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Study on Physico-chemical Properties and Fertility Status of Tumkur District (Zone-4) of Karnataka

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A study was conducted to an assessment of physico-chemical properties of soil of Chikknayakana Hally (CNH), Koratigere (KTG), Madhugiri (MDG) Pavagada (PVG), Sira and Tiptur (TPT) taluks of Tumkur district was carried out in 2018-2019 under natural farming. The main objectives of this study was to carried out the survey, collection of information and analysis of chemical properties of soil. Totally 952 soil samples were collected at a depth of 0-15 cm and the study revealed that pH ranged 3.70-7.50 acidic to neutral, and EC is slightly saline in nature. Available nitrogen content ranged from 46.5-657.1 kg ha^{-1}, phosphorus from 5.4-267.7 kg $ha^{-1}$and potassium status in soils of different taluks ranged from 17.25 to 667 kg ha^{-1}. Maximum soil samples of the area showed sufficient in manganese, Cu and Fe status, but Zinc and boron were deficient.

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1. INTRODUCTION

Soil is an unconsolidated material of earth's crust in which plants can grow, if water, temperature and nutrients are adequately available and toxic substances are in low concentration. It consists of mineral constituents, exhibits definite physical, chemical and biological properties of variable depth. The soil phase is broadly composed of 45% mineral matter and 5% organic constituents. Soil analysis can improve crop productivity and minimize wastage of these nutrients thus minimizing impact on environmental leading to bias through optimum production. Deficiencies of primary, secondary and micronutrients have been observed in intensive cultivated areas. Several states including Karnataka, Andhra Pradesh, Gujarat, Haryana and Uttar Pradesh have made commendable progress in soil testing programme in various ways such as expansion of soil testing facilities, popularization of the programme in campaign mode, development of soil fertility maps and use of information technology in delivering soil nutrients status and appropriate recommendation to farmers. This compendium is an effort to put together existing status of soil testing facilities state wise and highlight main issues in soil testing programme compendium on soil health (Joffe1949). In this view, a comparison soil study was made to study the effect of natural resource usage on soil characteristics and productivity.

2. MATERIALS AND METHODS

Tumkur district falls under Central Dry Zone -4 with an altitude 13°31'11.40" N and latitude 77°17'30"E. Longitude it comprises of six taluks. To study the fertility status of soils, 952 samples from six taluks were taken. Out of 952 soil samples collected from Tumkur district, From each taluka, 191 soils samples were from Chikknayakana Hally (CNH), 151 from Koratigere (KTG), 199 from Madhugiri (MDG), 121 from Pavaghada (PVG), 147 from Sira and 143 from Tiptur (TPT) taluks.

Surface soil samples from 0-15 cm depth were collected from 6 taluks of Tumkur district. Soil samples collected were air dried, processed to pass through 2 mm sieve and analyzed for pH (1:2.5 soil: water ratio) by pH meter (Model Systronics 361), electrical conductivity by Conductivity bridge [1] and soil organic matter by wet oxidation method [2]. Among soil major nutrients, alkaline potassium permanganate method for available-N [3] ammonium molybdate complex colorometric method for available P (Jackson, 1973) and ammonium acetate extractant-flame photometric method for available K (Jackson, 1973) were adopted. The secondary nutrients namely, available-S was determined by versenate titration and turbidometric method respectively [4]. DTPA extractable Zn, Fe, Cu and Mn was determined by atomic absorption spectrophotometer (Lindsay and Norvell, 1978) and hot water soluble Boron by method outlined by Wolf, 1974. Based on the soil test values for different nutrients, soil samples were generally classified into three categories viz., low, medium and high.

3. RESULT AND DISCUSSION

3.1 Soil pH and EC

Data presented in Table 1, showed that the soil pH of soil samples selected from tehsils of Tumkur district varied from 3.70-7.50 with an average of 5.6. According to classification of soil reaction suggested by Brady [5], soils are of acidic to neutral in soil reaction. The minimum value of pH 3.70, 4.70, 5.20, 5.90, 5.10 and 4.80 was noticed in CNH, KTG, MDG, PVG, Shira and TPT taluks. Slightly acidic pH values in the soils may be attributed to rainfall associated with loss of bases due to leaching and presence of Al on exchange complex. Due to precipitation and less evaporation demand, the salt accumulation is not prevalent in this region, which is suitable for crop growth. The electrical conductivity of soils varied from 0.05-1.47 dSm^{-1} with an average of 0.76 dSm^{-1}. On the basis of limits for salt problems of soils, all the samples were found to be non-saline.

3.2 Soil Organic Carbon

Soil organic carbon content in the survey area ranged from 0.05-1.47% with an average of 0.50%. If the organic carbon content of soil samples was lower than the rate of decomposition then, SOM will decline. Conversely, if the rate of organic matter addition is greater than the rate of decomposition, SOM will increase [6]. This might be due to the variation in organic carbon in different taluks of

Table 1. Status of major nutrient in surface soils of Tumkur district

Taluks	Total number of samples	pH	EC (dSm^{-1})	OC (%)	Available major Nutrients kg ha^{-1}				Available micro nutrients (mg kg^{-1})				
					Avail N	Avail P	Avail K	Avail (ppm) S	Avail Fe	Avail Cu	Avail Zn	Avail Mn	Avail B
CNH	191	3.70-6.60	0.06-0.53	0.08-0.83	59.4-381.9	5.4-182	17.25-463.25	0.7-37.2	1.2-14.2	0.14-0.91	0.1-0.75	1.0-10.2	0.02-0.90
		5.17	0.20	0.36	183.98	39.58	169.39	9.55	4.55	0.48	0.37	4.46	0.29
KTG	151	4.70-6.90	0.04-1.20	0.08-0.98	59.4-446	5.4-214.2	39.8-641.5	2.1-40.9	1.0-12.9	0.16-1.30	0.11-1.0	1.0-12.1	0.02-0.81
		6.11	0.32	0.53	254	58.76	238.70	20.03	3.94	0.52	0.39	4.83	0.28
MDG	199	5.20-7.30	0.08-2.80	0.05-1.20	46.5-541	5.4-75	28.3-630.25	2.2-40.9	1.0-14.0	0.1-10.71	0.1-1.4	1-10.1	0.02-0.90
		6.46	0.33	0.46	224.93	25.29	227.55	19.26	3.60	0.57	0.314	4.67	0.35
PVG	121	5.90-7.30	0.04-0.8	0.12-1.13	76.6-510.9	5.4-160.6	39.8-641.5	0.7-40.2	1.0-12.9	0.1-1.4	0.1-1.0	1.0-32.0	0.02-0.92
		6.31	0.37	0.519	248.35	41.60	215.44	16.74	3.77	0.47	0.55	4.81	0.36
Sira	147	5.10-7.2	0.10-1.80	0.17-1.40	98.1-627	5.4-267.7	42.5-667	0.7-40.9	1.0-14.0	0.14-1.4	0.1-2.4	1.1-21.0	0.02-0.77
		6.31	0.37	0.59	208.601	65.785	360.4	15.21	4.03	0.46	0.39	5.82	0.46
TPT	143	4.80-7.50	0.05-2.5	0.15-1.47	89.5-657.1	5.4-166	70.5-640.75	2.2-40.9	1.2-9.6	0.18-0.95	0.18-0.95	1.0-9.9	0.02-0.86
		6.45	0.28	0.57	272.05	42.32	303.66	17.92	4.70	0.45	0.45	4.69	0.36

***CNH-** Chikknayakana Hally, **KTG**-Koratigere, **MDG**-Madhugiri, **PVG**-Pavagada, Sira and **TPT**- Tiptur taluks*

Tumkur district. The minimum value of soil organic carbon (0.05%) was noticed in MDG, CNH, KTG taluks. Whereas higher soil organic carbon was found in TPT, Sira and PVG taluks. Soil organic matter (SOM) generally increases where biomass production is higher and organic material additions are common. The district is having high temperature with low rainfall which resulted in faster decomposition and lesser organic carbon content. Intensive cultivation affects the soil aggregates increasing the rate of SOM decomposition [7].

3.3 Available Nitrogen

Available nitrogen content in soils varied from 46.5-657.1 kg ha^{-1} with an average value of 231.98 kg ha^{-1}. In general available nitrogen ranges from low to high and higher available nitrogen was recorded in Sira, TPT and PVG taluks. The available nitrogen was low in CNH, KTG and MDG taluks and higher available nitrogen was recorded in TPT (657.10 kg ha^{-1}) and Sira (627 kg ha^{-1}) and PVG (510 kg ha^{-1}) taluks. The variation in nitrogen content may be related to available organic carbon status, management practices, application of FYM and fertilizer to previous crops (Ashok Kumar, 2000). The low organic matter content, low rainfall and vegetation in these soils facilitates faster degradation and removal of organic matter lost through leaching and volatilization leads to low nitrogen status. The medium N status in soils may be due to continuous application of N fertilizer recommended dose for the crop which maintains the nitrogen status in these soils. Anon., [8] reported that 35.8% of the soils in Karnataka state were moderate in available nitrogen particularly in the areas under irrigation and hilly region of the plateau, while rest of the area was low in available nitrogen content.

3.4 Available Phosphorus

Available phosphorus status in surface soils varied from 5.4-267.7 kg ha^{-1} with an average value of 45.55 kg ha^{-1}. In general available phosphorus ranges from low to high and lower value of available phosphorus was recorded in CNH, KTG, MDG, PVG, Sira and TPT taluks. The mean value of available phosphorus is high in all taluks as it ranges from (25.29-65.78). Available phosphorus is the second most limiting nutrient often affecting plant growth, which exists in soil in both organic and inorganic forms. Higher P content in soils of the study area might have increased due to addition of phosphatic fertilizers specially the DAP for the crops grown in that area.

3.5 Available Potassium

The available potassium status in soils of different taluks of Tumkur district ranged from 17.25 to 667 kg ha^{-1}. Considering the mean values, the highest K_2O content of 667 kg ha^{-1} K_2O was recorded in Sira taluk and the lowest value of 17.25 kg ha^{-1} in CNH with overall mean value of 252.52 K_2O kg ha^{-1}. All the taluks of Tumkur district recorded low to high range of available potassium content. In available potassium status, which indicates that K fertilizers were scantily applied in the last 2 decades as the low category has virtually remained the same and the high area has fallen [9]. Response of crops to applied potassium depends on the threshold levels of potassium. Based on available K, buffering capacity, rate constant of release and fixation and threshold levels which predicts potential K supply of a soil. It showed that response of crops to applied fertilizer depends on the position of threshold levels of K release in relation to its present level of available K.

3.6 Available Sulphur

Available sulphur content in soil varied from 0.70 to 40.90 mg kg^{-1} with mean value of 16.45 ppm. The mean available sulphur status was found to be low to high. Lower available sulphur was recorded in CNH, PVG and Sira taluk (0.70 ppm) and high in TPT, KTG and PVG (40.90 ppm) considering. About 75% soil samples were found to be low in available sulphur content. Low level of sulphur is due to lack of sulphur in soils and continuous removal by crops [10]. According to Scherer et al. [11], organic sulphur was more in surface horizons which could be attributed to the higher organic carbon content in surface layers. Fine textured soils resulted in higher available sulphur [12].

3.7 DTPA Extractable Micronutrients

DTPA Extractable Micronutrients method given by Lindsay WL [13]**.** The DTPA-Zn in soils of Tumkur district ranged from 0.1to 2.4 mg kg^{-1}. Lower value (0.1) and higher value (2.4 mg kg^{-1}) of Zn content was recorded in Sira taluk. Maximum soil samples showing deficient in zinc status. In general, the deficiency of Zn was

pronounced in most of the villages of the six taluks of Tumkur district. The DTPA-Fe content varied from 1.0 to 14.20 mg kg^{-1} with mean value of 4.09 mg kg^{-1}. The soils of KTG, MDG, Sira and PVG showed deficient and remaining all the taluks are sufficient in Fe availability Nagaraju et al., [14]. Among the 952 samples of the taluks, only <10% samples were deficient in available copper. The variation in DTPA-Cu availability in district may be attributed to the difference in the topography, texture and organic matter status of soils. Mn is essential to all the organisms and is responsible for the production of molecular oxygen in plants during photosynthesis. Manganese deficiency in the study area was only <2%, when compared to other micronutrients. Hot water soluble boron content in surface soils ranged from 0.02-0.92 mg kg^{-1}. Maximum soil samples of the taluks were deficient in hot water soluble boron in Tumkur district. Soil derived from igneous rocks and those in tropical and temperate region of the world have much lower B concentration than the soils derived from sedimentary rocks and those in arid and semi arid regions [15]. Decrease in hot water soluble boron might also be associated with the surface adsorption of borate by freshly precipitated Al (OH).

4. CONCLUSION

The study clearly indicated that soils of Tumkur district were acidic to neutral in reaction and non-saline to slightly saline in nature. Available nitrogen ranged from low to high. Available phosphorus ranged from low to high. All the taluks of Tumkur district recorded medium to high in potassium and available sulphur status was found to be low to high in status. Most of the surveyed areas are sufficient in Fe, Cu, Mn and 70% samples were deficient in Zn and boron status.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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