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RESEARCH PAPER

Spatial variability in soil nutrients and fertility mapping using geospatial techniques in Kurnool division of Andhra Pradesh

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Abstract : A revision was undertaken to draw correlation between nutrients available in soil and special indices in chickpea and cotton in the cram area of Kurnool revenue division in Kurnool district of Andhra Pradesh by means of remote sensing plus GIS techniques. A significant and positive correlation was observed between NDVI and available nitrogen during 2017-18 whereas both OC and nitrogen available had considerable positive correlation with NDVI during 2016-17 in chickpea. A significant and positive correspondence was recorded between the NDVI and organic carbon and nitrogen available in cotton during 2016-17. However, insignificant correlation was observed among NDVI and organic carbon or available nitrogen during 2017-18 under cotton cropping.

Key Words : Organic Carbon (OC), Spectral indices, NDVI, Geospatial Techniques, Soil available nutrients

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INTRODUCTION

Though conventional soil survey methods to obtain information of soil resources are reliable and accurate, do not help in creating or studying the layers of spatial variability of soil properties. The speedy development of spatial technologies in the present years has made available the new apparatus and capabilities for soil resource inventory in agriculture. In particular, the evolution of Geographical Information System (GIS), Global Positioning System (GPS) and Remote Sensing (RS) technologies enabled the gathering and analysis of data in all possible ways to create the accurate field maps and also to assess complex spatial relationships between soil fertility factors.

Normalized Difference Vegetation Index (NDVI) quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). The NDVI shows patterns of vegetative growth from green-upto senescence by indicating the quantity of actively

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photosynthesizing biomass on a landscape. Verhulst *et al.* (2008) reported to spatial variability of soil properties persuade the crop act which was correlated with the NDVI values by moving the spectral characteristics of vegetation. Belay *et al*. (2002) stated that soil fruitfulness and use of inorganic amendments were absolutely correlated with NDVI values by upsetting the spectral properties of plants. Ma *et al.* (1996) showed that higher the nitrogen contents increase the chlorophyll content and leading to increased NDVI values.

Keeping in view the above scenario, a cram was takenup with the aim to find out the relation between soil available macronutrient contented and spectral indices at farm level, to organize the soil fertility maps and to correlate NDVI values and soil macronutrient status in Kurnool revenue division of Andhra Pradesh.

MATERIAL AND METHODS

Study area:

The study area with five mandals (Kurnool, Gudur, Kallur, C. Belagal and Kodumur) of Kurnool Agricultural Revenue Division, Kurnool District, Andhra Pradesh state, is deliberately located on National Highway 44. Its geographic limits fall between 15°5421822 to 15°3321522 N latitudes and 77°3621822 to 78°1222122 E longitudes. It is situated in scarce rainfall agro climatic zone of Andhra Pradesh. The map location of present study area was indicated in Fig. 1.

Database:

Space borne multispectral data:

The data from satellite for the study was provided by Andhra Pradesh Space Applications Centre (APSAC), Vijayawada. The merged data of Cartosat-1 (PAN) and Resourcesat-2 (LISS-IV) in the form of digital and geo-coded false colour composites (FCC) were utilized for soil resource inventory of the study area.

Computers and peripherals:

In the current study, image analysis software ERDAS imagine version 11 available on SGI (Silicon Graphics) computer system was used towards of progression of satellite data, merging of images and developing FCCs. Geographic Information System (GIS) software, ArcGIS version 10 that was available on SGI system was used for the scrutiny of data, formation of digital database and preparation of diverse maps using the facilities available at APSAC, Vijayawada.

NDVI mapping and correlation of NDVI and soil macronutrients:

NDVI maps of studied area were prepared by obtaining cloud free landsat images for two years duration to calculate the NDVI values by using formula given by Chaudhury. Pearson correlation was completed to find the co-efficient of correlation among NDVI values and soil macronutrients. To minimize the error, NDVI values of fallow fields were excluded in correlation analysis.

NDVI = (pNIR - pR)/pNIR + pR

Vegetation vigour changes:

The Normalized Difference Vegetation Index (NDVI) highly correlate with vegetative characters such as green leaf biomass, leaf area a gauge of photosynthetic activity. Hence, it is of considerable value for vegetation discrimination and seasonal growing conditions for creation of prime productivity analysis. The NDVI is computed by means of infrared and red reflectance bands. These standards for NDVI range from -1 to 1. Vegetative areas show generally high values of NDVI because of their relatively high NIR reflectance and low visible reflectance. Water, snow and clouds have negative IR radiation. Rocks and bare soil have NDVI values around zero. Only green vegetation has positive NDVI values and high values being linked with elevated vegetation vigour. Based on these NDVI values, vegetation vigour was classified into dense, open and degraded vegetation. The fallow was classified as no vegetation.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Soil available nutrients and NDVI correlation studies in cotton:

The results of soil sample analysis revealed a significant and positive correlation between the NDVI and organic carbon ($r= 0.475^{**}$) and available nitrogen ($r= 0.610^{**}$) whereas, the other attributes had no correlation with NDVI during 2016-17 in cotton. A significant and positive correlation was recorded between nitrogen available and organic carbon ($r= 0.775^{**}$) and no correlation was noticed among other nutrients available

and OC in soil samples received from cotton crop (Table 1 and Fig. 1).

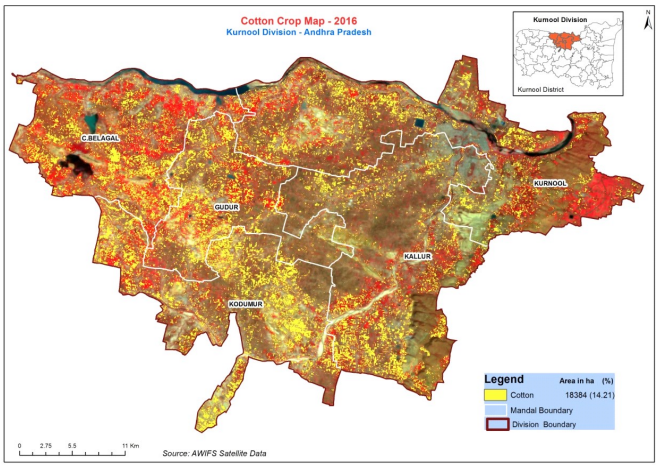

Fig. 1: Satellite image of cotton crop in study area during 2016-17

In contrary, during 2017-18, no significant correlation was measured between either organic carbon or available nitrogen with that of NDVI whereas, with respect to nitrogen and organic carbon, the same trend was observed as that in 2016-17. However, during 2017-18, a significant and constructive correlation was recorded between nitrogen available and P_2O_5 (r= 0.161*) (Table 2 and Fig. 2).

Soil available nutrients and NDVI correlation in chickpea:

During 2016-17, the correlation studies involving the

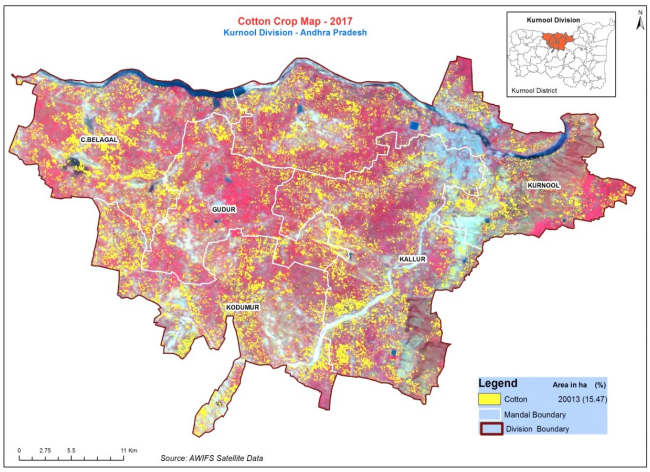

Fig. 2: Satellite image of cotton crop in study area during 2017-18

NDVI and the soil parameters such as OC, available N, P_2O_5 and K_2O pertaining to chickpea fields revealed a positive and significant correlation between NDVI with OC and nitrogen available (r=0.583** and r= 0.717**, respectively). However, available P_2O_5 and K_2O did not show any significant correlation with NDVI.

Among the different available nutrients, a significant and correlation in positive way was pragmatic between organic carbon and available nitrogen (r= 0.828**) whereas, the other available nutrients have no correlation with each other (Table 3 and Fig. 3).

Statistically significant and positive correlation was observed only between NDVI and available nitrogen (r= 0.389*) during 2017-18 unlike during 2016-17 wherein, both organic carbon and available nitrogen had positive

Table 1: Simple correlation between soil available nutrients and NDVI in cotton during 2016-17

n=222	NDVI	OC	N	P_2O_5	K_2O
NDVI	1				
OC	0.475**	1			
N	0.610**	0.775**	1		
P_2O_5	-0.061	-0.074	-0.093	1	
K_2O	-0.034	-0.054	-0.015	-0.037	1

**. Significant at 0.01 level (2-tailed)

Table 2: Soil available nutrients and NDVI simple correlation studies in cotton during 2017-18

n=222	NDVI	OC	N	P_2O_5	K_2O
NDVI	1				
OC	0.018	1			
N	0.061	0.867**	1		
P_2O_5	0.011	0.128	0.161*	1	
K_2O	0.115	-0.057	-0.032	0.005	1

*. Significant at 0.05 level (2-tailed) **. Significant at 0.01 level (2-tailed)

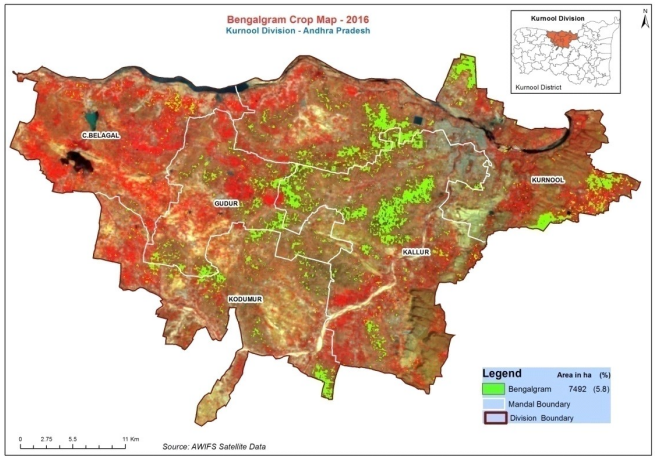

Fig. 3: Satellite image of chickpea crop in study area during 2016-17

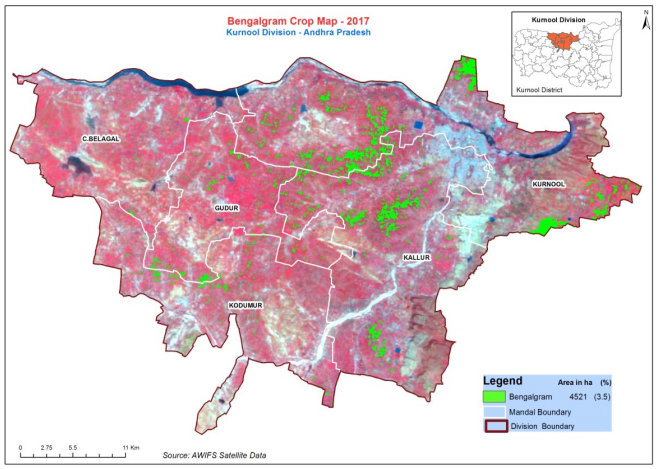

Fig. 4: Satellite image of chickpea crop in study area during 2017-18

correlation significantly with NDVI in chickpea.

With respect to available nitrogen and organic carbon, the same trend was observed as that of 2016-17 with a correlation coefficient value of 0.882.The other available nutrients and organic carbon had no correlation with each other (Table 4 and Fig. 4).

A positive and significant correlation between NDVI and organic carbon and available Nitrogen ($r=0.583^{**}$ and $r= 0.717^{**}$, respectively) was observed during 2016-17 under chickpea cropping. However, P_2O_5 and K_2O had no significant correlation with NDVI. During 2017-18 a significant and positive correlation was observed between NDVI and available nitrogen ($r= 0.389^{*}$) only. During 2016-17, a significant and positive correlation between the NDVI and organic carbon ($r= 0.475^{**}$) and available nitrogen ($r= 0.610^{**}$) was observed under cotton cropping. However, the other characters did not show any correlation with NDVI. Non significant correlation was observed between NDVI and organic carbon or available nitrogen during 2017-18 in cotton.

Conclusion:

The Normalized Difference Vegetation Index (NDVI) shows patterns of vegetative growth from green-up to senescence by indicating the quantity of actively photosynthesizing biomass on a landscape. Pearson correlation co-efficient studies were worked out for available macronutrient and NDVI for Chickpea and cotton in the investigating area of Kurnool division. Verhulst *et al.* (2008) confirmed that the spatial variability

Table 3 : Soil available nutrients and NDVI simple correlation affect in chickpea during 2016-17

n=33	NDVI	OC	N	P_2O_5	K_2O
NDVI	1				
OC	0.583**	1			
N	0.717**	0.828**	1		
P_2O_5	-0.222	-0.165	-0.149	1	
K_2O	-0.039	0.105	0.074	-0.168	1

**. Significant at 0.01 level (2-tailed)

Table 4 : Soil available nutrients and NDVI simple correlation in chickpea during 2017-18

n=41	NDVI	OC	N	P_2O_5	K_2O
NDVI	1				
OC	0.297	1			
N	0.389*	0.882**	1		
P_2O_5	-0.024	-0.246	-0.196	1	
K_2O	-0.183	-0.187	-0.169	0.101	1

*. Significant at 0.05 level (2-tailed) **. Significant at 0.01 level (2-tailed)

of soil properties influence the crop performance which affects the spectral characteristics of vegetation and correlated with the NDVI values. Comparable outcome was reported by Zeeshan *et al.* (2017) that the soil macronutrients were significantly and positively correlated with NDVI values of studied area of Chakwal region, Pakistan. The NDVI values have shown best relationship with soil nitrogen and organic carbon as higher nitrogen content enhances the chlorophyll content and leading to increased NDVI values.

There is always a positive and significant correlation between NDVI and available nitrogen and also between available nitrogen and organic carbon irrespective of the crop. Hence, it can be accomplished that special variability in soil nutrients is capable of successful relation with spectral indices for preparing soil fertility maps.

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