Original Research Article

Assessment of Physico-Chemical Properties and Secondary Nutrient Status of Soils from Soybean Growing Area of Renapur Tahsil of Latur District and their Correlation with these Properties

Abstract: The present investigation was carried out to study the status of secondary nutrients and their correlation with physico-chemical properties in soils of Renapur tahsil of Latur district. For this purpose, total 100 soil samples were collected from twenty villages and from each village, five soil samples were collected. According to their characteristics they were categorized into different orders *viz*., Inceptisol, Vertisol, Entisol. The soils of Renapur tahsil were neutral to moderately alkaline in soil reaction, no deleterious effect on crop in electrical conductivity, low to moderate to moderately high in organic carbon and non-calcareous (fit for all crops), calcareous (Fit for all crops except citrus) to highly calcareous (Unfit for all crops) in nature. According to the concept of "soil nutrient index", the availability of nutrients of these soils were moderate in available S (2.24) and high in exchangeable Ca (3.00) and Mg (3.00). Results revealed that all the soil samples are high in exchangeable Ca, Mg and only 16 per cent samples were found to be deficient in available S. This information could aid in decision making for application of plant nutrients for higher monetary returns to the farmers. The correlation study revealed that pH was negatively correlated with exchangeable Ca, available S and positively correlated with Mg. EC was positively correlated with Mg, S and negatively correlated with Ca while organic carbon and $CaCO_3$ was positively correlated with all nutrients.

(**Keywords**: pH, Electrical conductivity, Organic carbon, Calcium carbonate Exchangeable calcium and magnesium, available sulphur, correlation).

Introduction: A nutritional element is one that is required for an organism to complete its life cycle, and its relative deficiency causes the organism to exhibit certain deficiency symptoms. A nutritional element is dispersed in the soil in many chemical forms, which are typically in a state of dynamic equilibrium and serve as the pool from which the plant draws nutrients.

Essential nutrients are nutrients that a plant need to complete its life cycle, and nutrients are categorized as macronutrients or micronutrients depending on the quantity required by the plant. Calcium, Magnesium, and Sulphur are referred to as "secondary nutrients" since they are not normally present in sufficient proportions and must be supplemented by fertilization in order to grow the plant properly. They are essential to the growth of crops. In the middle lamella of the cell wall, calcium is the main cation, and calcium pectate is its main component. Calcium therefore gives tissue mechanical strength. Magnesium

is a crucial component of plant chlorophyll. Additionally, it is the most typical activator of the enzymes involved in energy metabolism. Due to its crucial role in the production of oil, sulphur is currently considered as the fourth key nutrient after the primary nutrients for oil seed crops. In addition, it facilitates the production of vitamins and enzymes and encourages nodulation, which helps legumes fix nitrogen. It is also included in a number of chemical molecules that give garlic, mustard, and onion their distinctive aromas.

The influence of physio-chemical parameters such as pH, EC, Calcium carbonate, and Organic carbon on the availability of nutrients in the soil, and hence on crop growth and production, are significant. The soils must provide the nutrients required for plant growth. To satisfy current human demands, appropriate monitoring and control of these qualities can supplement the supply of nutrients from soil.

Soybean was first grown in Maharashtra in 1985. Soybean is grown on 5 lakh hectares in Maharashtra, with a total production of 6 lakh tonnes. Soybean is from the Leguminaceae family, including the Papilionaceae subfamily. It is both a pulse and an oilseed crop, containing 20% oil, 40% protein, 30% carbohydrate, 4% saponin, and 5% fibre. It is known as poor man meat because of its high protein content. Soybean are high in lysine and amino acids. Soybean is used in the making of breads, biscuits, and cakes, among other things.

Renapur tahsil in the Latur district of Maharashtra's Marathwada area was chosen for this research because of its diverse soils. The current investigation will be conducted to assess the secondary nutrient status and their relationship with important soil properties from soybean growing area of Renapur tahsil of Latur district.

Materials and Methods

The Latur district is situated between 18^0 05' to 18^0 75' north latitude and 76^0 25' to 77^0 25' East latitude. The region covers 7166 square kilometres and receives 787 millimetres of rain annually. The district's maximum and lowest temperatures are 39.6^0 C and 13.9^0 C, respectively. The height is 725 to 750 metres above sea level, and it is located in the semiarid Central Marathwada Plateau Agro-climatic Zone. The weathering of Deccan trap rock, which is rich in lime, magnesia and iron forms the soils of Latur. Renapur tahsil has a total size of 557.91 square kilometres. Due to the presence of minerals including smectite, kaolinite, and vermiculite, the soils of Latur district are varied in colors. These soils were light textured and

deep to shallow black. Soybean, sugarcane, pegion pea, gramme, sorghum, wheat, peanut, sunflower, and various horticultural crops are the main crops grown in this region.

A total of 100 soil samples were collected from the Renapur tahsil's soybean producing region. These samples were used for furthur studies. Twenty villages were chosen as typical, and five samples were taken from each village. A total of a hundred typical surface soil samples (15-20 cm) were taken. According to USDA categorization, the soils were placed in distinct orders. The depth of the soil and the physical features of the soil were used to categorise them. At the time of soil sample collection, the latitude and longitude of the soil surface sample were recorded, and the soil samples were processed for further examination.

They were brought to the lab, thoroughly mixed, allowed to air dry in the shade, ground with a wooden mortar and pestle, and then put through a 2 mm sieve. In preparation for a subsequent study, the sieved soil samples were placed in polythene bags that were labelled. To prevent contamination, each and every safety measure recommended by Jackson (1973) was meticulously followed.

pH and EC was estimated by 1:2.5 soil water suspension as per the method described by Jackson (1973). Modified Walkley and Black's (1934) rapid titration procedure was followed for estimating the organic carbon content, classified as per rating given by Ramamurthy and Bajaj (1969). CaCo3 was estimated by rapid titration method as described by Piper (1966). Exchangeable Ca and Mg was determined by Versanate titration method (Jackson, 1973). Available Sulphur was estimated by using extractant 1:5 soil and 0.15 per cent $CaCl_2$ solution on spectrophotometer at 340 nm (Willams and Steinberg, 1969). The correlations of physio-chemical properties with secondary nutrients (r) were worked out as per standard method given by Panse and Sukhatme (1985).

The formula of nutrient index (NI) and classification of available nutrients as low (< 1.67), medium (1.67 – 2.33) and high (>2.33) as suggested by Ramamurthy and Bajaj, 1969 was evaluated as follows:

$$NIV = \frac{\text{No of samples under low category} \times 1 + \text{No. of samples under medium category} \times 2 + \text{No. of samples under high category} \times 3}{\text{Total number of samples}}$$

For secondary nutrients, the critical limits are taken as per given by Rattan *et al*. (2015) ISSS. Calcium is rated low (< 1.5), medium (1.5), high (>1.5), whereas magnesium is rated low (< 1.0), medium (1.0) and high (>1.0). Sulphur is rated low (< 10), medium (10 to 20) and high (>20).

Results and Discussion

Physicochemical Properties: The pH of Renapur tahsil soils were ranged from 6.54 to 8.20. The pH of Inceptisol, Entisol and Vertisol soils were ranged from 6.54 to 8.14, 6.65 to 8.11 and 7 to 8.2 with mean value 7.54, 7.51 and 7.60, respectively (Table 1), which indicated that these soils were neutral to moderately alkaline in reaction. The neutral nature may be due to presence of bases and calcium/magnesium carbonate in the soils and the alkaline nature could be due to presence of free lime in the soils. These results are also in close agreement with those reported by Patil *et al.* (2019) from the soils of Washi tahsil of Osmanabad district. Similar type of findings was also reported by Bachewar and Pathan (2017) from Mukhed area of Nanded district and Mali and Raut (2001) from Latur district.

The EC of Renapur tahsil soils were varied from 0.27 to 1.59 dSm^{-1}. The EC of Inceptisol, Entisol and Vertisol soils were varied from 0.27 to 1.59, 0.35 to 1.25 and 0.28 to 0.88 dSm^{-1}, respectively, which can be categorized as no deleterious effect on crop to critical for germination. The maximum mean values of EC were recorded in Entisols (0.69 dS m^{-1}) followed by Inceptisols (0.65 dS m^{-1}) and Vertisols (0.51 dS m^{-1}). The low content of EC was due to leaching of salt from the surface layer of soil. Ajgaonkar and Patil (2017) reported that the EC were ranged from 0.20 to 1.70 dSm^{-1} from the soils of Aurangabad district. Similar results observed by Raut *et al.* (2017) from Bhiwapur tahsil and Adat *et al.* (2017) from Malshiras tahsil of Solapur district.

The calcium carbonate content in Renapur tahsil soils were ranged from 20 to 119 g kg^{-1}. The calcium carbonate content in Inceptisol, Entisol and Vertisol soils were varied from 20 to 82, 27 to 119 and 35 to110 g kg^{-1} with an average value of 55.13, 81.39 and 63.65, respectively. The soils of Renapur tahsil categorized as non-calcareous (Fit for all crops) to Calcareous (Fit for all crops except citrus) in nature. This might be due to presence of calcium carbonate in powdery form and hyper thermic temperature. These results are in confirmatory with those of Magar *et al*. (2018) from Osmanabad district and Waikar *et al.* (2014) from Parbhani district of Maharashtra.

The organic carbon content of Renapur tahsil soils were ranged from 0.4 to 8.7 g kg^{-1} Organic carbon contents ranges from 1.5 to 8.7 g kg^{-1} with an average value of 4.52 g kg^{-1} in Inceptisols, 0.4 to 7.8 g kg^{-1} with an average value of 4.81 g kg^{-1} in Entisols and 2.2 to 7.9 g kg^{-1} with an average value of 4.08 g $kg^{-1}$of Vertisols (Table 1). In Inceptisol soils 2, 41, 41, 12 and 4 per cent soil samples were very low, low, moderate, moderately high and high, respectively. In Entisol soils 4, 31, 42 and 23 per cent soil samples were in very low, low, moderate, moderately high categories, respectively. In Vertisol soils 55, 39 and 6 per cent soil samples were low, moderate and moderately high, respectively. Organic carbon content in these soils ranged from low to moderate and moderately high in different soil orders. The variation in organic carbon content in the soil may be due to high temperature which is responsible for hasten the rate of oxidation and very little addition of organic matter and crop residues in the soil. The content of organic carbon in soils depends on the range of precipitation

Table 1. Physico-chemical properties of three soil orders

Parameters	Inceptisols				Entisols				Vertisols			
	Range	Mean	S.E.	C.V. (%)	Range	Mean	S.E.	C.V. (%)	Range	Mean	S.E.	C.V. (%)
pH	6.54-8.14	7.54	**0.04**	**4.16**	6.65-8.11	7.51	**0.13**	**9.40**	7.0-8.2	7.60	**0.06**	**3.87**
EC (dS m^{-1})	0.27-1.59	0.65	**0.03**	**37.07**	0.35-1.25	0.69	**0.04**	**34.41**	0.28-0.88	0.51	**0.04**	**35.02**
$CaCO_3$ (g kg^{-1})	20-82	55.13	**2.07**	**28.13**	27-119	81.39	**4.48**	**28.07**	35-110	63.65	**4.24**	**28.32**
OC (g kg^{-1})	1.5 - 8.7	4.52	**0.18**	**30.69**	0.4-7.8	4.81	**0.36**	**38.10**	2.2-7.9	4.08	**0.37**	**38.79**

within experiment area, pattern of rainfall in the area and also might be due to the variation in decomposition rate. These results are in agreement with results reported by Kashiwar *et al*. (2019) from the soils of Sakoli tahsil of Bhandara district and Naiknaware (2018) from the soils of Osmanabad district of Maharashtra.

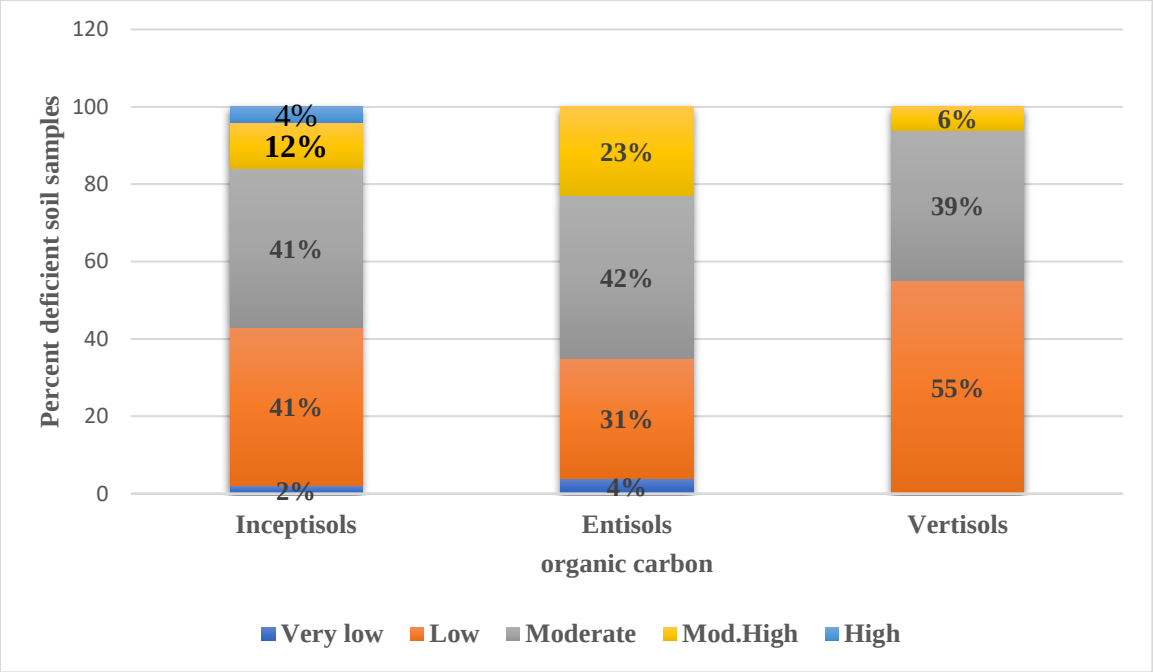

Fig. 1. Status of organic carbon in Inceptisols, Entisols and Vertisols

Table 2. Status of secondary nutrients in three soil orders

Secondary nutrients	Inceptisols				Entisols				Vertisols			
	Range	Mean	S.E.	C.V. (%)	Range	Mean	S.E.	C.V. (%)	Range	Mean	S.E.	C.V. (%)
Calcium (cmol (p^+)kg^{-1})	14.7-52.7	37.04	1.21	24.57	22.7-48.3	36.84	1.30	18.05	23.8-47.5	37.15	1.58	18.12
Magnesium (cmol (p^+)kg^{-1})	10.8-36.9	20.04	0.77	28.82	10.1-35.7	19.99	1.04	26.60	11.5-30.2	20.53	1.23	25.48
Sulphur (mg kg^{-1})	4.46-40.23	17.22	1.00	43.54	13.21-29.17	22.20	0.84	19.41	6.53-28.73	14.34	1.77	52.62

Exchangeable Calcium and Effect of Physico-chemical Properties

The exchangeable calcium in soils of Renapur tahsil ranged from 14.7 to 52.7 cmol (p^+)kg^{-1}. In Inceptisol, Entisol and Vertisol soils it was ranged from 14.7 to 52.7, 22.7 to 48.3 and 23.8 to 47.5 cmol (p^+)kg^{-1} with means of 37.04, 36.84 and 37.15 cmol (p^+)kg^{-1}, respectively (Table 2). All hundred soil samples taken from the Renapur tahsil, were high in exchangeable Ca++. It was revealed that high exchangeable calcium content was found in order Inceptisol (56

samples), followed by Entisol (26 samples), and Vertisol (18 samples). Ravte (2008) analysed the soils of Ausa and Nilanga tahsils of Latur district and reported that calcium content was ranged from 11.05 to 50.7 cmol (p^+)kg^{-1}. Similar contents were also observed by Mandal *et al*. (2003), Medhe *et al*. (2012), Parhad *et al.* (2018) and Magare *et al*. (2019). Exchangeable Ca showed negative correlation with pH (-0.087) and EC (-0.039) and positive correlation with $CaCO_3$ (0.183) and OC (0.198).

Exchangeable Magnesium and Effect of Physico-chemical Properties

The exchangeable magnesium in soils of Renapur tahsil varied from 10.1 to 36.9 cmol (p^+) kg^{-1}. The exchangeable magnesium in Inceptisol, Entisol and Vertisol soils were ranged from 10.8 to 36.9, 10.1 to 35.7 and 11.5 to 30.2 cmol (p^+)kg^{-1} with mean values of 20.04, 19.99 and 20.53 cmol (p^+)kg^{-1}, respectively (Table 2). The exchangeable magnesium in all the 100 samples of Renapur tahsil were high in category. It was found that among the three orders, exchangeable magnesium was high in Inceptisol (56 samples), followed by Entisol (26 samples) and Vertisol (18 samples). Medhe *et al*. (2012) found that the magnesium content varied from 8.7 to 29.7 cmol (p^+) kg^{-1} in soils of chakur tahsil of Latur district. Similar high content of exchangeable magnesium was observed by Ravte (2008), Gurumurthy and Sridhara (2012), Parhad *et al*. (2018) and Magare *et al*. (2019). Exchangeable Mg showed positive correlation with pH (0.098), EC (0.046), $CaCO_3$ (0.159) and OC (0.198).

Parent material strongly influence calcium and magnesium concentration through mineral weathering and soil formation processes, which subsequently affect the cation exchange capacity and base saturation of exchangeable sites. The high levels of exchangeable calcium and magnesium in the soil may be the result of the buildup of metallic cations in the calcareous soil caused by the dry and semi-dry environment. The primary cations on the soil exchange complex and in the soil solution are Ca++ and Mg++ since the parent materials are lime stone, calcite, and dolomite.

. **Available Sulphur and Effect of Physico-chemical Properties**

The available sulphur in soils of Renapur tahsil ranged from 4.46 to 40.23 mg kg^{-1}. In Inceptisol, Entisol and Vertisol soils it was ranged from 4.46 to 40.23, 13.21 to 29.17 and 6.53 to 28.73 mg kg^{-1} with mean values of 17.22, 22.20 and 14.34 mg kg^{-1}, respectively (Table 2). The Inceptisol, Entisol and Vertisol soils were 14.28, 0 and 44.4 % low, 57.14, 30.76 and 22.2 % medium and remaining 28.57, 69.23 and 33.3 % soil samples were high in available S,

respectively (Fig. 2). From the above data we it can be concluded that soils of Renapur tahsil were medium to high in case of available sulphur. This might be as a result of the higher prevalence of easily soluble sulphate accumulations in calcareous soils. Parhad *et al*. (2018) reported that available sulphur content ranged from 7.8 to 45.56 mg kg^{-1} in soils of sindkheda tahsil of Dhule district. These results were in confirmatory with those of Sharma and Gangwar (1997), Pradeep *et al*. (2006), Medhe *et al.* (2012) and Desai *et al.* (2018). Available S showed positive correlation with EC (0.291), $CaCO_3$ (0.067) and OC (0.153) and negative correlation with pH (-0.048).

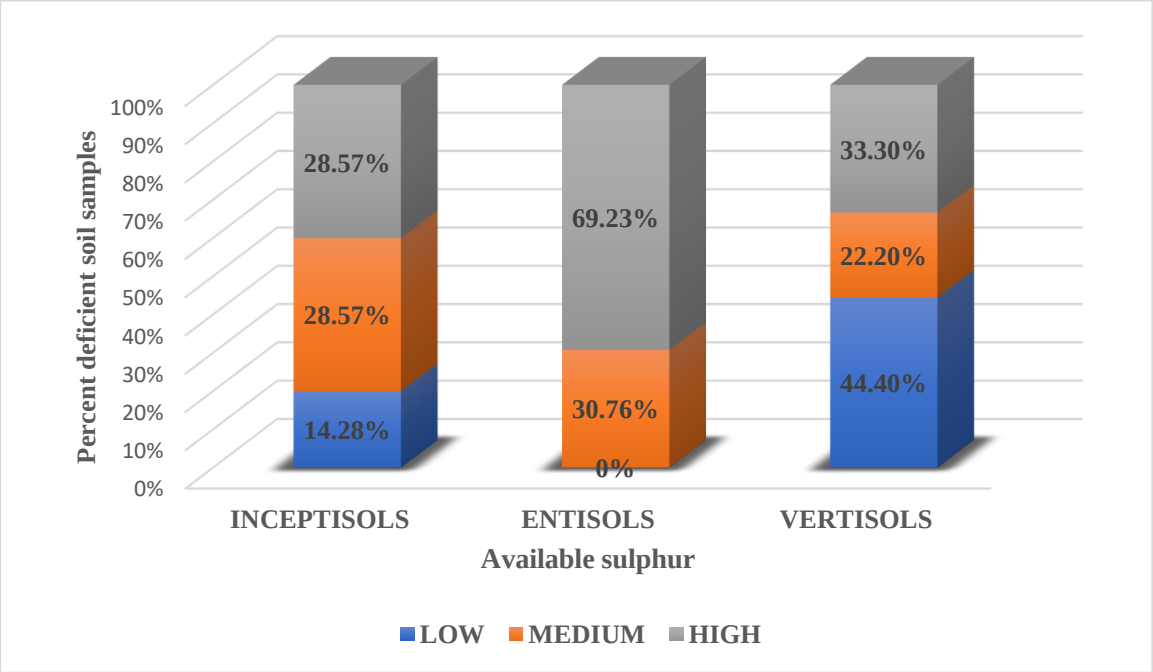

Fig. 2. Status of available sulphur in Inceptisols, Entisols and Vertisols

Soil Nutrient Index

According to the nutrient index value the status of exchangeable calcium (3.00) and magnesium (3.00) was "High" in three soil orders (Table 3). The available S in Inceptisols and Vertisols found in medium category, whereas high in Entisols. The nutrient index for available S in Inceptisol, Entisol and Vertisol soils were 2.14, 2.69 and 1.88, respectively.

Table 3. Nutrient index of secondary nutrients of three soil orders

Secondary nutrients	Soil orders		
	Inceptisols	Entisols	Vertisols
Ca	3.00	3.00	3.00
Mg	3.00	3.00	3.00
S	2.14	2.69	1.88

Conclusions

Most of the soils of Renapur tahsil was found neutral to moderately alkaline in reaction. EC of the soil was no deleterious effect on crop. The organic carbon status was low to moderate. Calcium carbonate content in these soils were non-calcareous (Fit for all crops) to calcareous (Fit for all crops except citrus) in nature. According to nutrient index values the status of available sulphur was moderate in Inceptisols and Vertisols whereas high in Entisols. The exchangeable calcium and magnesium status was high in three soil orders. pH was negatively correlated with exchangeable Ca, available S and positively correlated with Mg. EC was positively correlated with Mg, S and negatively correlated with Ca while organic carbon and $CaCO_3$ was positively correlated with all nutrients.

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