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Spectral Reflectance, Plant Growth, Chlorophyll and Water Use Relationships for Rice Crop in Semi-Arid Region of India

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ABSTRACT

The rice producing area has increased over the years from 30.52 M ha. in 1949-50 reaching about 42 M ha. in 1995 around which it seems to be stablising. It account for 34% of the area planted to food grain crops. Irrigated rice crop is practised in an area of about 21 million ha. which is about 49% of the country's rice producing area and contributing above 70% to the country's rice production. Due to expansion of irrigation, it has become possible to cultivate rice in dry areas and in dry season.

The aim of the present study was to establish relationship between spectral reflectance of rice canopy and crop growth, chlorophyll concentrations and water use. Taking account of the goals of the study, two fields were chosen for radiometric and agronomic measurements over the period from flowering to maturity (August to November).

A hand held Radiometer (model 100 BX) was used to measure spectral reflectance with four bands corresponding to band 1, 2, 3 and 4 of the Multi-Spectral Scanner on board Landsat 4 & 5. A high value of spectral response is observed for crop at water level because of multiple scattering effect between crop canopy and smooth water surface and low response is observed when rice plant is high above water level.

There is a functional relationship between spectral reflectance and rice plant growth (r=84), which indicate increasing trend in band 1 (0.45-0.52 um) reflectance values as growth of rice plant till the crop achieve maturity stage i.e., 100 days after planting (DAP) and than decline trend in wilting stage may be due to water stress on the plant. On the other hand bands 2 and 3 revealed decreasing trend up to 68 DAP and than increase in reflectance values during maturity stage. The near infrared band 4 (0.76-0.90 um) showed maximum reflectance at 59 DAP (panicle initiation stage) and a decline in reflectance thereafter through maturity. The peak value of IR/R ratio observed was 16.39 at 62 DAP during growing season and thereafter it decline gradually with senescence of crop.

The rice plant canopies show high chlorophyll 'a' concentration during early growth (vegetative and early reproductive stages) and decreased during the flowering and maturity stages when plant attain its maximum height (92 cms). The rice plant canopy show high chlorophyll 'a' concentration at 64 and 59 DAP for site A and B respectively. Chlorophyll 'a' concentration is higher in site A plant canopies, than the site B during entire crop cycle.

Negative correlation (r=0.91) has been found between chlorophyll 'a' and band 1. Band 2 and 3 radiance values show bi-phasic linear relationship with chlorophyll 'a' concentrations, negative for early growth and positive for flowering and maturity stages. Positive correlations (r-0.86) have been found between chlorophyll and near IR band 4. While IR/R ratio showed bi-linear relation (r=0.78), one for early growth period up to 62 DAP and another for senescence of crop and water stress.

In site A high water use efficiency causes high chlorophyll, which produces high yield (69.17 Q/ha) compare to low water use efficiency site B (59.53 Q/ha). Results indicate that the period between 66 to 70 DAP is most suitable for the assessment of rice crop yield based on chlorophyll 'a' concentration.