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Study of Crop Responses To Nitrogen Stress In Brassica Species Using Remote Sensing Technique

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ABSTRACT

The spectral properties of *Brassica species* were significantly influnced by nitrogen application. The percent red reflectance was higher in *Brassica napus* var. GSH-1 where as percent near infrared reflectance was higher in *Brassica carinata* var. HC-2 in comparison with other *Brassica species*. The mean value of spectral indices (SR or VI and NDVI) were highest in *Brassica caranita* and lowest in *Brassica napus* at maximum leaf area stage. Spectral indices could be used to differentiate the effect of nitrogen application and also between *Brassica species* . Spectral indices during pod formation phenophase were most significant for prediction of dry biomass and grain yield.

Introduction

Deficiency of nutrients is an important factor that seriously affects plant growth and development. Identification of the deficiency of nutrients in different crops over large areas is a basic pre-requisite for timely remedial measures to improve crop productivity. Among the nutrients, nitrogen is the most important for plant growth and it directly influences vegetative growth of plants.

Spectral responses of crop growth and yield to different nitrogen levels were studied by Jenson *et.al.* (1990) in maize. Das *et.al.* (1992) developed a prediction model for wheat to assess crop growth and yield through spectral indices. This study was, therefore, taken up to study crop responses to nitrogen stress using spectral indices in *Brassica species.*

Materials and Methods

Four Brassica species namely *Brassica juncea* var. Laxmi, *Brassica napus* var. GSH-1,*Brassica carinata* var. HC-2 and *Brassica campesteris* var. BSH-1 were sown under four nitrogen levels i.e. N_0 - no nitrogen, N_1- 40 kg/ha nitrogen, N_2 - 80 kg/ha nitrogen and N_3-120 kg/ha in Randomized Block Design with three replications. All other agronomic practices recommended for this crop were followed. Observations on leaf area and dry biomass were taken 15 days intervals after 30 days of sowing. Yield was recorded at harvest in each plot.

The spectral reflectance was measured in 4 TM bands with the use of Multi-band Ground Truth Radiometer. The percent reflectance values were computed by dividing canopy reflectance with that of standard. The spectral observations were taken on cloud free days at 1000 to 1200hrs. The spectral data were used to calculate vegetation indices : Infrared/ Red Vegetation Index (VI = IR/R) and Normalised difference Vegetation Index {NDVI=(IR-R)/(IR+R)}. Correlation and regression analysis was carried out between vegetation indices, crop growth and yield during different phenophases of the *Brassica species.*

Results and Discussion

Nitrogen application significantly influenced the spectral properties of *Brassica species* (Table 1). The spectral reflectance decreased from 7.0 to 4.2, 11.7 to 7.4 and 9.3 to 5.0 percent in blue, green and red bands, respectively. NIR reflectance increased from 32.6 to 51.7 percent with the application of nitrogen from 0 kg to 120 kg in *Brassica juncea* var. Laxmi. Similar influence of nitrogen application on spectral properties was observed in other *Brassica species* but magnitude of influence was different in all the four species. The percent red reflectance was higher in *Brassica napus* var. GSH-1 whereas percent NIR reflectance was higher in *Brassica carinata* var. HC-2 in comparison with other *Brassica species*. Infrared / red ratio increased with the crop growth and attained peak value at 85 days after sowing except *Brassica campesteris* (65 days after sowing). Then

Table 1. The influence of nitrogen levels on spectral reflectance (per cent) in Brassica species at maximum LAI stage

Brassica Species	Radiation Bands (um)							
	Blue (0.05-0.52)		Green (0.52-0.60)		Red (0.63-0.69)		NIR (0.76-0.90)	
	N_0	N_3	N_0	N_3	N_0	N_3	N_0	N_3
B. juncea (Laxmi)	7.0	4.2	11.7	7.4	9.3	5.0	32.6	51.7
B. napus (GSH-1)	8.1	5.2	11.5	8.1	12.9	7.3	40.2	54.0
B. carinata (HC-2)	7.8	6.7	10.3	8.7	9.5	5.9	48.3	71.0
B. campestris (BSH-1)	7.5	5.1	15.5	7.7	12.7	6.3	37.6	50.1

N_0 = 0 kg/ha Nitrogen application; N_3 = 120 kg/ha Nitrogen application

Table 2. Correlation coefficients between spectral indices and dry biomass and yield at different phenophases in Brassica species

Phenophase	Crop parameter	S1		S2		S3		S4	
		VI	NDVI	VI	NDVI	VI	NDVI	VI	NDVI
Maximum LAI phase	LAI	0.97	0.98	0.94	0.89	0.85	0.92	0.99	0.89
	DM	0.63	0.66	0.90	0.95	0.68	0.72	0.69	0.66
	Yield	0.74	0.71	0.96	0.83	0.90	0.91	0.73	0.71
Pod formation stage	LAI	0.91	0.92	0.88	0.82	0.64	0.87	0.64	0.60
	DM	0.69	0.70	0.93	0.98	0.82	0.98	0.89	0.98
	Yield	0.79	0.73	0.97	0.87	0.95	0.97	0.90	0.97
Physiological maturity	LAI	0.89	0.92	0.91	0.87	0.80	0.93	0.76	0.57
	DM	0.47	0.61	0.83	0.97	0.97	0.84	0.87	0.81
	Yield	0.51	0.70	0.94	0.87	0.95	0.99	0.76	0.82

S1 = *Brassica juncea* S2 = *Brassica napus*
S3 = *Brassica carinata* S4 = *Brassica campestris*

it decreased with the advancement of crop growth in all the four species. This might be because of decrease in leaf area due to senescence of leaves. Similar results were reported by Ajay *et.al.*, (1985) in winter crops.

The rate of change in temporal variation of infrared/red ratio was higher in *Brassica* crop fertilized with 120 kg nitrogen than that with no nitrogen application. Therefore, spectral indices could be used to differentiate between nitrogen deficient and adequately supplied crop at any growth stage during the crop cycle. The spectral difference was more prominent during maximum leaf area stage of *Brassica species* than other growth stages. The mean value of spectral indices (VI and NDVI) were highest (8.0 and 0.76) in *Brassica carinata* and lowest (5.5 and 0.68) in *Brassica napus* at maximum leaf area stage. Therefore, spectral indices could be used to differentiate the four *Brassica species*.

The spectral indices were directly and significantly related to leaf area index (LAI), dry biomass and yield (Table 2). Correlation coefficients between spectral indices and LAI were higher during maximum LAI stage while that between spectral indices, biomass and yield were higher during pod formation stage. Therefore, the spectral indices during pod formation stage were most significant for prediction of dry biomass and yield. The R^2 values varied between 0.79 and 0.98, which are significant at $P< 0.05$ (Table 3). The results demonstrated that NDVI would be appropriate in *Brassica carinata* and *Brassica compesteris*, while in *Brassica juncea* and *Brassica napus* VI (Infrared/

Table 3. Relationship of spectral indices with biomass and yield at pod formation phenophase in Brassica species

Brassica species	Regression equation	R^2
B. juncea (Laxmi)	DM = -95.26 + 130.81 VI	0.79
	DM = -889.73 + 2241.83 NDVI	0.80
	YLD = -4.31 + 4.65 VI	0.89
	YLD = -12.03 + 42.71 NDVI	0.83
B. napus (GSH-1)	DM = -325.98 + 146.43 VI	0.93
	DM = -1053.01 + 2217.55 NDVI	0.98
	YLD = -3.33 + 2.26 VI	0.97
	YLD = -13.24 + 32.18 NDVI	0.87
B. carinata (HC-2)	DM = -86.05 + 91.87 VI	0.82
	DM = -917.09 +1959.90 NDVI	0.98
	YLD = -13.33 + 4.46 VI	0.95
	YLD = -53.01 + 94.14 NDVI	0.97
B. campestris (BSH-1)	DM = -241.11 + 144.50 VI	0.89
	DM = -1315.40 + 2773.07 NDVI	0.98
	YLD = -5.33 + 3.27 VI	0.90
	YLD = -29.62 + 62.74 NDVI	0.97

DM = Dry Matter YLD = Yield

red) would be more appropriate for yield estimation.

Conclusion

It is concluded that nitrogen application significantly influenced the spectral properties of *Brassica species*. Spectral indices could be used to differentiate the effect of nitrogen application and also among the species. The spectral indices during pod formation phenophase were most significant for prediction of dry biomass and yield.

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