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Normalized Difference Vegetation Index and Growth Traits as Influenced by Optical Sensor based N Management in Irrigated Wheat

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ABSTRACT

Nitrogen management strategies developed so far are mainly based on soil tests targeted yield and generally N recommendations are made for large areas which certainly do not take into account the field to field and season to season variability. Nitrogen being the most dynamic nutrient, we have to develop real time N management strategies which are meant by applying the N doses to the crop as and when needed. Normalised difference vegetation index (NDVI) based on canopy reflectance in near-infra red and red spectral band is a potential tool to assess N status as well as crop growth vigour in terms of dry matter accumulation, leaf area index and to estimate of the in-season yield potential, thereby assessing the N requirement. Total dry matter at different crop growth stages was determined from destructive sampling. Leaf area index and plant height were also measured at different crop growth stages. NDVI values were collected using GreenSeeker optical sensor. Grain yield from each treatment was measured at harvest. NDVI predicted crop growth traits at 90 DAS more closely as compared to other stages generally and predictive capacity for LAI was more than that for dry matter accumulation. In-season yield estimation was also better at later stages as compared to earlier stages.

Introduction

Nitrogen is one of the most important growth factors for growth and development of plants and most limiting nutrient in crop production particularly in irrigated cereal-based cropping systems and is applied by farmers with priority to get profitable yields. Nitrogen consumption by cereals is 60% and 72% of total N consumption in world and India, respectively (Raun and Johnson, 1999; FAI, 2010). Farmers have a tendency to apply N in excess of the requirement of crop to avoid risk of N deficiency. Overall farmers use about 10.5 to 24.5% (166 to 187 kg ha^{-1} as against recommended dose of 150 kg ha^{-1}) higher N dose in rice-wheat cropping system of Haryana (Singh *et al.*, 2012; Erenstein *et al.*, 2007). Over-application of N fertilizer in cereal crops lead to further lowering of N recovery efficiency and increasing the cost of production. Fertilizer N becomes available to plants very quickly (in 7-10 days of application) and N excessive of the plant needs escapes from the root zone. Therefore, in season estimation of N requirement of crop at different crop growth stages is crucial to reduce N losses and to increase N use efficiency by synchronizing N application with crop demands. Normalized difference vegetation index is a measure of total biomass and greenness of leaves and is used for mid season prediction of final grain yield. It is measured as normalized difference between reflectance in near-infra red and red band of the spectrum.

$$NDVI = (NIR_{ref} - Red_{ref}) / (NIR_{ref} + Red_{ref})$$

where, NIR_{ref} or Red_{ref} represent reflectance in the near infrared and red bands. The GreenSeeker® hand held optical sensor uses high intensity light emitting diodes (LED's) that emit light at 660±10 nm (red) and 780±10 nm (NIR) as light source and provide direct NDVI value. In this study Greenseeker was used to assess N requirement at mid-season stages in combination of fixed N doses at early stages.

Materials and Methods

A field experiment was carried out at Agronomy Research Farm of CCS Haryana Agricultural University, Hisar to assess the effect of different time and doses of N application on NDVI values and predictability of grain yield during the crop growth period using canopy reflectance. There were 12 treatments comprising N application with and without using Green Seeker (Optical sensor) laid out in RBD. Treatment one and two comprised of recommended dose of N i.e.150 kg/ha in two and three equal splits, respectively at sowing, CRI stage and 2nd irrigation. One treatment was control. In treatments three to eleven Green Seeker guided N application was combined with fixed rate (75, 100 and 125 kg/ha) and fixed time N application (nine treatments) as basal and at 25 DAS. Green seeker guided N was applied at 50 DAS (2nd irrigation stage) and/or 65 DAS (3rd irrigation stage). Fertilizer N doses were calculated using Green Seeker were calculated using procedure as described by Raun *et al.,* (2002); Raun *et al.,* (2005) and Bijay-Singh *et al.,* (2011). Normalized difference vegetation index (NDVI) measurements were made using Green Seeker at different dates and used for calculating N doses. Predictive capacity of NDVI values for different growth traits was assessed by using correlation coefficients. Grain yield from each treatment was measured at harvest. In-season Estimation of yield (INSEY) was made by using following formula:

$$INSEY = \frac{NDVI}{\text{Days from planting to sensing,}}$$

Results and Discussion

The data pertaining to NDVI values at different crop growth stages (from 50 DAS to 120 DAS) are presented in Figure 1. NDVI values increased upto 73 DAS in all the treatments except control, whereas increased values of NDVI at 90 DAS were generally observed when fertilizer N was applied at 65 DAS i.e. 3rd irrigation stage while at next crop growth stage i.e. at 120 DAS, NDVI decreased in all the treatments, irrespective of the rate and time of N application. These results corroborated with Pradhan *et al.,* (2013) who also observed similar spectral reflectance patterns at different phenological stages of wheat crop. Control treatment recorded much lower NDVI values throughout the crop growth period. At 50 and 58 DAS the treatment having recommended schedule of N application (@ 150 kg/ha) recorded highest NDVI values, followed by treatments where initially 125 kg N/ha had been applied i.e. T_9, T_{10} and T_{11}. However, beyond 65 DAS N application in three splits i.e. T_2 (total N @ 150 kg/ha) was higher in NDVI values than T_1.

At 73 DAS and beyond that NDVI values

tended to be more in treatments having N applied into more number of splits and higher doses of total N. Ma *et al.*, (1996) reported that NDVI values could differentiate the higher N dose treatments from lower and no N dose treatments in maize. At 90 and 120 DAS, T_{11} recorded highest NDVI followed by T_2 and T_9. Among the treatments having same level of fixed rate N application, single stage GS guided N at 3rd irrigation recorded lowest value of NDVI from 58 DAS till end. Changes in NDVI values (11.6 to 13.5%) between the second (50 DAS) and third irrigation (65 DAS) stages were large in treatments where N was applied at 3rd irrigation as compared to changes (2.6 to 5.6%) in treatments having no N application at 2nd irrigation.

NDVI serves as an excellent indicator of crop growth and vigour which can be illustrated by showing the relationship of crop growth parameters with NDVI values at different crop growth stages (Table 1). All the best fit equations were non-linear. Significant associations were found between growth traits and NDVI values at different growth stages. In general, the predictive values tended to increase at later growth stages in comparison to earlier stages as also reported by Aparicio *et al.*, (2002) and Cabrera-Bosquet *et al.*, (2011). Leaf area index which is an indicator of leaf greenness was highly correlated with NDVI at early as well as later stages. Ma *et al.*, (1996) also observed the significant difference between NDVI reading of greener and early senescing maize hybrids and suggested canopy light reflectance as important parameter in selecting genotypes for leaf greenness.

Table.1 Relationship of crop growth parameters with NDVI values at different crop growth stages

Growth Stage	Growth Parameter	R^2	Equation
60	Plant Height	0.73	$y = 29.185\ln(x) + 49.652$
90		0.97	$y = 45.048x^2 + 28.226x + 30.241$
120		0.96	$y = 40.764e^{1.124x}$
60	Dry Matter Accumulation(DMA)	0.89	$y = 13.855x^2 + 59.793x + 3.231$
90		0.84	$y = 124.4x + 69.591$
120		0.73	$y = 218.39x + 134.1$
60	Leaf Area Index (LAI)	0.87	$y = 3.1799x + 2.1015$
90		0.92	$y = 2.9162x + 3.5654$
120		0.95	$y = 4.3595x - 0.5407$

Fig.1 Effect of time and rate of GreenSeeker based N application on NDVI values of wheat

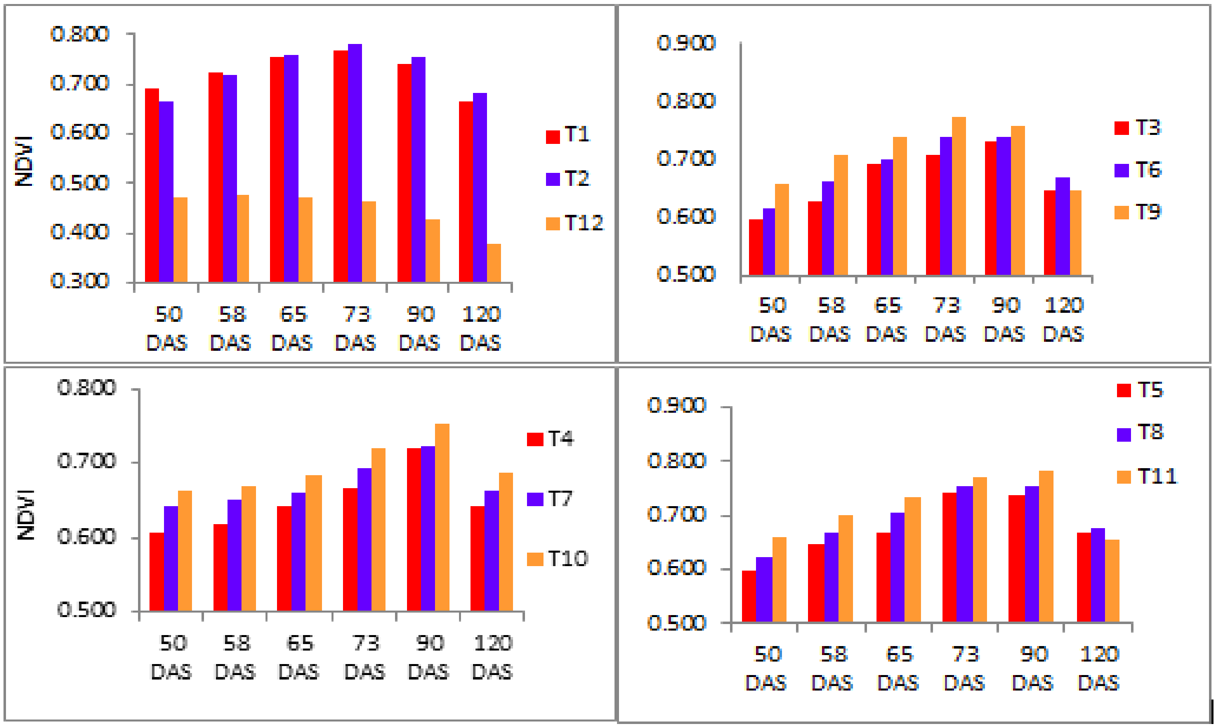
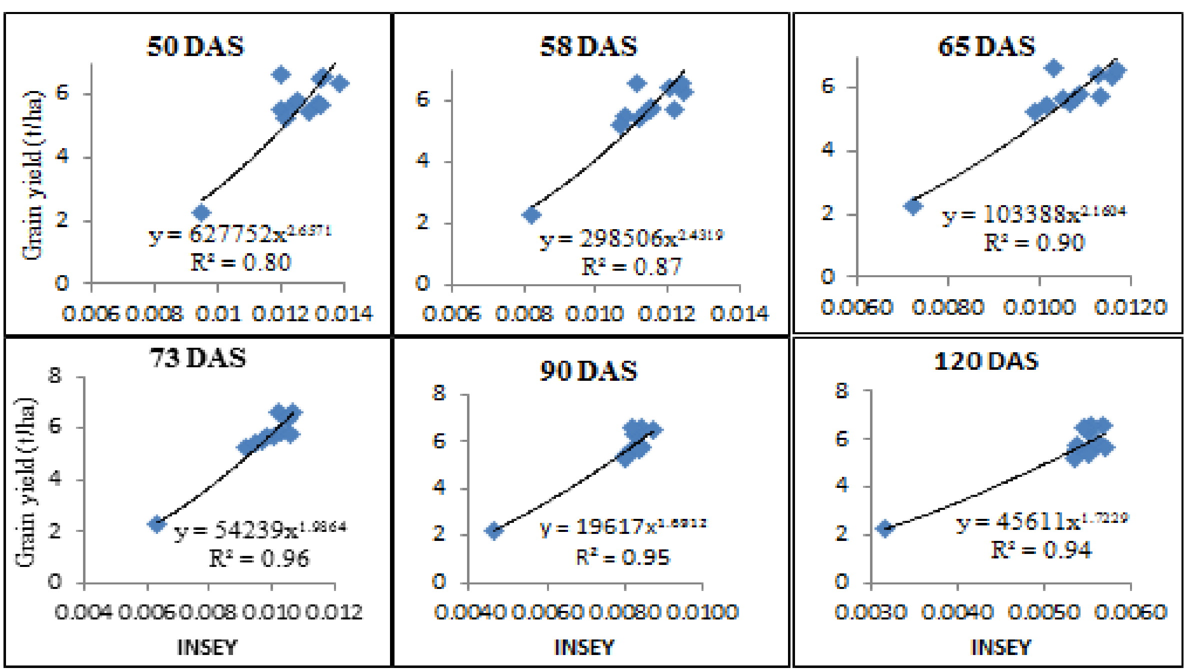


Fig.2 Relationship between grain yield and in- season estimation of yield (INSEY) based on NDVI values



The in-season estimation of yield (INSEY), an estimate of biomass produced per day when growth was possible, was plotted against actual wheat grain yield (Fig. 2). Power functions were used to describe the INSEY and grain yield relation. The highest value of coefficient of determination was observed at 73 and 90 DAS i.e. just after applying last dose of fertilizer N dose at 3rd irrigation. This may be attributed to comparatively more increase in LAI and CGR (data not shown) values at 90 DAS due to 3rd irrigation applied N and it indicates that grain yields can be improved by N application upto 3rd irrigation stage. As INSEY is estimate of biomass produced per day, higher values of R^2 at 120 DAS than 50 DAS indicated that N applied at 2nd and 3rd irrigation considerably contributes to increase in grain yield. Correlation between yield and reflectance was also shown to be greater at later stages than at earlier stages by Ma *et al.,* (2001). Gupta (2006) also reported In-Season estimation yield in rice and wheat with the help of greenseeker was better at later stages as compared to early stages. Moges *et al.*, (2007) reported NDVI to be better predictor of yield in sorghum at growth stage 3 than at growth stage 2.

References

Aparacio, N., Villegas, D., Araus, J.L., Casadesus, J. and Royo, C. 2002. Relationship between growth traits and spectral vegetation indices in durum wheat. *Crop Sci*. 42: 1547-1555.

Bijay-Singh, Sharma, R.K., Kaur, J., Jat, M.L., Kent, L.M., Singh, Y., Singh, V., Chandna, P., Choudhary, O.P., Gupta, R.K., Thind, H.S., Singh, J., Uppal, H.S., Khurana, H.S., Kumar, A., Uppal, R.K., Vashistha, M., Raun, W.R. and Gupta, R. 2011. Assessment of the nitrogen management strategy using an optical sensor for irrigated wheat. *Agron.Sust.Development.*31: 589-603. DOI 10.1007/s13593-011-0005-5.

Carabrera-Bosquet, L., Molero, G., Stellacci, A.M., Bort, J., Nogues, S. and Araus, J.L. 2011. NDVI as a potential tool for predicting biomass, plant nitrogen content and growth in wheat genotypes subjected to different water and nitrogen conditions. *Cereal Res. Commun*.39: 147-159.

Erenstein, O., Malik, R.K., Singh, S. 2007. Adoption and impacts of Zero- tillage in the rice-wheat zone of irrigated Haryana, India. Comprehensive Assessment of water Management in Agriculture. Research Report. CIMMYT and RWC, New Delhi, pp. 33-34.

FAI. 2010. Fertilizer statistics. Fertiliser Association of India, New Delhi, India. http://www.indianfertilizer.com/contentFileView.do?page=statistics

Gupta, R. 2006. Progress report. Crop canopy sensors for Efficient Nitrogen management in the Indo-Gangetic plains: USDA funded project.

Ma, B.L., Lianne, L.M., Dwyer, M., Costa, C., Cober, E.R. and Morrison, M. J. 2001.Early prediction of soybean yield from canopy reflectance measurements *Agron. J.* 93: 1227-1234.

Ma, B.L., Morison, M.J. and Dwyer, L.M. 1996. Canopy light reflectance and field greenness to assess nitrogen fertilization and yield of maize. *Agron. J*. 88: 915-920.

Moges, S.M., Girma, K., Teal, R.K., Freeman, K.W., Zhang, H. Arnall D.B., Holtz, S. L., Tubana, B.S., Walsh, O., Chung, B. and Raun, W.R. 2007. In-season estimation of grain sorghum yield potential using a hand-held optical sensor. *Arch. Agron. Soil Sci.*, 53: 617-628.

Pradhan, S., Bandopadhyay, K.K., Sahoo, R.N., Sehgal, V.K., Singh, R., Joshi, D.K. and Gupta, V.K. 2013.Prediction of wheat (*Triticum aestivum*) grain and biomass yield under different irrigation and nitrogen management practices using canopy reflectance spectra model. *Indian J. Agric. Sciences*. 83: 1136-1143.

Raun, W.R. and Johnson.G.V. 1999.Improving nitrogen use efficiency for cereal production. *Agron. J.* 91: 357-363.

Raun, W.R., Solie, J.B., Stone, M.L., Martin, K.L., Freeman, K.W., Mullen, R.W., Zhang, H., Schepers, J.S. and Johnson, G.V. 2005.Optical Sensor-based algorithm for crop nitrogen fertilization. *Commun. Soil Sci. Plant Anal.* 36: 2759–2781.

Raun, W.R., Solie. J.B., Johnson, G.V., Stone, M.L., Mullen, R.W., Freeman, K.W., Thomason, W.E and Lukina, E.V. 2002.Improving nitrogen use efficiency in cereal grain production with optical sensing and variable rate application. *Agron. J.* 94: 815-820.

Singh, S., Malik, R.K., Garg, R., Devraj, R., and Sheoran, P. 2012. On-farm nitrogen use pattern in rice-wheat cropping system of the trans-Gangetic plains of India. *Cereal Res. Commun*. 40: 122-134.

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