ORIGINAL RESEARCH PAPER

Environmental Science

SPATIAL VARIABILITY MAPPING OF MACRONUTRIENTS TO IMPROVE PRODUCTIVITY USING GEO-INFORMATICS TECHNOLOGY IN ARAVALLI AND MAHISAGAR DISTRICT, GUJARAT

KEY WORDS: Macronutrients, Geographic Information System (GIS), Inverse Distance Weighting (IDW), Spatial Distribution, Soil Nutrients Indices (SNI)

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ABSTRACT

GIS based soil fertility mapping can provide a cost effective alternative strategy for an effective nutrient management. For this purpose soil macronutrients datasets of Aravalli (330 samples) and Mahisagar district (301 samples) were obtained in spreadsheet format from Anand Agriculture University, Gujarat. Further, generated spatial distribution maps of macronutrients {viz. Nitrogen (N), Phosphorus (P) and Potassium (K)} using IDW interpolation technique of GIS. Range and average variability status also estimated using Exploratory Spatial Data Analysis tool of ArcGIS10. Soil Nutrients Indices evaluate fertility class of soil. The results of SNI revealed medium and higher fertility class of phosphorus across Aravalli and Mahisagar district, respectively. Across Aravalli and Mahisagar district SNI also revealed low fertility class of nitrogen and higher fertility class of potassium into soil. On the basis of spatial distribution maps and SNI recommended fertilizer doses for macronutrients management and improving crop productivity across Aravalli and Mahisagar district, Gujarat.

1.INTRODUCTION

Crop production is largely based on availability of soils nutrients so it is necessary to determine basic needs of soil. Availability of appropriate rate of macronutrients is essential for satisfactory crop growth and production (Patel, 2014). It has been estimated that about 50% of the increment in agricultural production of the world has been possible due to improved soil fertility management through mineral fertilizers (Stewart *et al.,* 2005). Under this context, GIS based soil fertility mapping can provide a cost effective alternative strategy for an effective nutrient management practice (Patil *et al.,* 2010). An IDW method of interpolation creates continuous surface maps for each parameter allowing estimation of soil properties for un-sampled points within the study area (Sen *et al.,* 2008). GIS based soil fertility mapping is emerging as a promising technology for assessing spatial variability of soils and preparing soil fertility maps for fertilizer recommendation with lesser numbers of soil analysis (Patil *et al.,* 2010; Sen *et al.,* 2008). The objectives of the study were to generate spatial distribution maps of soil primary macronutrients, to evaluate fertility class of soil for enhancing crop productivity across Aravalli and Mahisagar district of Gujarat state, India.

2.STUDY AREA

For spatial variability mapping of soil macronutrients as a study area selected Aravalli district from north zone and Mahisagar district from central zone of Gujarat state, India.

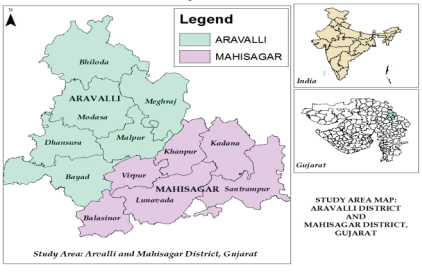

Fig.1: Location map of study area

3.METHODOLOGY

For the present study analyzed soil nutrients datasets of Aravalli (330 samples) and Mahisagar district (301 samples) were obtained in spreadsheet format from Anand Agriculture University, Gujarat. Entire work programme was broadly grouped into two phases. During the first phase of the work, prepare proper data sets to import and visualize into ArcGIS10. Using Inverse Distance Weighting (IDW) interpolation method further generated spatial distribution maps of soil macronutrients for effective nutrient management. During the second phase of work programme geo-statistical analysis were carried out through Exploratory Spatial Data Analysis (ESDA) tool which displays the summary statistics *(range and mean value)* of available primary macronutrients. Also to evaluate fertility class of soil across study area calculated Soil Nutrients Indices using following formula

Nutrient Index= {(NL*1)+(NM*2)+(NH*3)}/TNS

Where,
NL = Number of samples in low category
NM = Number of samples in medium category
NH = Number of samples in high category
TNS = Total number of samples

For classification of soil nutrients datasets into low, medium and high category is based on following ratings.

(Table-1: Ratings for classification of soil macronutrients values)

Ratings	Macronutrients		
	N (kg/ha)	P (kg/ha)	K (kg/ha)
Low	<250	<28	<140
Medium	250-500	28-56	140-280
High	>500	>56	>280

(*Source*: www.gsfclimitd.com)

A SNI value less than 1.67, between 1.67 to 2.33 and more than 2.33 indicates low, medium and high fertility status of soil, respectively.

4.RESULTS AND DISCUSSION

4.1 Available Nitrogen:

Available nitrogen of investigated soils across Aravalli district varied from 88 – 408 kg ha^{-1} with mean value of 174 kg ha^{-1} and soil nutrient index value was 1.00 revealed low fertility class of nitrogen into soil while across Mahisagar district available nitrogen varied from 75 – 251 kg ha^{-1} with mean value of 138 kg ha^{-1} and SNI value was 1.00 revealed low fertility class of nitrogen into soil. Spatial variability maps of available nitrogen status across the soil of Aravalli and Mahisagar district are shown in figure 2 and 3.

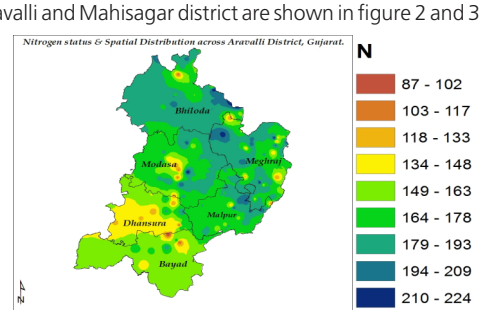

Fig.2: Available nitrogen status and spatial distribution across Aravalli district, Gujarat.

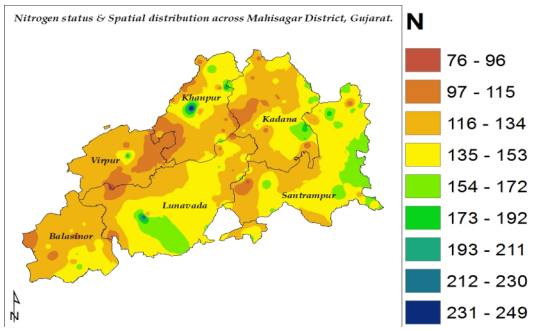

Fig.3: Available nitrogen status and spatial distribution across Mahisagar district, Gujarat

Recommendation: Across Aravalli and Mahisagar district SNI revealed low fertility class of available nitrogen so, it is recommended to give 25 to 30% more N contain fertilizers.

4.2 Available phosphorus:

Available phosphorus of investigated soils across Aravalli district varied from 14 – 123 kg ha^{-1} with mean value of 46 kg ha^{-1} and soil nutrient index value was 2.09 revealed medium fertility class of phosphorus into soil while across Mahisagar district available phosphorus varied from 17 – 372 kg ha^{-1} with mean value of 70 kg ha^{-1} and SNI value was 2.50 revealed high fertility class of phosphorus into soil. Spatial variability maps of available phosphorus status across the soil of Aravalli and Mahisagar district are shown in figure 4 and 5.

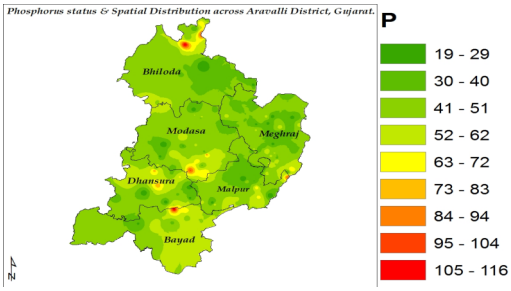

Fig.4: Available phosphorus status and spatial distribution across Aravalli district, Gujarat.

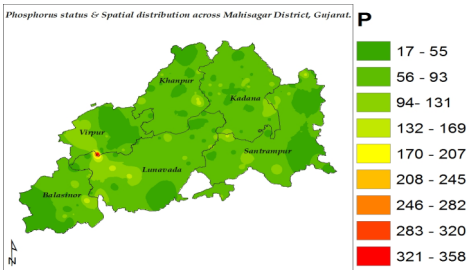

Fig.5: Available phosphorus status and spatial distribution across Mahisagar district, Gujarat.

Recommendation: Across Aravalli district SNI revealed medium fertility class of available phosphorus so, it is recommended to apply appropriate P contain fertilizer according to type of soil while across Mahisagar district available phosphorus was high so, it is recommended to give 15 to 20% less P contain fertilizer.

4.3 Available potassium:

Available potassium of investigated soils across Aravalli district varied from 69 – 1419 kg ha^{-1} with mean value of 293 kg ha^{-1} and soil nutrient index value was 2.70 revealed high fertility class of potassium into soil while across Mahisagar district available potassium varied from 117 – 1151 kg ha^{-1} with mean value of 422 kg ha^{-1} and SNI value was 2.77 revealed higher fertility class of potassium into soil. Spatial variability maps of available potassium status across the soil of Aravalli and Mahisagar district are shown in figure 6 and 7.

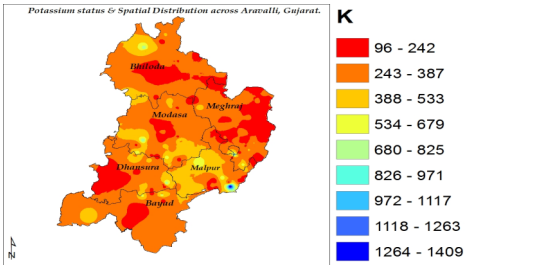

Fig.6: Available potassium status and spatial distribution across Aravalli district, Gujarat.

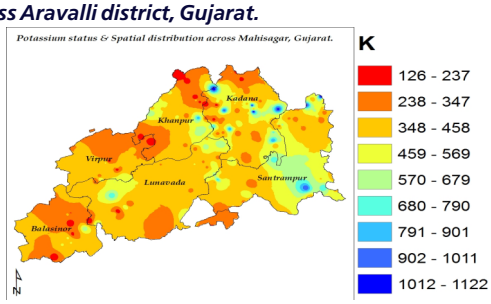

Fig.7: Available potassium status and spatial distribution across Mahisagar district, Gujarat.

Recommendation: Across Aravalli and Mahisagar district SNI revealed higher fertility class of available potassium. So, it is recommended to give 15 to 20% less K contains fertilizer.

5.CONCLUSIONS

It can be concluded that the spatial maps generated under the study will be useful for guiding the farmers to decide the amount and kind of macronutrients to be applied for site specific nutrient management. Geo-statistical analysis estimates range and average variability status of available nutrients while Soil nutrient indices evaluated low fertility class of N and higher fertility class of K across Aravalli and Mahisagar district. SNI also evaluated medium fertility class of P across Aravalli and higher fertility class of P across Mahisagar district. Both, Geo-statistical analysis and SNI helps in better understanding of primary macronutrients management and enhancing crop productivity across Aravalli and Mahisagar district of Gujarat state, India.

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