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HORIZONTAL SOIL SULPHUR STATUS AND FERTILITY MAP OF NORTH-EASTERN REGION OF HARYANA, INDIA

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ABSTRACT

An experiment was conducted to investigate the horizontal status of sulphur in north-eastern region of Haryana. 264 surface soil samples (0-15 cm depth) were collected at an interval of 2-3 km. from Ambala (86), Yamuna nagar (102) and Panchkula (76) districts using GPS. Textural classes of the concerned districts varied from sandy to clay loam. Available sulphur ranged from 4 to 39 mg/kg soil with a mean value of 15.4 mg/kg soil in Ambala. In Panchkula it ranged from 1.9 to 39.4 mg/kg soil with a mean value of 13.6 mg/kg soil where as in Yamuna nagar sulphur content varied from 3.8 to 41.3 mg/kg soil with a mean value of 20 mg/kg soil. Maximum percent sulphur deficiency was found in Panchkula (38.2 %) whereas in case of Ambala and Yamuna nagar percent deficiency of sulphur was found to be 30.2 and 11.8 % respectively. Nutrient index value for sulphur was found 2.29, 1.95 and 1.80 in Yamuna nagar, Ambala and Panchkula. On the basis of surface soil available sulphur status a horizontal fertility map was prepared using GPS data. Sulphur fertilization is strongly suggested with recommended dose to check further depletion of soil available sulphur of the top soil layer.

KEY WORDS
Sulphur status
Fertility map
Nutrient index value

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INTRODUCTION

Soil, being the natural medium for plant growth has a direct impact on yield and quality of crops growing on it. Measurement of the fertility of an agricultural soil tells much about the productive potential (Nafiu *et al.,* 2012). Soil fertility map is a geographical representation showing diversity of soil fertility status of a region and preparation of soil fertility map is a fast and efficient way of generating information about soil fertility of any region in a large scale basis which is very helpful to the farmers. Sulphur is the thirteenth most abundant mineral in the earth crust averaging about 0.10 %. Sulphur is the next to major elements N, P, K and hence rightly called fourth major nutrient. It not only influences yield but also improves grain quality owing to its influence on protein metabolism and oil synthesis (Limbikai *et al.,* 2015). More sulphur requirement for higher crop yield, presence of minute quantity of sulphur impurity in modern fertilizers, reduction of sulphur containing pesticide uses have resulted increased importance of sulphur as a limiting nutrient in crop production in recent years.

Widespread deficiencies of sulphur in India were reported by Tandon, (1991). Deficiency of sulphur in Indian soil is increasing mainly due to use of sulphur free fertilizers and greater removal of sulphur by the high yielding varieties. Sulphur losses from soil through leaching and erosion are other important reasons for growing incidence of sulphur deficiency in soils. Despite such an important role in agriculture, research pertaining to the status of S in soils and crop response studies related to this element are very few in India. Kumar *et al.* (2001) reported that the gap between addition and removal of sulphur in Haryana has increased during last three decades and as a result of which the area under S deficiency in the state has increased to 21 %. Dalvinderjit *et al.* (2001) found 77% samples as sulphur deficient while determining surface soil available sulphur status in north-western India.

Farmers generally apply fertilizer without knowing the actual requirement of current fertility status of the soil. Intensive cropping with high yielding varieties of crops resulting in faster nutrient depletion, demanding higher nutrient input. It is also proved that plant remove more nutrient from the soil in modern intensive cultivation and hence needs constant replenishment (Prajapat *et al.,* 2015). On the other hand over fertilization is not only an economic loss but also causes adverse effect on plant growth and environment. So, optimum fertilization is very important for sustainability aspect too. Fertility status of the nutrients is imperative in order to recommend optimum fertilization rate.

Therefore, keeping in view of above mentioned facts the present study was undertaken to investigate the horizontal distribution of sulphur in Ambala, Yamunanagar and Panchkula districts of Haryana with the objective to assess the horizontal fertility status of sulphur in north-eastern region of Haryana.

MATERIALS AND METHODS

Collection and preparation of soil samples

For the investigation of status of sulphur in north-eastern region of Haryana, surface soil samples (0-15cm depth) were collected at an interval of 2-3 km. from Ambala, Yamunanagar and Panchkula districts using GPS. These samples were air dried ground and passed through a 2 mm sieve and analyzed for available sulphur. Nutrient Index Value (NIV) was also calculated on the basis of the available sulphur of the surface soil using the formula stated below.

Textural class

soil textural class was determined by rapid feel method as described by Pal, 2013.

Available Sulphur

Available sulphur was extracted by 0.15% calcium chloride and was estimated turbidimetrically on spectronic 20 spectrophotometer as described by Chesnin and Yien (1950). On the basis of available sulphur surface soil was rated as low, medium and high as described by Hariram and Dwivedi, 1994 (Table 1).

Nutrient Index Value: Nutrient index value (NIV) was determined by using the following formula as described by Parker *et al.*, 1951 and the nutrient index range chart from Motsara, 2002 (Table 2).

$$NIV = \frac{(SL + 2SM + 3SH)}{(SL + SM + SH)}$$

Where,

SL = Number of samples of low nutrient content

SM = Number of samples of medium nutrient content

SH = Number of samples of high nutrient content

Preparation of soil fertility map

Base map of the Ambala, Panchkula and Yamunanagar districts was digitized and geo-referenced. Polygons were superimposed on the geo-referred map. Latitude, longitude and analysis data were entered into attributed table and linked to GIS software for making thematic soil fertility maps as described by Mishra *et al.*, 2014.

Table 1: Available soil Sulphur rating classes (Hariram and Dwivedi, 1994)

Available Sulphur (in ppm)	Soil fertility class
Below 10	Deficient/Low
10-20	Medium
Above 20	Sufficient/High

Table 2: Nutrient index chart after Motsara, M.R., 2002

Range	Nutrient Index
Below 1.5	Low
1.5-2.5	Medium
Above 2.5	High

RESULTS AND DISCUSSION

Surface soil samples were collected using GPS at an interval of 2-3 km. from Ambala, Yamunanagar and Panchkula districts and were analyzed for different soil textural classes and available sulphur status of the soil.

Status of sulphur

Soil textural classes varied from sandy to clay loam in Ambala district whereas in Panchkula and Yamuna nagar districts it ranged from sandy to loamy texture (Table 3). In all the three districts a wide range of soil available sulphur content was found. Available sulphur ranged from 3.8(Saini majra) to 39.4 (Devinagar village) mg/kg soils with a mean value of 15.4 mg/kg soil in Ambala district. In panchkula district it ranged from 1.9 (Pota village) to 39.4 (Ramgrh village) mg/kg soil with a mean value of 13.6 mg/kg soil where as in Yamuna nagar district sulphur content varied from 3.8 (Shakhonmajra village) to 41.3 (Pritnagar village) mg/kg soil with a mean value of 19.5 mg/kg soil (Table 3). But, average soil available sulphur contents of the three districts were found medium. Medium sulphur contents in the soils of the three districts may be ascribed to medium to coarse textural nature of the soil. These results are in agreement with those reported by Singh *et al.*, 2009 and Sharma *et al.*, 2015. Similar results on sulphate sulphur content of the surface soil were found by Kumar and Singh (1999),

Dalvinderjit *et al.* (2001) and Patra *et al.* (2012). Patel and Patel (2008), Patel *et al.* (2011) and Singh and Mishra (2012) also reported similar findings. But, Bandyopadhayay and Chattopadhyay (2001) found all soils deficient in sulphate sulphur content in some soils of Birbhum district of West Bengal, lateritic soils of Birbhum district of West Bengal may be the reason for such low level of surface soil sulphate sulphur content. Basumatary *et al.*, 2010 and Basumatary and Das, 2012 reported that presence of variable proportions of different component of soil organic carbon content may be accounted for such wide range of sulphate sulphur content of the surface soil. But, according to Patel and Patel (2008) soil and crop management practices such as cropping intensity and nature of crop grown, water use and differential fertilizer addition is the reason for such wide range of available sulphur.

The percent of soil samples high, medium and low were 25.6, 44.2 and 30.2 for Ambala district, 18.4, 43.4 and 38.2 for Panchkula district and 41.2, 47.0 and 11.8 for Yamuna nagar district (Table 4).Nutrient index values of sulphur were found 1.95, 1.80 and 2.29 in Ambala, Panchkula and Yamuna nagar district, respectively. Maximum percent deficiency was found in Panchkula that is 38.2 % whereas in Ambala and

Table 3: soil textural classes and Sulphur status of the surface soils

Sl. No.	Soil property	Districts		
		Ambala	Panchkula	Yamunanagar
1	Textural class	S-CL	S-L	S-L
2	Available sulphur	3.8-39.4 (15.4)	1.9-39.4 (13.6)	3.8-41.3 (19.5)

*Values in the parenthesis indicate mean values. S = Sandy, L = Loamy, CL = Clay loam.

Table 4: Nutrient index value and percent deficiency of sulphur in three districts

Districts	No of samples high in S	No of samples medium in S	No of samples low in S	Nutrient index value	Percent deficient samples
Ambala [86]	22 (25.6%)	38 (44.2%)	26 (30.2%)	1.95	30.2 %
Panchkula [76]	14 (18.4%)	33 (43.4%)	29 (38.2%)	1.80	38.2 %
Yamunanagar[102]	42 (41.2%)	48 (47.0%)	12 (11.8%)	2.29	11.8 %
Overall [264]	78 (29.5%)	119 (45.1%)	67 (25.4%)	2.04	25.4 %

Number in [ ] indicate total no. of samples

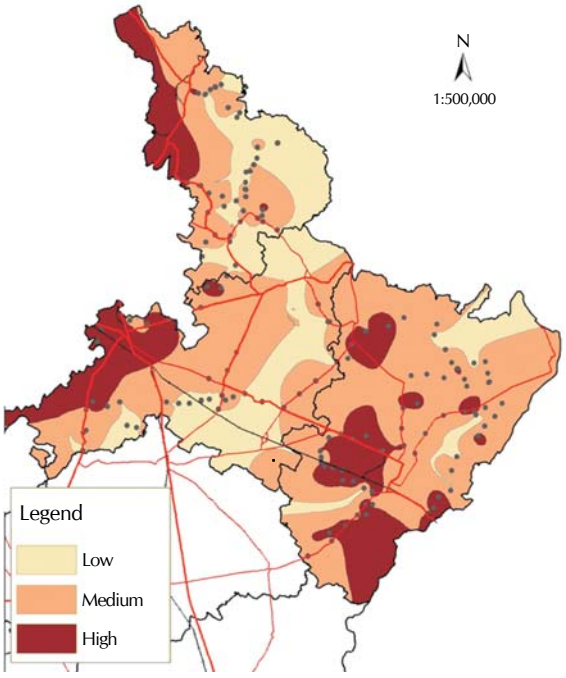

Figure 1: Horizontal soil available sulphur status map of north-eastern region of Haryana (Panchkula, Ambala and Yamunanagar districts)

Yamunanagar districts percent deficiencies of sulphur were found to be 30.2 and 11.8 % respectively (Table 4). In all the three districts overall nutrient index value was found to be medium (2.04) and 25.4% of the sample were found deficient in available sulphur. Similar results were found by Singh *et al*., 2009. But, interestingly, Paul and Mukhopadhyay (2015) found 40 to 100% soil sample high and no sample low in available sulphur in some Terai soils under sub-tropical zone of eastern India which may be due to finer textural class of the Terai soils of eastern India unlike the soils of north-eastern region of Haryana.

Fertility status map

Status of sulphur of north-eastern regions of Haryana was found low to medium with a medium nutrient index value for all the three districts. And based on those data a status map of Amabala, panchkula and Yamunanagar districts was prepared which is depicted as Fig. 1.

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