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STATUS OF SULPHUR IN SOILS AND VEGETABLE CROPS OF AGRA DISTRICT OF UTTAR PRADESH

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ABSTRACT

Sulphur status in soils and vegetable crops of Agra district of Uttar Pradesh was evaluated in relation to soil properties. Three hundred soil samples collected from vegetable growing areas were analyzed for their sulphur status. The results revealed that the available S content ranged from 4.5 to 21.6, 3.0 to 24.0, 6.5 to 20.0, 4.5 to 20.5, 5.5 to 20.0 and 6.0 to 20.0 mg kg^{-1} in carrot, garlic, onion, potato, radish and spinach soils, respectively. Among these vegetable soils, maximum and minimum values of available S were noted in onion and radish soils, respectively. About 61% of soils were deficient in available sulphur. Available S had significant and positive relationship with organic carbon and EC of soils. It did not bear any significant relationship with $CaCO_3$ content. There existed significant and negative relationship soil pH and available sulphur. Sulphur content in carrot, garlic, onion, potato, radish and spinach ranged from 0.27 to 0.50, 0.44 to 0.78, 0.19 to 0.56, 0.16 to 0.45, 0.30 to 0.76 and 0.16 to 0.41 percent, respectively. The percentages of plant samples showing below 0.20% sulphur were 30 percent. On an average, garlic had the maximum amount of sulphur in its cloves. Available S in soils was found to have significant and positive calationships with sulphur content in all the vegetable crops.

Keywords: Status, sulphur, soils, vegetable crops, relationship, propecties

INTRODUCTION

Sulphur is one of the essential secondary nutrients required for growth and development of plants, animals and human beings. Sulphur is the fourth most important nutrient after nitrogen, phosphorus and zinc for Indian agriculture. Sulphur has become very important because of its reported deficiency in certain crops due to increasing use of sulphur free fertilizers. In vegetable crops, sulphur plays a significant role in quality and development of curds, roots and tubes. Probably for these reasons vegetable crops need comparatively higher amounts of sulphur for proper growth, development and higher yield. The cultivation of vegetable crops has been encouraged in India both in Kitchen gardening and on the commercial lines. About 60% soils of Agra sulfer from various degrees of sulphur deficiency (Chandel et al 2012 and Ali et al 2014). The fast decline in available soil S is chiefly due to higher crop removal by high yielding genotypes; high cropping intensity, poor replenishment in soil due to use of S free fertilizes. Sulphur deficiency in crop plants has been recognized as a limiting factor not only for crop growth and seed yield but also for poor quality of products, because suphur is a constituent of several essential compounds such as cysteine, methionine, cystine, coenzymes, thioredoxine and sulpholipids etc. Sulphur also plays an important role in chlorophyll formation. It has been generally observed that soil and plant tests are complementary to each other and at times one supplies the information that the other does not foliar analysis provides a comprehensive picture of sulphur absorbed by the plants and helps in identifying the deficiency of sulphur. So far, inadequate information is available regarding the status of sulphur in vegetable crops growing soils of Agra district. In view of this, the present study was undertaken to determine the status of available S in soils and vegetable crops and to find out the relationship of various soil properties with available sulphur.

MATERIALS AND METHOD

Fifty plant samples of each of the vegetable crops namely carrot (*Daucees carota* L), garlic (*Allinm sativum* L.) onion (*Allinm cepa* L.), potato (*Solanum tuberosum*), radish (*Raphanus sativus* L) and spinach (*Spinacia oleracea*) were collected when these were ready for eating as vegetable from Agra district of Uttar Pradesh. Soil samples were also collected from the same sites. The physico-chemical properties of the soils were determinate by adopting standard methods (Jackson, 1973). Available sulphur (0.15% $CaCl_2$ solution) in these soils was determined by turbicdimetric method (Chesnin and Yien 1951). The samples of vegetable crops were washed with 0.1 N HCL followed by washing with distilled water. The oven-dried samples were powdered by crushing them with hands/grinder. Diacid (HNO_3 and $HClO_4$) digested samples of vegetable crops were analyzed for sulphur by turbidimetric method. Simple correlations were worked out relating available soil sulphur with physico-chemical properties of the soils

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and S content in plants by standard statistical methods.

RESULTS AND DISCUSSION

Physico-chemical properties

The soils were alkaline in reaction, the variation in pH being from 7.0 to 8.9 in carrot soils, 7.0 to 8.8 in garlic soils, 7.0 to 8.4 in onion soils, 7.0 to 8.5 in radish soils, 7.0 to 8.8 in potato soils and 7.2 to 8.8 in spinach soils. The electrical conductivity of soil -water suspension (1:2.5) ranged between 0.06 and 0.46 dSm^{-1}. Mean values of EC of carrot, garlic, onion, potato, radish and spinach soils were 0.21, 0.10, 0.18, 0.22, 0.18 and 0.18 dSm^{-1}, respectively. Thus, soluble salts do not appear to pose any problem for successful cultivation of crops in these soils. Calcium carbonate content in these soils ranged between 5 and 35 g kg^{-1}. The mean values of $CaCO_3$ in carrot, garlic, onion, potato, radish and spinach soils were 9.6, 11.8, 11.8, 11.7, 11.6 and 11.1 g kg^{-1}, respectively. In general, these soils did not differ markedly in respect of $CaCO_3$ content in soils. The mean values of organic carbon status in carrot, garlic, onion, potato, radish and spinach soils were 4.4, 4.3, 5.1, 4.6, 4.5 and 4.1 g kg^{-1}, respectively indicating higher amount in onion and potato soils. Organic carbon content in these soils may be considered low to medium as most of them were found to contain less than 7.5 g kg^{-1} of it.

Table 1: Status of sulphur in soils and plants

Soil Charaitavistics	Carrot	Garlic	Onion	Potato	Radish	Spinach
pH	7.0-8.9	7.0-8.8	7.0-8.4	7.0-8.8	7.0-8.5	7.2-8.8
EC (dSm^{-1})	0.10-0.46 (0.21)	0.10-0.40 (0.19)	0.10-0.55 (0.18)	0.16-0.41 (0.22)	0.10-0.38 (0.18)	0.08-0.36 (0.18)
Organic C (g kg^{-1})	2.8-6.5 (4.5)	2.8-6.6 (4.3)	3.8-6.6 (5.1)	2.8-6.6 (4.6)	3.0-6.0 (4.5)	2.8-5.6 (4.1)
$CaCO_3$ (g kg^{-1})	5.0-35.0 (9.6)	5.0-35.0 (11.8)	5.0-25.0 (11.5)	5.0-30.0 (11.7)	5.0-35.0 (11.6)	5.0-35.0 (11.1)
Sulphur						
Available S (mg kg^{-1}) soil	4.5-21.6 (10.7)	3.0-24.0 (11.4)	6.5-20.0 (12.1)	4.5-20.5 (10.9)	5.5-20.0 (10.0)	6.0-20.0 (9.9)
Plant Sulphur (%)	0.2-0.50 (0.38)	0.44-0.78 (0.60)	0.19-0.56 (0.37)	0.16-0.45 (0.28)	0.30-0.76 (0.50)	0.16-0.41 (0.24)

Available sulphur in soils

Available S (extracted by 0.15% $CaCl_2$) is used as an index of S availability in many soils, since the variation in this form causes variation in yield and S uptake by crops. The average available S content ranged from 4.5 to 21.6, 3.0 to 24.0, 6.5 to 20.0, 4.5 to 20.5, 5.5 to 20.0 and 6.0 to 20.0 mg kg^{-1} in carrot, garlic, onion, potato, radish and spinach soils, respectively. The corresponding mean values of available S were 10.7, 11.4, 12.1, 10.9, 10.9 and 9.9 mg kg^{-1}. On an average, onion soils were found to be relatively rich in available S as compared to other vegetable soils. Spinach soils of Agra district showed the lowest mean amount of available sulphur. Similar results were reported by Omprakash et al (1997) in vegetable soils and Singh (2002) in cereal soils. As per limits of available S, 61% soils samples was low or deficient range (less than 10 mg kg^{-1}), 39% soil samples were marginal (10-25 mg kg^{-1}) and none of the samples was high in available sulphur (more than 25 mg kg^{-1}). The soils growing spinach may be categorized more problematic than soils growing other vegetable crops with respect to sulphur. The major reasons for S deficiency may be low organic matter status of the soils. Available S was significantly and negatively related with soil pH (Table 2), but this relationship appears to be less pronounced in carrot soils. Mahajan et al (2007) and Das et al (2012) also reported similar relationship between available S and soil pH. Electrical conductivity of soils had significant and positive relationship with available S (Table 2). The relationship between these two variables was more pronounced in spinach soils. Similar relationship was reported by Singh et al (2009). There existed no uniform relationship between $CaCO_3$ and available S in all the vegetable soils. Ali (2010), Ali et al (2014) and Chandel *et al.* (2012) also reported similar results. The available S was positively and significantly correlated with organic carbon (Table 2) in all the vegetable growing soils. The highest correlation (r=0.581) was noted in spinach soils and minimum in garlic soils (r=0.362). The observed significant and positive correlation of available sulphur with organic carbon suggests that S supplying power of these soils is largely dependent upon organic matter. These results are in accordance with those of Kaur and Jalali (2008) and Ali *et al.* (2014).

Table 2: Correlation coefficienst of availables with soil characteristics and plant sulphur

Vegetable Crops	pH	EC	Org. C	$CaCO_3$	Plant Sulphur
Carrot	-0.590**	0.211*	0.495**	0.155	0.610**
Garlic	-0.609**	0.230*	0.362*	0.102	0.752**
Onion	0.653**	0.205*	0.472**	0.180	0.690**
Potato	-0.747**	0.240*	0.479**	0.164	0.677**
Radish	-0.631**	0.261*	0.552**	0.117	0.701**
Spinach	-0.778**	0.270*	0.581**	0.158	0.788**

** Significant at 5% level, ** significant at 1% level*

Sulphur in vegetable crops

Sulphur concentration in vegetable crops varied from 0.27 to 0.50% in carrot, 0.44 to 0.78% in garlic, 0.19 to 0.56% in onion, 0.16 to 0.45% in potato, 0.30 to 0.76% in radish and 0.16 to 0.41% in spinach (Table 1). The corresponding mean values of sulphur were 0.38, 0.60, 0.37, 0.28, 0.50 and 0.24 percent. On an average, the samples of garlic contained the maximum amount (0.60%) of sulphur than rest of the vegetable crops. The minimum amount of sulphur (0.24%) was recorded in spinach leaves. The samples of vegetable crops collected from soils having low available sulphur accordingly had low sulphur concentration. Sulphur content in vegetable crops recorded in this study is comparable with those reported by Ali (2010) and Chandel *et al.* (2012). Extent of sulphur deficiency by plant analysis in these vegetable crops was about 30% percent. The concentration of S in vegetable crops exhibited a definite relationship with its available status of soils (Table 2). Highest correlation coefficient between these two variables was, however, found in spinach (r=788**). The results thus indicate that soil test values corroborate with plant analysis and it is possible to forecast deficiency of sulphur from soil analysis prior to sowing of crops. Similar were the finding of Singh (2002). The extent of S deficiency as renealed by plant analysis was of small order as compared to soil analysis (Ali *et al.* 2014).

The present study revealed considerable variation in the status of available sulphur in vegetable growing soils and plants. The study pointed out to the need of use of sulphur fertilizers and organic menures for ensuring vegetable crops to sustain production in the long run.

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