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"Study of correlation between S fractions with soil properties in Soils of Tuljapur tahsil of Osmanabad District"

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Abstract: *The present investigation was carried out to study assessment of different nitrogen and sulphur forms in soils of Tuljapur tahsil of Osmanabad district. For this purpose 180 representative soil samples were collected from 30 villages of Tuljapur tahsil. The collected soil samples were grouped into three orders* viz. *Vertisols, Inceptisols and Entisols. Out of the total surveyed soil samples, 34 per cent samples were grouped under Vertisols while, 47 per cent and 19 per cent samples were grouped under Inceptisols and Entisols, respectively and orderwise anaysis was carried out.In chemical analysis, the soils under study area were alkaline in reaction, safe in limit of electrical conductivity and moderately calcareous to calcareous in nature. The organic carbon content in soils was found low to medium.The soils were found to be low in all the fractions of S* viz. *total S, available S, organic S, water soluble S and non-sulphate S.The pH and $CaCO_3$ showed negative and significantly correlated with all the fractions of sulphur in Inceptisols and Entisols. Whereas, organic carbon showed positive and significant correlation with different fractions of sulphur in all soil orders. However, electrical conductivity showed negative and significant correlation with all the fractions of S except available S in Vertisols and EC did not showed any relation with S fractions in Inceptisols and Entisols under study.*

Keywords: *correlation, S fractions, soil properties, Vertisols, Inceptisols and Entisols.*

INTRODUCTION

Osmanabad district is located between 18^0 28' to 19^0 28' North altitude and 76^0 25' to 77^0 25' East latitude. The geographical area of the district is 7512.40 sq. km. Osmanabad district is the South western part of Marathwada region of Maharashtra state with annual rainfall 769 mm. Maximum and minimum temperature of this district is 43.3^{0}C and 11.9^{0}C, respectively. The elevation is 725-750 m from mean sea level and which comes under Central Maharashtra Plateau Agro-climatic Zone and Semi- arid region. Osmanabad district comprises 8 tahsils, out of these Tuljapur tahsil is considered for the study. The chemical characteristics like, pH, EC, organic carbon and calcium carbonate are important as these affect on availability of nutrients in soil and thereby on crop growth and production. The soil must supply the nutrients that are essential for plant growth and necessary component of human and animal food for sustainable agriculture. In the mineral soils of arid and semi-arid regions, textural classification, pH and calcium carbonate have been reported to influence the sulphur supplying capacity of the soils. Sulphur present in the soil, added through fertilizers undergoes chemical to transformation and ultimately changes into sulphate before it can ranges from less than 20 to several thousand ppm but in most cases within 50-500 ppm. Sulphur in soils is mostly present in organic form combines with carbon, sulphur and nitrogen of the soil. Sulphur is an essential element, becoming deficient due to continuous use of sulphur free fertilizers, high yielding crops, varieties, intensive cropping with high sulphur requiring crops. Several soil factors influence the availability of sulphur and hence the status of different forms of sulphur in soil varies widely with soil type. A knowledge of different forms of sulphur and C: N: S ratios throughout the zone of root penetration is essential in improving sulphur nutrition of crops. (Rai *et al.,* 2010). Distribution of different sulphur forms at various soil depths decides the sulphur supplying power of soil by influencing its release and dynamics in soil particularly where sulphur is added as a carrier. Knowledge of the relative distribution of sulphur at different soil depths may be helpful in formulating a

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sound fertilizer programme in realizing higher economic productivity under long-term fertilizer use in a cropping system (Setia and Sharma 2005).

The present study is undertaken on "Study of correlation between S fractions with soil properties in Soils of Tuljapur tahsil of Osmanabad District" with following objective: To establish correlation between S fractions with soil properties.

MATERIALS AND METHODS

Geography and climate of Osmanabad district, Soils of Osmanabad district, Selection of site or location, Collection of soil samples, Preparation of soil samples

Chemical properties of soil

Soil pH, EC, Organic carbon, Calcium carbonate

Sulphur fractions in soils

Total sulphur, Available sulphur, Organic sulphur, Non-sulphate sulphur, Water soluble sulphate sulphur

Statistical analysis

Materials: Geography and climate of Osmanabad district

Osmanabad district is located between 18^0 28' to19^0 28' North altitude and 76^0 25' to 77^0 25' East latitude. The geographical area of the district is 7512.40 sq. km. Osmanabad district is the South western part of Marathwada region of Maharashtra state. Annual rainfall is 769 mm. Maximum and minimum temperature of this district is 43.3^{0}C and 11.9^{0}C, respectively. The elevation is 725-750 m from mean sea level and which comes under Central Maharashtra Plateau Agro-climatic Zone and Semi- arid Region.

Soils of Osmanabad district

Soils of Osmanabad district mostly belongs to order Vertisols, Inceptisols and Entisols. The soils were varied in colour due to presence of different types of minerals like plagioclase, augite, calcite, dolomite, magnetite *etc*. The soils in the area vary widely in both texture and depth. The soils of the area are rough and rocky largely consisting of basalt. Thin deposits of fertile black soil are found in the northern part and in the South at the western region. Most of the land of the district is full of rock and thin layers of soil except Kumbhari, Kilaj, Masala, Hangarga and Kathi where the land consists of rich fertile black cotton soil.

Selection of site or location

Tuljapur tahsil consist of 109 villages, out of these 30 villages were selected for this study. The villages were selected randomly in such way that it should cover whole area of the tahsil. The selected villages from Tuljapur tahsil of Osmanabad district wereKakramba, Khandala, Wadgaodev, Kilaj, Horti, Jalkot, Hangarga, Sindhagao, Lohgao, Sindhafal, Masala, Kati, Jalkotwadi, Wadgao, Suratgao, Pinpala, Devkurali, Dhotri, Eatkal, Nilegao, Gujnur, Khumbhari, Nanduri, Vasantvadi, Chivari, Andur Tirthbuduruk, Aapsinga, Kamtha, Mardi for collection of soil samples.

Collection of soil samples

In order to study the fertility status of soils from Tuljapur tahsil of Osmanabad district, six soil samples were collected from each village. One hundred and eighty representative surface (0-20 cm) soil samples were collected. The soils were grouped into different orders according to USDA classification.

Preparation of soil samples

Soil samples collected from different villages of Tuljapur tahsil were brought to the laboratory, thoroughly mixed, air dried in shade, ground with wooden mortar and pestle and passed through 2 mm sieve. The sieved soil samples were stored in cloth bags/polythene bags with proper labeling for subsequent analysis. All the precautions outlined by Jackson (1973) were scrupulously followed in order to avoid contamination.

Methodology: The standard methods were followed for determination of physico- chemical properties and forms of Sin soils which are given below.

Soil pH: It was determined in soil: water suspension (1:2.5) using glass electrode pH meter (Jackson, 1973).

Electrical conductivity: It was estimated from supernant solution of soil water suspension (1:2.5) by using conductivity bridge (Jackson, 1973).

Organic carbon: Modified method of Walkley and Black (1934) was used for determination of organic carbon.

Calcium carbonate: Free calcium carbonate was determined with rapid titration method as outlined by Piper (1966).

Sulphur fractions

Total sulphur

Total sulphur from soil was estimated in diacid digestion mixture (Chapman and Pratt, 1961). From the diacid extract of soil, the total sulphur was determined by turbidimetric method as described by Chesnin and Yein (1951).

Available sulphur

It was extracted with 0.15 percent $CaCl_2$and the soluble sulphate sulphur was estimated turbidimetrically on a colorimeter using blue filter on spectrometer at 440 nm. (Wiliam and Steinberg,1959).

Organic sulphur

Organic suphur was estimated by the procedure described by Evans and Rost (1945).

Non sulphate sulphur

Non sulphate sulphur was determined by substraction of organic sulphur and sulphate sulphur from total sulphur as given by Chesnin and Yein (1951).

Water soluble sulphate sulphur

Water soluble sulphate sulphur was estimated as per the method described by Jackson (1973).

Statistical analysis

The correlation between soil properties and forms of N and S were worked out as per standard method given by Panse and Sukhatme (1961).

RESULTS AND DISCUSSION

In order to determine the sulphur fractions of the soils from Tuljapur tahsil of Osmanabad district, one hundred and eighty representative surface soil samples were collected from different villages.The collected soil samples were grouped into three orders. Total surveyed soil samples, 34 per cent soil samples were grouped under the order Vertisol while, 47 per cent and 19 per cent soil samples were grouped under the order Inceptisol and Entisol, respectively.Soil samples from Tuljapur tahsil of Osmanabad district were analyzed for its chemical properties and sulphur fractions. The correlation between chemical properties and different fractions of sulphur in soil were also worked out. The results obtained after analysis are presented and discussed under following head.

Chemical properties in soils of Tuljapur tahsil

Out of 180 soil samples, 62 samples were grouped under Vertisols, while, 84 and 34 soil samples were placed in Inceptisols and Entisols, respectively. The data on chemical properties of soils from Tuljapur tahsil are presented orderwise categorization of soils (Table 1)

Vertisols: out of 62 soil samples of Vertisols, 5 samples (8%) were normal and 57 samples (92%) were alkaline in pH. All samples (100%) in Vertisols showed normal range hence these soils were safe for crops. Out of 62 samples, 20 samples (32%) were low, 28 samples (45%) were medium and 14 samples (23%) were high in organic carbon. $CaCO_3$content in the soils ranged from 5.0 to 81.0 g kg^{-1} with an average 48.7 g kg^{-1}. Out of 62 samples, 27 samples (45%) were non-calcareous and 35 samples (55%) were calcareous in nature.

Inceptisols: The soil pH varied from 7.0 to 8.9 with an average value of 8.2. It is revealed from the data 10 per cent soils were found neutral in reaction and 90 per cent soils were alkaline in reaction. Data revealed that all the soil samples from inceptisols were safe in EC. Out of 84 samples from Inceptisols, 27 samples were (32%) low, 33 samples (39%) were medium and 24 samples (29%) were high in organic carbon content. Out of 84 soil samples, 31samples were (37%) non calcareous in nature, 27 samples (32%) were calcareous and remaining 26 samples (31%) were highly calcareous.

Entisols

These soils were varied in pH from 6.1 to 8.9 with a mean value of 8.0. Out of 34 soil samples, 5 samples (15%) were neutral and 29 samples (85%) were alkaline in reaction. All the soil samples in Entisols order were safe, as far EC categorization. Most of soils in Entisols were low to medium in organic carbon content. Out of 34 soil samples, 23 samples (68%) were non- calcareous and remaining 11 samples were (32%) calcareous in nature. Thus, the majority soil samples in Entisols showed non-calcareous in nature. The data revealed that 92, 90 and 85 per cent soil samples in Vertisols, Inseptisols and Entisols, respectively were alkaline in reaction. These values of pH indicated that most of the soils under study were alkaline in reaction. The alkaline reaction of soil is probably due to the presence of sufficient free lime content and basaltic alluvium parent material rich in alluminosilicates and alkaline earth from which these are derived. Similar findings were also reported by Mali and Raut (2001) that most of the soils of Latur district were alkaline in nature under Vertisols, Inceptisols and Entisols. With regards to soil EC, 100 per cent soil samples showed safe EC for growing crops. The values of EC obtained in the investigation were found within desirable range as proposed by Richard and Cambell (1948). When EC exceeds 4 dSm^{-1}, the present salts become harmful to the crop growth. However, EC values below 1.0 dSm^{-1} was considered as normal. Normal range of EC of soil of Chakur and Shirur- anantpal tahsil were ranged from 0.13 to 0.79 and 0.12 to 0.75 dSm^{-1}, respectively reported by Jagtap (2007).It was observed that in Vertisol 32, 45 and 23 per cent soil samples were low, medium and high in organic carbon content, respecrively while, in case of Inceptisols 32, 39 and 29 per cent soil samples were low, medium and high respectively. With regards to Entisol 44, 29 and 27 soil samples were low, mdium and high in organic carbon content, respectively. From the values of organic carbon, it was clearly depicted that the majority of soil samples were low to medium in range. The agro climate and agro ecological unit is very important from standpoint of soil fertility and plant growth. The content of organic carbon in soils depends on the range of precipitation within experimental area, considerable variation in precipitation is observed. The differences in the level of organic carbon in these soils are largely attributed to the pattern of rainfall in the area. In addition, hot and dry climate is directly related with the temperature variation in the region/ecological unit. Organic carbon is also attributed to the variation in decomposition rate. Similar results are also reported by Malewar *et al.* (2004). Majority soils from Vertisols and Inceptisols were calcareous in nature and contribute 56 and 37 per cent while, 68 per cent soils from Entisols were non calcareous. Relative more accumulation of $CaCO_3$ in Vertisols and associated black soils may be partly associated with their recent origin with rich in alkali earth and partly due to calcification process prevalent in this region (Joshi, 2000). Dhage *et al*. (2000) reported that the $CaCO_3$ content in Shevgaon tahsil (A.nagar district) was ranged from 11.4 to 161.3 g kg^{-1}. Similar range of $CaCO_3$ (13.0 to 156 g kg^{-1}) was recorded in swell-shrink soils of Vidarbha region (Padole and Mahajan, 2003). Similarly, Waghmare *et al.* (2007) reported that the $CaCO_3$ content in Ausa tahsil of Latur district was ranged from 8.80 to 125 g kg^{-1}.

Status of Sulphur fractions in soils of Tuljapur tahsil

The results on various forms of sulphur in these soils such as total, available, organic, water soluble and non-sulphate sulphur showed that total S content in Vertisols varied widely from 300.00 to 2500.00 mg kg^{-1} with a mean value of 1654.38 mg kg^{-1}. In Inceptisols, it was ranged from 370.00 to 1875.00 mg kg^{-1} with an average of 1251.02 mg kg^{-1}. However, in Entisols it was varied from 162.50 to 1585.00 mg kg^{-1} with a mean value of 561.27 mg kg^{-1}.Wide variation in the total S content in these soil orders may be due to greater heterogeneity in content of organic matter and parent material. Comparatively lower amounts of total S in the Entisols might be due to lower content of clay and organic carbon. Dharaknath *et al.* (1995) reported that the total S content in the Vertisols of the Mahrashtra varied from 1125 to 2525 mg kg^{-1} with an average of 1788 mg kg^{-1}. Similar findings were reported by Venkatesh and Satyanarayana (1999) that total S content in the soils of Vertisols of North Karnataka varied from 1120 to 4620 ppm with an average of 2794ppm. Available sulphur content in Vertisols ranged from 2.00 to 57.75 mg kg^{-1} with an average value of 12.93 mg kg^{-1}. In Inceptisols, it was ranged from 1.25 to 51.25 mg $kg^{-1}$with a mean value of 10.11mg kg^{-1}. However, in Entisols varied from 1.50 to 42.75 mg $kg^{-1}$with an average of 6.59 mg kg^{-1}. It was low in most of the soils under all the soil order, which might be due to continuous removal of sulphur by crop in intensive cropping system. Ravate (2008) reported that sulphur content in Ausa and Nilanga tahsil of Latur district were ranged from 3.62 to 84.61 mg kg^{-1}, respectively. The mean values for organic sulphur, water soluble sulphur and non-sulphate sulphur in all the surface soil samples of Vertisols were recorded 51.40, 26.59 and 1590.06 mg kg^{-1}, respectively. In Inceptisols, the mean values of organic sulphur, water soluble sulphur and non-sulphate sulpur recorded were 54.54, 25.93 and 1186.36, respectively.In Inceptisols, the mean values of organic sulphur, water soluble sulphur and non-sulphate sulpur recorded were 54.54, 25.93 and 1186.36, respectively. However, in Entisols the mean values for organic sulphur, water soluble sulphur and non-sulphate sulphur recorded were 95.37, 33.83 and 459.40, respectively. The highest amount of organic sulphur content in Entisols and lowest organic S content in Vertisols was observed in soils. This variation in organic S content was attributed to variation in soil texture as well as organic carbon content and accumulation of large amount of soil organic matter and clay. These results are corroborated with results of Das, *et al.* (2012) in the soils of Assam and Das *et al.* (2006). Highest amount of water soluble S present in Entisols and lower in Inceptisols. Lower content of this might be due to concomitant leaching loss of sulphate from soil. Similar result reported by Das, *et al.* (2012) and Basumatari *et al*. (2010). Non-sulphate S is mostly made up of SO_4^{2} occluded in and adsorbed on carbonates or insoluble S compounds of Fe and Al in soil which remains unextractable after removal of organic carbon and SO_4-S (Balanagoudar and Satyanarayana, 1990) reported that appreciable quantity of sulphate sulphur was occluded to CaCO3 and adsorbed on clay fraction in the soils of Vertisols and Alfisols of Karnataka.

Correlation coefficient between chemical properties and sulphur fractions in soils of Tuljapur tahsil

The results obtained on soil properties and sulphur fractions were subjected to the simple correlation. The results of simple correlation coefficients of sulphur fractions with chemical properties are presented in table 3, 4, 5.

Vertisols

The data on correlation coefficient between chemical properties and different fractions of sulphur in Vertisols is presented in table 3. From the results it was indicated that total sulphur was significantly affected by pH, EC, organic carbon and $CaCO_3$ content. pH, EC and $CaCO_3$ showed negative but significant relationship with total sulphur content which is evident by 'r' value -0.581**, -0.287* and -0.580**, respectively. Further, it was indicated that organic carbon was showed positive and significant correlation with total sulphur which is expressed by 'r' value (0.639**). pH and $CaCO_3$ showed negatively significant relationship with available sulphur whereas, organic carbon was associated positively and significantly with available sulphur which was evident by 'r' values for pH (-0.791**), $CaCO_3$ (-0.576**) and organic carbon (0.818**). However, the electrical conductivity did not showed any relationship with available S. The remaining fractions of sulphur also found to be influenced by soil properties. pH, EC and $CaCO_3$ content were negatively but significantly correlated with organic S (-0.239*, -0.235* and -0.530**), water soluble S (-0.695**, -0.249* and -0.482**) and non-sulphate S (-0.737**, -0.342** and -0.663**). However, organic carbon content showed significantly positive correlation with organic S (0.317*), water soluble S (0.673**), and non-sulphate S (0.732**) under Vertisols of Tuljapur tahsil.

Inceptisols

The data on correlation coefficient among chemical properties and different fractions of sulphur in Vertisols are presented in table 4. The data indicated that total sulphur was significantly affected by pH, organic carbon and $CaCO_3$ content. It could not established any relationship with electrical conductivity. pH and $CaCO_3$ established negative but significant relationship with total sulphur content which is evident by 'r' value -0.700** and -0.592**, respectively. Whereas, organic carbon was positively and significantly correlated with total sulphur which is expressed by 'r' value (0.659**). pH and $CaCO_3$ showed negatively significant relationship with available sulphur whereas, organic carbon was associated positively with available sulphur which was evident by 'r' values for pH (-0.838**), $CaCO_3$ (-0.655**) and organic carbon (0.765**). However, the effect of electrical conductivity did not reach to the level of significance.The remaining fractions of sulphur also found to be influenced by physico-chemical properties of soil. pH and $CaCO_3$ content were negatively but significantly correlated with organic S (-0.646** and -0.685**), water soluble S (-0.447** and -0.655**) and non-sulphate S (-0.673** and -0.550**). However, organic carbo was showed significantly positive relationship with organic S (0.674**), water soluble S (0.524**) and non-sulphate S (0.634**).

Entisols

The data regarding correlation coefficient between physico-chemical properties and different fractions of sulphur in Entisols are presented in table 5. In Entisols, similar trend was found as Inceptisols. All sulphur fractions were significantly influenced by pH, organic carbon and $CaCO_3$ but EC did not reach to the significance level. The data revealed that the pH and $CaCO_3$ associated negatively significant correlation with total S (-0.496** and -0.420*), available S (-0.724** and -0.488**), organic S (-0.762** and -0.583**), water soluble S (-0.570** and -0.387*) and non-sulphate S (-0.731** and -0.523**). Whereas, organic carbon associated positively but significant relationship with total S (0.656**), available S (0.556**), organic S (0.724**), water soluble S (0.445**) and non-sulphate S (0.557**).The result (Table 3, 4 and 5) showed the negative relationships between almost all the fractions of sulphur and pH and $CaCO_3$ content. Lower values of total S in the soils might be associated with lower amounts of clay and organic carbon. It is established that soil texture largely controls S status by regulating the leaching losses of soluble SO_4^-.

These observations collaborated with the findings of Das *et al.* (2012) who studied the forms of S in some rapeseed growing soils of Assam. Similar findings were also reported by Sharma, *et al.* (2000) from some parts of Western U.P. and Singh, *et al.* (2000) in soils of Nagaland.pH and E.C. of soil had negative correlations with all fractions of sulphur. This might be due to presence of H^+ and OH^- ion in the soil complex, where sulphate ions are attracted to H^+ ions.

Table 1
Order wise categorization of soils from Tuljapur tahsil on the basis of chemical properties

Para-meter		*Soil orders*								
		Vertisols			*Inceptisols*			*Entisols*		
pH		*Acidic (< 6.5)*	*Neutral (6.5-7.5)*	*Alkaline (> 7.5)*	*Acidic (< 6.5)*	*Neutral (6.5-7.5)*	*Alkaline (> 7.5)*	*Acidic (< 6.5)*	*Neutral (6.5-7.5)*	*Alkaline (> 7.5)*
	%	0	8	92	0	10	90	0	15	85
	No. Samples	0	5	57	0	8	76	0	5	29
EC(dSm^{-1})		Safe (< 0.8)	M.safe (0.8-2.5)	Unsafe (>2.5)	Safe (< 0.8)	M.safe (0.8-2.5)	Unsafe (>2.5)	Safe (< 0.8)	M.safe (0.8-2.5)	Unsafe (>2.5)
	%	100	0	0	100	0	0	100	0	0
	No. Samples	62	0	0	84	0	0	34	0	0
Organic carbon		Low (< 5)	Medium (5- 10)	High (> 10)	Low (< 5)	Medium (5- 10)	High (> 10)	Low (< 5)	Medium (5- 10)	High (> 10)
(g kg^{-1})	%	32	45	23	32	39	29	44	29	27
	No. Samples	20	28	14	27	33	24	15	10	9
$CaCO_3$ (g kg^{-1})		N.ca (<50)	Ca. (50-100)	H.ca (>100)	N.ca (<50)	Ca. (50-100)	H.ca (>100)	N.ca (<50)	Ca. (50-100)	H.ca (>100)
	%	45	55	0	37	32	31	68	32	0
	No. Samples	27	35	0	31	27	26	23	11	0

N.ca- Non calcareous, Ca. - Calcareous, H.ca-Highly calcareous, M.safe- Marginal safe

Table 2
Range and average value of sulphur fractions in soil

Soil order	*Total sulphur*	*Available sulphur*	*Organic sulphur*	*Water soluble sulphur*	*Non-sulphate sulphur*
			mg kg^{-1}		
Vertisols	300.00-2500.00 (1654.38)	2.00-57.75 (12.93)	18.50-93.75 (51.40)	9.62-52.00 (26.59)	273.00-2416.6 (1590.06)
Inceptisols	370.00-1875.00 (1251.02)	1.25-51.25 (10.11)	15.50-110.25 (54.54)	10.93-45.25 (25.93)	290.88-1828.2 (1186.36)
Entisols	162.50-1585.00 (561.27)	1.50-42.75 (6.59)	26.87-196.25 (95.37)	5.93-68.75 (33.83)	61.25-1521.38 (459.40)

Table 3
Correlation between chemical properties and sulphur fractions in Vertisols

Chemical properties	*Total S*	*Available S*	*Organic S*	*Water soluble S*	*Non-sulphate S*
pH	-0.581**	-0.791**	-0.239*	-0.695**	-0.737**
EC	-0.287*	-0.224	-0.235*	-0.249*	-0.342**
O.C	0.639**	0.818**	0.317*	0.673**	0.732**
$CaCO_3$	-0.580**	-0.576**	-0.530**	-0.482**	-0.663**

* Significant at 5% level:- 0.230
** Significant at 1% level: - 0.325

Table 4
Correlation between chemical properties and sulphur fractions in Inceptisols

Chemical properties	*Total S*	*Available S*	*Organic S*	*Water soluble S*	*Non-sulphate S*
pH	-0.700**	-0.838**	-0.646**	-0.447**	-0.673**
EC	-0.012	-0.131	0.009	-0.088	0.032
O.C	0.659**	0.765**	0.674**	0.524**	0.634**
$CaCO_3$	-0.592**	-0.655**	-0.685**	-0.655**	-0.550**

* Significant at 5% level:- 0.212
** Significant at 1% level: - 0.283

Table 5
Correlation between chemical properties and sulphur fractions in Entisols

Chemical properties	*Total S*	*Available S*	*Organic S*	*Water soluble S*	*Non-sulphate S*
pH	-0.496**	-0.724**	-0.762**	-0.570**	-0.731**
EC	-0.070	-0.160	-0.143	-0.091	-0.041
O.C	0.656**	0.556**	0.724**	0.445*	0.557**
$CaCO_3$	-0.420*	-0.488**	-0.583**	-0.387*	-0.523**

* Significant at 5% level:- 0.349
** Significant at 1% level: - 0.449

Moreover, at high salinity level sulphate ions may be leached down owing to the existence of salts in soluble forms. Similar results were reported by Jat and Yadav, (2006) in the soils of Entisols of Rajasthan. The organic carbon was positively and significantly correlated with the different forms of sulphur because organic matter could be a good reservoir or source of sulphur. (Jat and Yadav, 2006). Similar result also given by Kumar, *et al.* (2002) in the acidic soils of Jharkhand and indicating that S as the integral part of soil organic matter. Similarly Basumatari, *et al.* (2010) reported that significant positive correlations of organic carbon with all forms of sulphur indicated their dominant influence on sulphur status in soils of Inceptisols of Assam.

CONCLUSION

The results summarized can be concluded as follows.

Most of soils of Tuljapur tahsil were alkaline in nature and EC was found in safe limit for the crop growth. The organic carbon content was low to medium and soils of these area were calcareous in nature. Sulphur fractions like total S, available S, organic S, water soluble S and non-sulphate S were also recorded as low in soils of Tuljapur tahsil. All the sulphur fractions showed negative and significant correlation with pH and $CaCO_3$ in Inceptisols and Entisols. In Vertisols, pH, EC and $CaCO_3$ were negatively and significantly correlated with all the fractions of S except available S. While, organic carbon showed positively significant correlation with all fractions of sulphur in Vertisols, Inceptisols and Entisols.

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