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EVALUATION OF MICRONUTRIENT STATUS WITH PHYSICO-CHEMICAL PROPERTIES OF SOME AGRICULTURAL SOILS OF SELECTED AREAS OF PENDURTHI MANDAL, VISAKHAPATNAM DISTRICT, ANDHRA PRADESH

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ABSTRACT

Soil Sustainability is influenced by different soil parameters among which soil pH and Micronutrients are considered to be very important. The study was conducted in Cheemalapalli village in Pendurthi Mandal of Vishakapatnam district to establish a relationship between Boron, Iron, Manganese, Zinc, and Copper and soil pH. Almost 15 fields were selected from which samples were collected from different points at approximately 15 cm depth and were analyzed by standard methods. This process of sample collection and analysis was done for two consecutive years. The results revealed that maintaining of most favourable pH conditions is the major thing to deal with. The Soil samples were sandy textured with pH ranging from 7.0 – 8.3, and electrical conductivity ranging from 0.0–0.44 dsm^{-1}, showing that the soil samples were non-saline. SOM ranged from 1.034 to 2.758 these values show that the soils have a medium amount of SOM. The available micronutrient values show that copper, iron, and zinc were sufficient to high in concentration, and manganese was deficient in a few areas and sufficient in a few areas. Available boron was found to be insufficient in a few areas and high in a few areas.

Keywords: Micronutrients, Correlation, Sandy Textured, Physico-Chemical properties.
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INTRODUCTION

Soil is considered to be very important hold up for foliage and other life forms on earth**.** Yield and growth of crops are regulated by factors like fertility of the soil and the vital role in maintaining the fertility of soil and crop production is played by micronutrients that are needed in smaller quantities when compared to macronutrients. Though nutrients are supplied in balance if micronutrients are deficient high yielding crops are not possible. Depletion of natively available nutrients and micronutrients are observed due to the usage of varieties, which give high yields and use of high analysis fertilizers for longer time periods[1]. The growth and yield of leafy vegetables are determined by soil fertility which in turn is determined by the availability of micro and macronutrients. Soil environmental, synthetically, and botanical characteristics and their interactivity control the standard of soil[2]. The major limitation to the strength, productiveness, and effectiveness of soils is the deficiency of nutrients[3]. The boron requirement in dicotyledons is more than any other nutrients on a molar basis[4]. Based on the accessibility of plant supplements and the toxic ranges of these supplements to plants, soil pH shows a greater impact[5] when pH ranges between 4.0 – 6.0, the majority of micronutrients are more available for plant growth, when pH values are high they are tightly bound to soil and when pH values are low they are more available to plants[6] the required nutrients are taken up by the plants from the soil so crop yield and plant growth not only depend on nutrient concentration present but also on their availability which depends on physicochemical properties like pH, E.C, Soil Texture, SOM[7]. Considerable quantities of supplements are pulled out of soil due to continuous cropping for enhancement of yield. The soil quality gets depleted due to improper irrigation, imbalance use of chemicals, and inadequate use of fertilizers. There is a fluctuation in soil fertility for every rotation due to alternation in the availability and quality of supplements. Status of soil fertility is very much needed for judicious use of fertilizers. Research on soil boron is not only intriguing in its complexity but also its potential which is of great practical benefit to agriculture.

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EXPERIMENTAL

Site Description

The present study was conducted in Cheemalapalli area of Chintala Agraharam Village located in Pendurthi Mandal with coordinates 17 °49’9" N 83°11’33" E of Visakhapatnam District (17 °6904’ Latitude, 83 °231’ Longitude) in the state of Andhra Pradesh (12 °41’ and 19 °07’ North Latitude and 77° and 84 °40’ East longitude), which is located in the south-eastern part of India and its annual rainfall is 1202 mm. The coordinates of Pendurthi Mandal are (17.8333°N83.2000 °E) (in Fig.-1).

Fig.-1: The coordinates of Pendurthi Mandal are (17.8333°N83.2000 °E)

Sampling and Preparation

Soil sampling was done during April month from the agricultural fields under vegetable (green leafy) cultivation. From each field, five subsamples were taken in 0 –15cm depth in a ‘V’ shape. These samples were combined to form a composite sample. These samples were stored in zip-lock polyethylene bags. These bags were brought to the laboratory and were made moisture-free, grounded, filtered using a 2 mm sieve, labelled properly, and stored for Physico-chemical analysis and micronutrient analysis. The samples were coded as ‘P’ for season-1 and ‘2P’ for season-2.

Analysis of Soil

Soil pH is a principal chemical limiting factor that shows an impact on nutrient accessibility. The pH of the soil was carried out using 1: 2 (soil: water) suspension and samples were kept for few hours for complete digestion and pH was measured. The same suspension was kept for measuring E.C using a conductivity meter[8]. Walkley-Black method[9] was followed to determine soil organic matter. In this method, 0.5 g of the soil sample, 10 mL 1N $K_2Cr_2O_7$, 20 mL conc. H_2SO_4 mixture was taken and kept undisturbed for half an hour, to this mixture 100 mL of deionised water, 10 mL of H_3PO_4, and ferroin indicator (2drops) were added, and titration was done using a 0.5M solution of Ferrous ammonium sulfate solution until a reddish-brown colour endpoint is observed. Soil texture analysis was done using the Hydrometer method[10]. The textural class of soil samples was ascertained from the dispersal of sand, silt, and clay, and the denseness of soil suspension is found with a hydrometer, and from the percentage contents of sand, silt, and clay the textural class of the soil was found out using a triangular textural diagram. Cu, Mn, Fe, and Zn in DTPA extractable soil are obtained by extracting 10 g (<2 mm) with 20 ml of 0.005 M DTPA + 0.01 M $CaCl_2$ + 0.1 M TEA (triethanolamine solution). The pH of the DTPA mixture is modified to 7.3 with dilute HCl. Zn, Fe, Mn, and Cu are estimated with a suitable cathode lamp using the AAS method[11]. Hot water extraction[12] is considered to be the best technique for the evaluation of boron in the available form in soils. In this method Azomethine –H reagent forms a firm colored complex with H_3BO_3 at pH = 5.1, in water which obeys Beer-Lambert’s law. Boron stock solution of 100 ppm concentration was prepared using H_3BO_3 of AR grade. 25 g of sample with 50 ml distilled water and 0.5 g of activated charcoal were taken in a titration flask. It was boiled for 5 minutes and filtered using Whatman No: 42 filter paper. 5 mL of the filtrate along with 2 ml ammonium acetate-acetic acid buffer solution and 2ml of Azomethine – H reagent was taken into a 25ml volumetric flask. This suspension was kept aside for one hour till yellow colour was developed and absorbance was measured at λ max = 420 nm, Using UV- a visible spectrophotometer.

RESULTS AND DISCUSSION

Soil pH

The soil under study possessed wide variations in soil pH. The soil samples showed pH values ranging from 7.1 to 8.3 with a mean of 7.78 considering 6.6% of soil samples as neutral, 40% of soil samples as slightly alkaline, and 53.3% of soil samples as moderately alkaline during season-1 and in season-2 the pH values ranged from 8.0 to 8.3 with mean 8.14 considering 100% soil samples as moderately alkaline.

Electrical Conductivity

The soil profiles under study showed variations in E.C values. During season-1 it ranged from 0.01 to 0.34 dsm-1 with a mean of 0.21 dsm^{-1} and during the season - 2 it ranged from 0.01 to 0.44 dsm^{-1} with a mean of 0.2 dsm^{-1}.

SOM

The SOM values of soil samples under investigation ranged from 1.724-2.586 % with a mean of 2.08% during the season -1 and during the season - 2 it ranged from 1.034-2.758 % with a mean of 1.965% (Table –1).

Table 1. Physico-Chemical Properties and Micronutrients of the Soil from Pendurthi Sampling Site Minimum – Maximum and Mean Values are presented

Parameter	Season-1		Season-2	
	Range	Mean Value	Range	Mean Value
pH	7.1-8.3	7.78	8.0-8.3	8.14
E.C (dsm^{-1})	0.01-0.34	0.21	0.01-0.44	0.20
SOM (%)	1.72-2.58	2.08	1.03-2.75	1.96
% of Sand	70.25-78.0	74.19	71.05-76.5	73.612
% of Silt	3.16-7.0	4.39	3.00-6.96	4.08
% of Clay	15.2-25.75	21.46	16.8-24.3	21.082
B (mg/kg)	0.96-3.84	1.66	0.72-3.36	1.35
Cu (mg/kg)	0.52-1.36	0.88	0.34-1.98	0.81
Fe (mg/kg)	8.72-11.99	10.35	8.31-21.82	11.42
Mn (mg/kg)	2.68-4.72	3.39	2.9-4.16	3.34
Zn (mg/kg)	0.97-11.4	6.15	2.48-12.63	6.15

The reports revealed the majority of sampling sites were alkaline, the SOM was medium and E.C values showed that the soils were non-saline. The soil textural class differed from sandy loam to clay according to the values observed from soil separates.

Soil Textural Analysis

The soil samples under study had sand percentages ranging from 70.25-78% with a mean of 74.194%, silt percentages ranging from 3.16-7.0% with a mean of 4.39%, and clay percentages ranging from 15.2-25.75% with a mean 21.46% during season-1 and season-2 sand percentage ranged from 71.05-76.5% with mean 73.612%, silt percentage ranged from 3.00-6.96% with mean 4.08% and clay percentage ranged from 16.8-24.3% with mean 21.082% (Table–2).

Table-2: Textural Analysis of Soil Samples from Sampling Sites

S. No.	Sample Code	Sand%	Silt%	Clay%
1	P2	72.08	3.87	24.08
2	P5	76.08	3.92	20
3	P8	74.56	3.16	22.31
4	P11	70.25	4	25.75
5	P15	78	7	15.2
	Mean	74.194	4.39	21.468
	Range	70.25-78	3.16-7	15.2-25.75

Available Micronutrient Analysis

The range of DTPA - Cu was 0.52-1.36 with a mean of 0.88 for season-1 and season-2 was 0.34-1.98 with a mean of 0.81. DTPA - Mn had values ranging from 2.68-4.72 with a mean of 3.39 for season-1 and the season - 2 the range was 2.9-4.16 with a mean of 3.34. DTPA - Fe values ranged from 8.72-11.99 with a mean of 10.35 during season-1 and during season-2 the values were 8.31-21.82 with a mean of 11.42. DTPA - Zn values ranged from 0.97-11.4 with a mean of 6.15 during season - 1 and during the season - 2 they ranged from 2.48-12.63 with a mean of 6.15. Available boron ranged from 0.96-3.84 with a mean of 1.66 during the season -1 considering 86.6% of soil samples were sufficient and 13.3% of soil samples had high concentrations of available boron. During season –2 the range was 0.72-3.36 with a mean of 1.35 considering 60% of soil samples sufficient, 33.3% of soil samples low, and 6.65% of soil samples having high concentrations of available boron (Table–3).

Table –3: Descriptive Statistics and Observations of Soil Samples from Sampling Sites Based on Critical Limits

Parameter	Season-1			Season-2		
	Mean	Range	Status	Mean	Range	Status
pH	7.78	7.1-8.3	Moderately alkaline	8.14	8.0-8.3	Moderately alkaline
E.C	0.21	0.01-0.34	Non-saline	0.20	0.01-0.44	Non-saline
SOM	2.08	1.72-2.58	Medium	1.96	1.03-2.75	Medium
Micronutrients in ppm						
Boron	1.66	0.96-3.84	High	1.35	0.72-3.36	High
Copper	0.88	0.52-1.36	High	0.81	0.34-1.98	High
Iron	10.35	8.72-11.99	High	11.42	8.31-21.82	High
Manganese	3.39	2.68-4.72	High	3.34	2.9-4.16	High
Zinc	6.15	0.97-11.4	High	6.15	2.48-12.63	High

From the above mean values, the DTPA - Cu, Mn, Fe, and Zn were very high in these sampling sites and available boron was sufficient in maximum sampling sites but few sampling sites showed low concentrations. The acidic and basic nature of the soil is determined using pH measurement that affects nutrient solubility and their availability in the soil. Soil pH is influenced by various factors like SOM decomposition, the disintegration of native minerals, weather conditions, and cultivation practices. Soil pH has a greater influence on micronutrients present in the soil. Changes in soil pH are caused by biological activities involving living species and biochemical transformations using the remnants of deceased organisms[13]. Their solubility, concentration in soil solution, ionic form mobility, and acquisition of these nutrients by plants are greatly affected by soil pH[14]. As a rule, there is a decrease in the availability of micronutrients as pH value increases, but in our present study, all the micronutrients were high in concentration not crossing toxic levels for better growth of crops. Soil samples under investigation are alkaline in reaction; the holding capacity of basic cations was mainly due to the interaction of soil colloids[15] with the fertilizer applied which attributed alkaline nature to the soil. The E.C. values give the salt concentrations of the soil and in the present study; the soils under investigation were non-saline and are suitable for the healthy growth of plants. Based on the limits suggested by Muhr[16] for judging salt problems in soils all soil samples under investigation were found normal (E.C < 1.0). The lower base concentrations and leaching of salts urge for salt agglomeration which is not common in this zone as a result the soils are fit for better cultivation or development of plants.SOM is an important component of the earth's various physicochemical properties.SOM aids nutrient availability by providing chelates and increasing soil CEC as well as solubility of certain nutrients in the soil solution. SOM content depends on organic residue form, climate, and cropping practices. Once SOM decomposes it benefits soil aeration, nutrient and water holding capacities are decreased and carbon is lost from the system as CO_2. SOM is frequently used as a crucial indicator of soil productivity. It's a nutrient reserve that helps create soil aggregates, enhances soil porosity, accelerates root growth, and activates soil biota development. Soil degradation eventually results in a drop of soil productivity. When soils become more deteriorated, crop yields decline and the likelihood of a complete crop failure rises[17]. SOM forms the base for fruit full soils and it is considered a very important parameter for improving environmentally effective cultivation methods. In our present study, samples were high in DTPA - Fe, Mn, Cu, Zn, and available boron was sufficient in a few samples and low in a few soil samples. At pH > 7.8, which is in the alkaline range, negatively charged ions of zinc called zincate ions are formed. Hydroxide ions of zinc are formed in alkali solutions[18]. The stability of soluble and insoluble organic complexes of zinc or antagonistic ions solubility may alter with a change in pH[19]. Moreover, Fe gets precipitated as insoluble Fe $(OH)_2$ as Fe^{2+}ions get converted to Fe^{3+} ions with an increase in pH. When pH increases Cu gets precipitated as hydroxides, Mn^{2+}gets converted to Mn^{3+} to Mn^{7+} and is not usable for plants as it is insoluble in water. But in our present study, all micronutrients were found to be sufficient and high in concentrations which might be due to the supply of these nutrients in the form of fertilizers. Crops' ability to efficiently utilize B nutrients varies greatly. As a result, critical cultivars of agronomic and horticultural crops with robust root systems that can use available B and survive well in B shortages are needed from an agricultural perspective [20]. These nutrients were high but did not exceed toxic levels and so were considered to be within safe limits for plant growth.

CONCLUSION

The results of our present study will help to suggest proper measures for appropriate reclamation and suitability for growing crops. It will be helpful to find out the degree and type of problems related to soils. This study will give farmer's approx the idea about which fertilizer to be used and which nutrient is needed by the soil to increase the yield. From the studies, it can be concluded that the appropriate fertilizer management and measures taken for soil conservation like SOM management and soil erosion control are required by the system. An increase in internal use efficiency is observed by the inclusion of micronutrients in a balanced fertilization schedule. Therefore different parameters are to be considered for micronutrient management like soil type, crop type, source, method, the severity of the deficiency, time, rates, and frequency of application for the maintenance of human health and sustainable agricultural production. In our findings values of Cu, Mn, Fe, Zn and boron are higher than the normal range in maximum soil samples which can be due to poor drainage conditions in this area, as a result, the nature of the soil is found to be alkaline. The best remedy suggested is to use acidic fertilizers and organic manures which can help to raise the yield of the crop. The systematic or well-organized way to judge the ample metal concentrations is to monitor the micronutrients in the soil periodically. The information regarding the micronutrient status of various samples of Pendurthi Mandal in our present investigation may help to formulate an integrated nutrient management schedule for better cultivation practices and maintenance of long-term soil health.

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REFERENCES

1. Mostafa Mohamed Selim, *Hindawi International Journal of Agronomy*, **2020**, Article ID 2821678, 14 pages, https://doi.org/10.1155/2020/2821678
2. J. Parr, R. Papendick, S. Hornick and R. Meyer, *American journal of Alternative Agriculture,* **7(1-2**), 5(1992), https://doi.org/10.1017/S0889189300004367
3. P. Chaudhari, D. Ahire and V. D. Ahire, *Journal of Chemical Biological and Physical Sciences,* **2(3)**, 1493(2012).
4. MilkaBrdar-Jokanovi´, *International Journal of Molecular Sciences,* **21,** 1424(2020), https://doi.org/10.3390/ijms21041424
5. N. Brady and R. Weil, The Nature and Properties of Soils, 13th Edition, In: New Jersey: Pearson Education Ltd, (2002).
6. J. L. Havlin, S. L. Tisdale, W. L. Nelson and J. D. Beaton, J. D, Soil Fertility and Fertilizers, New Delhi: Pearson Education India, (2016).
7. R. W. Bell and B. Dell, Micronutrients for Sustainable Food, Feed, Fibre and Bioenergy Production (1st Edition ed.), France: International Fertilizer Industry Asso- ciation (IFA), (2008).

8. M. Jackson, R. Miller and R. Forkiln, Soil Chemical Analysis, Prentic-Hall of India Pvt.& Ltd. New Delhi: 2nd Indian Rep(1973).
9. A. Walkleyand I. A. Black, *Soil Science*, **37(1)**, 29(1934), https://doi.org/10.1097/00010694-193401000-00003
10. G. J. Bouyoucos, *Agronomy Journal,* **54(5)**, 464(1962), https://doi.org/10.2134/agronj1962.000219620054 00050028x
11. W. L. Lindsay, and W. A. Norvell, Soil *Science Society of America Journal,* **42(3)**, 421(1978).
12. K. Berger E. and E. Truog, *Industrial & Engineering Chemistry Analytical Edition,* **11(10)**, 540(1939), https://doi.org/10.1021/ac50138a007
13. Dora Neina, *Applied and Environmental Soil Science,* **2019**, Article ID 5794869(2019).
14. V. Fageria, *Journal of Plant Nutrition,* **24(8)**, 1269(2001), https://doi.org/10.1081/PLN-100106981
15. R. P. Singh and S. K. Mishra, *Indian Journal of Scientific Research,* **3(1)**, 97(2012).
16. G. R. Muhr, N. P. Datta, N. Shankara Subraney, F. Dever, Soil Testing in India, (1963).
17. María Daniela Chavez, Paulus Bernardus Maria Berentsen, Oene Oenema, Alfons Gerard Joseph Maria Oude Lansink, *Agricultural Sciences,* **5**, 743(2014).
18. J. S. Kanwar, Soil Fertility-Theory and Practice, *Indian Council of Agricultural Research, India,* 533 (1976).
19. M. Singh and K. S. Singh, *Annals of Arid Zone*, **20**, 77(1981).
20. F. Shireen, M. A. Nawaz, C. Chen, Q. Zhang, Z. Zheng, H. Sohail, J. Sun, H. Cao, Y. Huang, Z. Bie, *International Journal of Molecular Sciences*, **19(7)**, 1856(2018), https://doi.org/10.3390/ijms19071856

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