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SOIL FERTILITY STATUS OF GUDIPALAMANDAL OF CHITTOOR DISTRICT, ANDHRA PRADESH FOR SITE SPECIFIC RECOMMENDATIONS

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ABSTRACT

Two hundred fifty representative soil samples from seventy three villages of Gudipala mandal in Chittoor district of Andhra Pradesh were collected at 250 m grid interval leaving hills and water bodies and assessed for their fertility parameters. Fertility data was interpreted and statistical parameters *viz.*, range, mean, standard deviation and coefficient of variation were calculated. Soils were moderately to highly alkaline, non-saline and soil organic carbon was low to very high. The available nitrogen (57.0-305.0 kg ha^{-1}) was low to medium, available phosphorus (20.0-85.0 kg ha^{-1}) and potassium (201.0-416.0) was low to high and available sulphur (8.00-50.0 ppm) as deficient to sufficient. DTPA extractable micronutrients zinc (Zn), iron (Fe) and manganese (Mn) were deficient to sufficient range and whereas, available copper (Cu) was sufficient range in the study area. The fertility status of soils revealed that, the available N, S, Zn, Fe and Mn major soil fertility constraints.

KEY WORDS: alkaline soils, micro nutrients, soil fertility

INTRODUCTION

Soil – a nature's marvel is one among the vital natural resources of the earth, whose health decides the survival of all living organisms depending on it. The soil must be in harmony with its inherent properties and productivity to maintain sustainable soil health. In India, crop productivity has been driven by increased use of fertilizers during the past four decades for meeting growing demand for food. Hence, proper management of the vital natural resource soil is a paramount significance for sustenance. Nutrient imbalance in soil could be due to the increased demand from high yielding varieties (HYV), intensive cropping, continued expansion of cropping on to marginal lands with low micronutrients application (Richard and Bernie, 2006), increased use of fertilizers, poor recycling of crop residues and little use of animal wastes (Setia and Sharma, 2004). Hence, soil fertility problems are predominant in recent times and hindering optimum crop productivity. Soil fertility limitations being assessed by scientific soil samples collection from farmer's fields and evaluation of available major and micro nutrients.

The Gudipala mandal of Chittoor district is affected by drought frequently, which is pre-dominantly under rainfed farming with erratic rainfall distribution associated with low crop productivity and which further needs site-specific information in terms of soil characteristics, their productivity potentials and limitations for soil resource development and management. Hence, the present investigation was planned and executed with the objective of identifying available nutrient constraints in soils of Gudipala mandal in Chittoor district of Andhra Pradesh.

MATERIAL AND METHODS

The study area geographically located between 13° 06´ to 14° 00´ N latitudes and 79°12´ to 79°25´ E longitudes with a cultivated area of 2500 ha. The climate was semi-arid monsoonic with distinct summer, winter and rainy seasons. The decennial mean annual rainfall was 952.5 mm. The mean annual minimum and maximum temperatures were ranged from 21.1°C to 37.7°C.

The composite soil samples at 0-15 cm depth were collected by using a handheld GPS on grid points of 250 m interval in the study area. A total of 250 samples were collected from the Gudipala mandal. The soil samples were airdried, grounded (< 2 mm) and analyzed for physico-chemical and fertility parameters. The pH (1:2.5) and electrical conductivity (EC) (1:2.5) of soils were measured using standard procedures as described by Jackson (1973). Organic carbon (OC) was determined using the Walkley-Black method (Nelson and Sommers 1996). Available nitrogen (N) was estimated by alkaline

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permanganate method (Subbiah and Asija 1956). Available phosphorus (Olsen P) was measured using sodium bicarbonate ($NaHCO_3$) as an extractant (Olsen and Sommers 1982). Available potassium (K) was determined using the ammonium acetate method (Jackson, 1973). Available sulphur (S) was measured using 0.15 percent calcium chloride ($CaCl_2.2H_2O$) as an extractant (Williams and Steinbergs, 1959). Micronutrients (Fe, Zn, Cu and Mn) were extracted by DTPA using the procedure outlined by Lindsay and Norvell (1978). Soil fertility variability was assessed using mean standard deviation and coefficient of variation for each set of data. Availability of N, P and K in soils are interpreted as low, medium and high and that of available sulphur (S), zinc (Zn), iron (Fe), copper (Cu) and manganese (Mn) interpreted as deficient and sufficient range by following the criteria given in Table 1.

RESULTS AND DISCUSSION

Soil reaction and electrical conductivity

The soil pH in the study area varied from 6.10 to 8.40 with a mean, standard deviation and CV of 7.51, 0.50 and 6.67 per cent, respectively Soil reaction of Gudipala mandal range indicates that soils are moderately acidic to highly alkaline. The lowest value of pH under cultivated soils might be due to depletion of basic cations bycrop harvest and drainage to streams in run-off by accelerated erosion (Foth and Ellis (1997). The higher pH of soils could be attributed to low intensity of leaching and accumulation of bases. These results were in agreement with findings of Patil *et al.* (2016). Electrical conductivity of the soils in study area ranged from 0.09 to 0.96 d Sm^{-1} and the soils are non-saline, with a mean ,standard deviation and CV of0.35, 0.17 and 49.05 per cent, respectively non salinity of the study area attributed to good drainage condition and favours the leaching of salts to lower horizons, which is highly favorable to crop growth (Sharma and Sanjeev, 2008 and Satish *et al*., 2018).

Organic carbon

The organic carbon content of Gudipala mandal was low to very high and ranged from 0.22 to 1.41 per cent with mean, standard deviation and CV of 0.52, 0.15and28.16 per cent, respectively. The organic carbon content indicated that, soils of Gudipala mandal showed wide variations spatially. Rice and sugarcane are the major crops in the study area and crop residue of these crops left in soil after harvest and their subsequent degradation is the reason for low organic carbon content in these soils. Similar results were also reported by Prabhavati *et al.* (2015) and Nalina *et al.* (2016).

Available major nutrients

The available nitrogen content varied from 57.0 to 305.0 kg ha^{-1}, with a mean value of 178.02 kg ha^{-1} and standard deviation of 53.53 with CV of 30.07 per cent. It is quite obvious that the use efficiency of applied nitrogen was very low due loses by various mechanisms like volatilization, nitrification, denitrification, chemical and microbial fixation leaching and runoff. However, the reason for medium status in available nitrogen which was observed in the surface horizons could be attributed to the addition of higher quantities of N at regular interval especially to the rice crop during crop cultivation.

The available phosphorus status was under low to high range from 20 to 85 kg ha^{-1}, with mean value of 34.22 kg ha^{-1} and standard deviation of 7.71 with CV of 22.54 per cent. In majority soils of the Gudipala mandal were low to high in available phosphorus content. The lower phosphorus content could be attributed to the fixation of released phosphorus by clay minerals and oxides of iron and aluminium. The high P_2O_5 in some of these soils was ascribed to buildup of P_2O_5 due toindiscriminate use of DAP and other complex fertilizers (Sashikala *et al*., 2019).

Available potassium

The available potassium ranged between 201 to 416 kg ha^{-1}, with mean of 335.88 kg ha^{-1}, standard deviation of 36.47 and CV of 10.86 per cent. The slower rate of weathering of mica minerals and fixation of applied potassium might have resulted in low available potassium status. The higher potassium in some of the soils could be attributed to more intense weathering, release of liable K from micacious minerals, application of K fertilizers. Similar results were reported by Vedadri and Naidu (2018) in soils of Chillakur mandal of SPSR Nellore district in Andhra Pradesh. Present results are in accordance with Patil *et al*., 2016.

Available calcium content varied from 8 to 22 cmol (p+) kg^{-1} with a mean value of 14.52 Cmol (p+) kg^{-1} with standard deviation of 3.23 cmol (p+) kg^{-1} and C.V of 22.20 per cent and results are in accordance with Sashikala *et al*., 2019.

Table 1. Physico-chemical properties and available major nutrients status in Gudipala mandal at 0-15 cm depth

	pH	EC (dS m^{-1})	Organic carbon (%)	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
Range	6.10 – 8.40	0.09 – 0.96	0.22 – 1.41	57.0 – 305.0	20.0 – 85.0	201.0 – 416.0
Mean	7.51	0.354	0.52	178.0	34.2	335.8
SD	0.50	0.17	0.15	53.5	7.7	36.5
CV (%)	6.67	49.1	28.2	30.1	22.5	10.9

Table 2. Summary of ground truth analysis data of secondary and available micronutrients of Gudipala mandal at 0-15 cm depth

	Exchangeable Ca (cmol (p^+) kg^{-1})	Exchangeable Mg (cmol (p^+) kg^{-1})	Available Sulphur (mg kg^{-1})	DTPA extractable Zn (mg kg^{-1})	DTPA extractable Cu (mg kg^{-1})	DTPA extractable Mn (mg kg^{-1})	DTPA extractable Fe (mg kg^{-1})
Range	8.00 – 22.00	0.46 – 0.95	8.00 – 50.0	0.08 – 1.58	0.22 – 3.48	2.0 – 10.0	2.0 – 10.0
Mean	14.52	0.54	24.42	0.69	0.71	5.46	4.37
Std. Dev	3.23	0.07	8.42	0.22	0.44	1.39	1.93
CV (%)	22.22	12.56	34.46	31.53	61.65	25.4	44.1

Exchangeable magnesium

Available magnesium content varied between 0.46 to 0.95 cmol (p+) kg^{-1} with a mean value of 0.54 cmol (p+) kg^{-1} with standard deviation of 0.07 cmol (p+) kg^{-1} and C.V of 12.56 per cent and results are in accordance with Sathish *et al.*, 2018 in Ramanagar district of Karnataka.

Available sulphur

Available sulphur content in soils varied from 8.00 to 50 mg kg^{-1} with mean value of 24.42 mg kg^{-1} with standard deviation of 8.42 mg kg^{-1} and C.V of 34.46 per cent. According to Tandon (1991) the sufficiency level of sulphur in Indian soils was above 10 mg kg^{-1} soil. Based on this, status of sulphur in the nearly 50 per cent of soil samples were found to be deficient and remaining 50 per cent were sufficient.

DTPA extractable micronutrients

Available iron

The available iron content in soils ranged from 2.0 to 10.0 mg kg^{-1} with an mean of 5.46 mg kg^{-1}, standard deviation of 1.39 and CV of 25.41 per cent. The low iron content might be due to iron fixation by clay which decreased its availability. Similar results were also observed by Ravikumar *et al.* (2017) and Patil *et al.* (2016).

Available copper

The available copper content in soils ranged between 0.22 to 3.48 mg kg^{-1} with a mean value of 0.71 mg kg^{-1}, standard deviation of 0.44 and CV of 61.65 per cent. All the soil samples recorded sufficient copper content of more than 0.3 mg kg^{-1}. The higher concentration of copper in the surface horizons might be due to the chelating of organic compounds, released during the decomposition of organic matter left after harvesting of crop. Similar findings were made by Reddy and Naidu (2016) in soils of Chennur mandal of Kadapa district in Andhra Pradesh.

Available zinc

The available zinc content in soils ranged from 0.08 to 1.58 mg kg^{-1} with a mean value of 0.69 mg kg^{-1}, standard deviation of 0.22 and CV of 31.53 per cent. The low DTPA extractable zinc was possibly due to high soil pH values which might have resulted in the formation of insoluble compounds of zinc or insoluble calcium zincate (Prasad *et al.*, 2009). Zinc deficiency was wide spread in soils with high pH, low organic matter and calcareousness.

Available manganese

The available manganese content of soils ranged from 2.00 to 10.00 mg kg-1 with a mean value of 4.37 mg kg^{-1}, standard deviation of 1.93 and CV of 44.10 per cent. All the soils of study area were recorded sufficient manganese content and results are in accordance with Sathish *et al.*, 2018 in soils of Ramanagara district of Karnataka.

The data of micronutrient status in the Gudipala mandal have shown that DTPA extractable iron, copper and manganese content were sufficient range in the soils with exception of zinc, which was deficient in majority area.

CONCLUSION

The soils of Gudipala mandal of Chittoor district, Andhra Pradesh were moderately alkaline to highly alkaline and non-saline in nature. Soil organic carbon was low to very high. Available N was low to medium, available P and K_2O were low to high, available S was deficient to sufficient range. The available micro nutrients *viz.*, Zn, Mn and Fe were deficient to sufficient range, whereas Cu was sufficient in majority of the soils. The fertility status of study area revealed that, available N, S, Zn and Fe are important soil fertility constraints which indicate immediate attention for harnessing sustained crop production.

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