PRI being the best and the worst indices, respectively, for the assessment of crop growth and yield. In rainfed conditions, the spectral reflectance indices measured at any crop stage were positively correlated ($P<0.05$) with LAI and yield. Under irrigated conditions, correlations were only significant during the second half of the grain filling. He suggested that for durum wheat, the usefulness of the SR and NDVI for calculating green area and grain yield is limited to LAI value <3.

MATERIALS AND METHODS

Field experiment were conducted during Kharif 1999 and Kharif 2001 at the research farm of Indian Agricultural Research Institute, New Delhi to study the influence of fertilizer on the puddle and unpuddled rice by remote

Table-1 : Band Ratio changes with different growth stages of puddled rice (grown in the year 1999) using different fertilizer treatments.

Treatments	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	110 DAT
$N_0P_0K_0$	3.390	4.027	5.910	9.600	8.730	6.419	4.614	3.270
$N_0P_{60}K_0$	3.461	4.018	5.926	9.730	8.910	6.429	4.612	3.723
$N_0P_0K_{40}$	3.561	4.032	6.154	9.730	8.800	6.572	5.123	3.581
$N_0P_{60}K_{40}$	3.721	4.144	6.381	10.000	9.270	6.768	5.220	4.233
$N_{40}P_0K_0$	1.963	4.013	6.004	9.213	9.870	6.970	5.520	3.290
$N_{40}P_{60}K_0$	3.680	4.413	6.680	9.603	10.550	7.840	5.921	3.480
$N_{40}P_0K_{40}$	3.542	4.550	6.970	9.870	10.650	8.410	5.912	3.480
$N_{40}P_{60}K_{40}$	4.160	5.030	7.145	10.402	10.740	8.710	6.290	4.160
$N_{80}P_0K_0$	3.205	3.776	6.680	10.450	10.813	8.411	6.303	3.305
$N_{80}P_{60}K_0$	3.162	5.089	7.260	10.813	11.232	9.014	6.718	3.606
$N_{80}P_0K_{40}$	3.429	4.449	7.550	11.211	11.513	9.504	6.708	4.117
$N_{80}P_{60}K_{40}$	3.788	5.520	7.613	11.520	11.901	9.821	7.114	4.405
$N_{120}P_0K_0$	3.211	5.621	7.740	11.631	12.600	10.214	7.410	4.502
$N_{120}P_{60}K_0$	3.911	5.910	8.211	11.914	13.321	10.504	7.704	4.603
$N_{120}P_0K_{40}$	4.627	6.290	8.320	12.019	13.318	11.404	8.208	4.608
$N_{120}P_{60}K_{40}$	4.118	6.807	8.804	12.405	13.619	12.061	8.504	5.201

Table-2 : Band Ratio changes with different growth stages of unpuddled rice (grown in the year 1999) using different fertilizer treatments.

Treatments	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	110 DAT
$N_0P_0K_0$	2.445	3.474	5.517	9.420	7.600	5.937	4.120	2.710
$N_0P_{60}K_0$	2.512	3.680	5.710	9.600	7.930	5.804	4.430	2.806
$N_0P_0K_{40}$	2.800	3.620	5.667	9.520	7.830	6.424	4.815	3.019
$N_0P_{60}K_{40}$	3.480	3.632	6.355	10.000	8.230	6.589	5.114	3.290
$N_{40}P_0K_0$	2.850	4.401	6.429	8.988	10.277	6.882	5.187	4.022
$N_{40}P_{60}K_0$	3.317	4.938	6.462	9.408	10.452	7.123	5.014	4.248
$N_{40}P_0K_{40}$	4.204	4.866	6.594	9.534	10.361	7.330	5.094	4.443
$N_{40}P_{60}K_{40}$	4.260	5.014	6.801	9.540	10.523	7.332	5.444	4.502
$N_{80}P_0K_0$	3.672	4.428	6.856	9.626	10.642	7.433	5.467	4.592
$N_{80}P_{60}K_0$	3.915	5.372	6.875	9.843	10.658	7.490	5.365	4.623
$N_{80}P_0K_{40}$	4.318	5.231	6.899	9.926	10.666	7.439	5.229	4.594
$N_{80}P_{60}K_{40}$	4.500	5.418	7.067	10.177	10.971	7.834	5.731	4.650
$N_{120}P_0K_0$	3.718	5.360	7.127	10.261	11.201	7.872	5.562	4.699
$N_{120}P_{60}K_0$	4.315	5.677	7.744	10.470	11.345	7.886	5.800	4.753
$N_{120}P_0K_{40}$	4.666	5.612	7.831	10.301	11.476	8.171	5.801	4.730
$N_{120}P_{60}K_{40}$	4.044	6.152	8.182	10.860	11.642	8.436	6.258	4.931

Table-3 : Band Ratio changes with different growth stages of puddle and unpuddled rice (grown in the year 2001) using different fertilizer treatments.

Treatments	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	110 DAT
Puddled rice								
N0P0K0	2.722	4.014	6.840	9.070	8.510	6.414	4.612	2.598
N80P60K40	2.863	4.222	7.475	9.470	9.600	7.300	5.087	3.393
N120P60K40	3.013	4.517	8.153	10.714	10.911	7.980	5.737	3.830
N180P60K40	3.245	4.980	8.745	10.978	11.748	9.600	6.865	4.350
Unpuddled rice								
N0P0K0	1.934	2.965	5.130	6.579	6.190	4.106	3.246	2.075
N80P60K40	2.132	3.286	5.854	7.410	7.330	5.085	3.956	2.259
N120P60K40	2.389	3.536	6.590	8.012	8.895	6.128	4.549	2.562
N180P60K40	2.627	4.288	7.448	8.853	9.837	7.687	4.867	2.958

sensing technique. Rice was grown following Split Plot Design consists of main and sub-plot in both the years. Tillage treatment was considered as main factor (puddled and unpuddled) and sub-factor was fertilizer with three replications.

Spectroradiometer was used to take spectral reflectance data. The crop spectral reflectance, expressed in percentage, was calculated by taking ratio of measured canopy reflectance (numerator) to the incoming solar radiation. Incident radiation (standard) measurements were taken by holding the sensor horizontally with focusing it above which provided the standard value. The standard readings were taken at the beginning and at the end of each observation. Then it was averaged to get a mean value. The reflectance measurement of crop canopy was taken at 5 nm band intervals from 330 nm to 1100 nm on clear sky conditions at around solar noon local time. The sensor was held at a height of 1 m above the crop canopy with the sensor facing the crop and oriented perpendicular to the crop canopy. Precautionary measures were taken to prevent any shadow cast on the sensor element.

Band Ratio (BR) or Ratio Vegetation Index (RVI) or Radiance Ratio (RR) has been developed by Birth and Mc. Vey (1968). It is calculated by the ratio of infrared reflectance (IR) to red reflectance (R) or reflectance in MSS 7 band to reflectance in MSS 5 band. Maximum values are expressed for healthy crop whereas low for stressed or poor crop.

$$BR = \frac{IR}{R}$$

or,

$$BR = \frac{\text{Reflectance in MSS 7 band}}{\text{Reflectance in MSS 5 band}}$$

RESULTS AND DISCUSSION

Band ratio (also called Ratio Vegetation Index) revealed the increasing trend of value up to milking stage (80 DAT) of rice crop in puddled and unpuddled treatments, thereafter the trend was found reversed (Table-1, 2 and 3). The maximum value of BR during first crop was 13.619 which found in N120P60K40 fertilizer dose at 80 DAT and 11.748 in N180P60K40 dose of fertilizer during second year of crop at 80 DAT in puddled rice whereas minimum values in the same tillage practice (puddled) were 1.963 at 40 DAT for N40P0K0 and 2.598 at 110 DAT for control (N0P0K0) during both the years respectively (Table-1, 2 and 3). Unpuddled rice has always showed the lower value of BR compared to puddled rice (Table-1 and 2). During first year of crop the maximum value were observed 11.642 at 80 DAT for N120P60K40 fertilizer dose and 9.837 at 80 DAT for N180P60K40 fertilizer dose during second crop for the unpuddled rice whereas minimum values of BR in the same tillage practice (unpuddled) were 2.445 and 1.934 in respective years of crop which were found at 40 DAT for controlled (N0P0K0) plots in both crops. Higher dose of fertilizer contributed to higher value of BR, whereas lower values were observed incase of controlled (0 Kg N/ha) and nitrogen deficit (40 or 80 Kg N/ha) plots.

Recommended fertilizer dose (120:60:40::N:P:K) can also be compared with controlled plots. Fertilized plots were observed to have a higher value of BR than controlled ones throughout the crop growth period, both in puddled and unpuddled treatments.

Band Ratio observed in puddled rice was higher in value than in unpuddled rice at peak growth stage (80 DAT) (Table-1) because puddling contributed to healthy crop canopy geometry and hence had higher influence on spectral reflectance characteristics. Bajpai and Tripathi (2000) found the higher vegetation and canopy geometry in puddled rice compare to unpuddled rice, because of increasing soil water holding capacity due to reduced hydraulic conductivity.

CONCLUSION

Band Ratio increased with crop growth stages up to peak growth stage (80 DAT) and decreased thereafter up to crop maturity. Nitrogen stressed (0 kg N/ha) crop attained early peak for Band Ratio than the adequately fertilized crop. The higher values of Band ratio were observed in puddled rice as compare to the unpuddled rice irrespective of growth stages and fertilizer application levels.

REFERENCES

1. Allen WA and Richardson AJ (1986). Interaction of light with a plant canopy. *J Optical Soc America 58:* 1023-1028.
2. Aparicio N, Villegas D, Casadesus J, Araus JL and Royo C (2000). Spectral vegetation indices as nondestructive tool for determining durum wheat yield. *Agronomy J 92 (1) :* 83-91.
3. Bajpai RK and Tripathi RP (2000). Evaluation of non puddling under shadow water tables and alternative tillage methods as soil and crop parameters in a rice-wheat system in Uttar Pradesh. *Soil Tillage Res 55 (1-2):* 99-101.
4. Birth GS and McVey GR (1968) Measuring the colour of turf with a spectrophotometer. *Agron J 60 :* 640-643.
5. Gilabert MA, Gandia, S and Melia J (1996) Analysis of spectral biophysical relationships for a corn canopy. *Remote Sens Environ 55 :* 11-20.
6. Srivastava SK, Nageswara Rao PP and Jayaraman V (1998) Towards space borne terrestrial imaging spectrometry. *Scientific Report ISRO-NNRMS-SR :* 41-98.