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RESPONSE OF NORMALIZED DIFFERENCE VEGETATION INDICES OF PADDY UNDER NITROGEN LEVELS AND TILLAGE PRACTICES

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

A field experiment was conducted at the research farm of Indian Agricultural Research Institute, New Delhi during Kharif 1999 and Kharif 2001 to study the influence of nitrogenous fertilizer on the tilth of rice crop by remote sensing technique. Spectral radiance observations of the crop canopy were collected with the Portable Spectroradiometer which scanned from 330 nm to 1100 nm of electromagnetic spectrum range at 5nm interval (band-width). Normalized Difference Vegetation Index was calculated for the both tillage practices, puddle and unpuddled situation at different growth stages for different fertilizer treatment. The higher values of normalized difference vegetation index were observed in puddled rice compare to the unpuddled rice irrespective of growth stages and fertilizer application levels.

Key words : *Vegetation Indices, NDVI, puddle, unpuddled, rice, fertilizer.*

Remote sensing technique is used on large scale to monitor the crop under different stress condition. Spectral reflectance forms the basis for remote sensing. 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.

Crop N status and shoot growth rate of rice were found directly related to the formation of crop components. However, N uptake rate per second was not a reliable variable to relate to production. Until flowering, the N use efficiency for leaf biomass and specific leaf weight were constant (Stutterheim and Barbier, 1995). The sum of LAI of rice crop at the panicle differentiation stage, heading stage and 20 days after heading was positively correlated with the Nitrogen rates (Lin *et al,* 1990).

Chlorophyll contents, yield and seed quality of rice are affected by nitrogen fertilizer. Nitrogen application results in an increment in chlorophyll content (Gopal *et al,* 1999; Jago *et al.,* 1995; Jain *et al.,* 1999). Pandey *et al,* 2000 revealed that higher nitrogen dose (150 kg/ha) yielded higher grain biomass than comparatively lower dose (120kg/ha). Basal urea incorporation into soil without standing water gave significantly higher paddy yield than same amount of urea incorporated in 5 cm of standing water in both wet land preparation methods, puddled as well as in unpuddled (Jamil *et al,* 1992).

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.

MATERIALS AND METHODS

The experiments were conducted at the research farm of Indian Agricultural Research Institute, New Delhi during Kharif 1999 and Kharif 2001 to study the influence of nitrogenous fertilizer on the tilth of rice crop by remote 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.

Spectral Observations : Spectral radiance observation of the crop canopy were collected with the Portable Spectroradiometer, model LICOR (LI-1800). It can continuously scan from 330 nm to 1100 nm of electromagnetic spectrum range at 5nm interval (5 nm band-width). The optical system of the instrument has three major components, a filter wheel, a holographic grating monochromator and a silicon detector. Light entering the slit through the standard cosine receptor (diffuser) is directed through a filter wheel before entering the monochromator. At each scan the internal microcomputer rotates the filter wheel to select the filter for the spectral region to be scanned. The entering beam of light is dispersed by a holographic grating monochromator in the wavelength range of 330 nm to 1100 nm. The spectroradiometer has an internal microcomputer, which controls scanning, collection, reduction and storage of data. The storage capacity of this spectroradiometer is 256 kilo bytes. The spectroradiometer was connected to a computer and thus files were down loaded from the instrument and saved on soft disc.

The crop spectral reflectance, expressed in

Table-1 : NDVI changes with different growth stages of puddle and unpuddled rice (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								
$N_0P_0K_0$	0.277	0.364	0.449	0.604	0.591	0.540	0.453	0.311
$N_{80}P_{60}K_{40}$	0.260	0.379	0.464	0.657	0.721	0.649	0.531	0.373
$N_{120}P_{60}K_{40}$	0.327	0.377	0.511	0.658	0.760	0.720	0.633	0.428
$N_{180}P_{60}K_{40}$	0.360	0.435	0.552	0.724	0.784	0.760	0.686	0.484
Unpuddled rice								
$N_0P_0K_0$	0.245	0.312	0.422	0.546	0.530	0.472	0.396	0.264
$N_{80}P_{60}K_{40}$	0.252	0.332	0.406	0.595	0.628	0.590	0.482	0.283
$N_{120}P_{60}K_{40}$	0.268	0.353	0.432	0.611	0.735	0.685	0.520	0.301
$N_{180}P_{60}K_{40}$	0.276	0.350	0.577	0.673	0.736	0.700	0.508	0.369

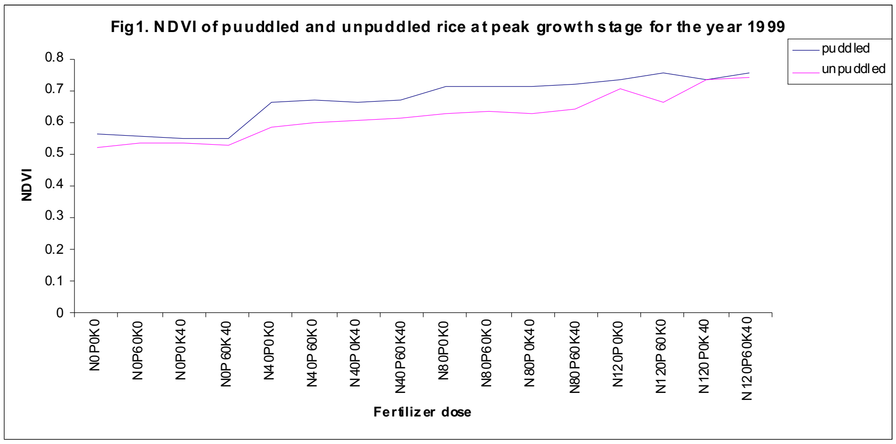

Fig1. NDVI of puuddled and unpuddled rice at peak growth stage for the year 1999

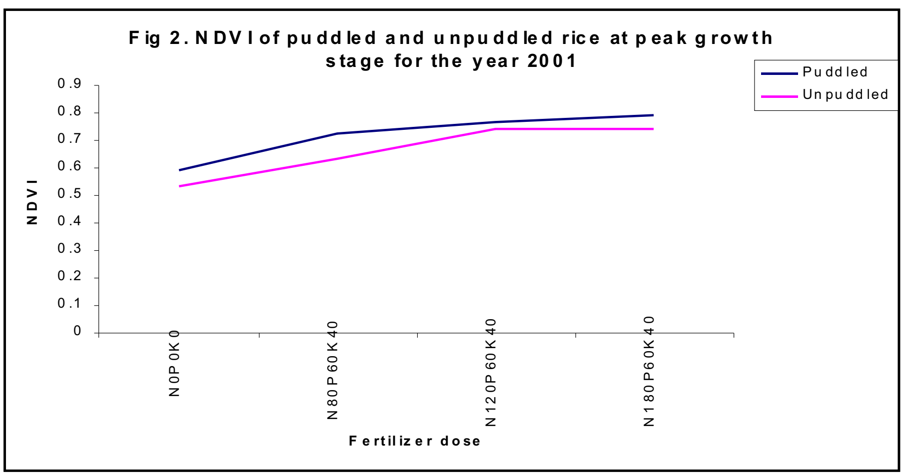

Fig 2. NDVI of puddled and unpuddled rice at peak growth stage for the year 2001

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. The data collected was integrated to obtain reflectance in the following MSS (Multispectral Scanner) bands for further use in calculating different indices.

MSS 4 : 500-600 nm, MSS 5 : 600-700 nm

MSS 6 : 700-800 nm, MSS 7 : 800-1100 nm

Normalized Difference Vegetation Index (NDVI)

NDVI was developed by Rouse et al. (1973). The value lies between –1 to +1. Maximum value is expressed for healthy crop with more vegetation cover whereas the lower values expressed for stressed/poor vegetation with a low crop cover.

$$NDVI = \frac{(NIR- R)}{(NIR+ R)}$$

or, $$NDVI \quad \frac{(MSS\ 7\ -\ MSS\ 5)}{(MSS\ 7\ +\ MSS\ 5)}$$

RESULTS AND DISCUSSION

As observed in Table-1, the highest value of NDVI were observed in puddle rice. This may be because of more healthy crop canopy due to high water holding capacity of soil (Bajpai and Tripathi, 2000). The maximum and minimum values of NDVI for puddled rice were 0.784 at 80 DAT for N180P60K40 fertilizer dose and 0.260 at 40 DAT for nutrient stressed plots (N80P60K40) were observed, whereas the maximum and minimum values of NDVI for unpuddled rice were 0.736 at 80 DAT for N180P60K40 and 0.245 at 40 DAT for control (N0P0K0) respectively, were observed.

NDVI revealed clear effect of fertilizer response throughout the crop growing period in both the practices, puddle as well as unpuddled (Table-1). Table 1 showed that the plots treated with high nitrogenous fertilizer have more values of NDVI over control plots throughout the crop period. These figures revealed that maximum value of NDVI in control plots are observed at 70 DAT, which is 10 days earlier than N180P60K40 fertilized plots because without fertilizers plots achieved early senescence.

Effects of nitrogen and tillage have been analyzed using SAS (1998) software to test the significance level of each parameter by calculating multiple factor ANOVA. Effect of nitrogen and tillage viz. puddled and unpuddled, are found to be highly correlated for NDVI at peak growth stage (80 DAT). Nitrogen is significant at 1% level of probability for almost all growth stages. Similarly, tillage has also been found to be highly correlated for all growth stages except 60 DAT.

Similar trend of NDVI for puddle and unpuddled rice for different growth stages were also observed in the year 1999. Fig. 1 and Fig. 2 showed that puddle rice have always higher value of index as compare to unpuddled rice irrespective of fertilizer treatments and growth stages.

CONCLUSION

NDVI 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 NDVI than the adequately fertilized crop. The higher values of normalized difference vegetation index were observed in puddled rice compare to the unpuddled rice irrespective of growth stages and fertilizer application levels.