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Nutrient Application Based on Soil Testing – Quantification of nutrients of irrigated soils of Tadepalligudem Tehsil and fertilizer recommendation for paddy cultivars with special reference to zinc for end user applications.

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A B S T R A C T

Rice (Paddy) is the main cultivated crop in the Tadepalligudem Tehsil of Andhra Pradesh. Growth and yield of any crop depends on factors like soil fertility and nutrient availability from the soil, besides other soil properties. To know the soil characteristics of the study area, soil samples are collected and analyzed for physico-chemical characteristics like pH, EC, % OC, macronutrients(N,P,K) and micronutrients(Fe, Cu, Zn ,Mn, etc., by using Atomic Absorption Spectroscopy.) Of the 38 representative samples analysed, in 39% of the samples nitrogen level is high and in 19% phosphorus levels are high whereas in 6% of the samples potassium is to the higher side. It has been found that, in most of the soils zinc is below the critical value. According to recent studies, zinc deficiency in soils of Andhra Pradesh is further expected to increase from the current 49% to 63% by the year 2025 as most of the marginal soils are being brought under cultivation. Since several research studies have reported antagonistic effect between phosphorus and zinc, care must be observed while applying macronutrients in the paddy fields of the study area. Therefore it is proposed to advise the stake holders about the results obtained in this analysis so that they can apply the fertilizers according to the need only. Sincere efforts are going on to convince farmers about the use of fertilizers based on soil testing is a good practice. It is a practical tool for optimizing the use of fertilizers which leads to higher yields.

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Introduction:

Growth and yield of any crop is dependent on factors like agro-climatic conditions, variety, crop management practices, spacing, seed rate, weed control, water management, soil fertility and nutrient availability from the soil besides other soil properties. A study of soil profile supplemented by physical, chemical and biological properties of the soil will give full picture of soil fertility and productivity. Since some years there are big efforts to convince farmers that using fertilizers based on sound soil testing as a practical tool for optimizing the use of fertilizers and thus, leads to higher yields. In the present study, soil samples are collected from the study area and analysed for physico-chemical properties like soil pH, EC, OC, N,P,K, and micronutrients and attempt was made to decipher the soil characteristics and convince the farmers to go for soil test based fertilizer application which helps to avoid wasteful expenditure on nutrient(s) that need not be applied and in rationalizing the apportionment of different nutrient quantities that

need to be applied to maximize the returns from investment on nutrient application.

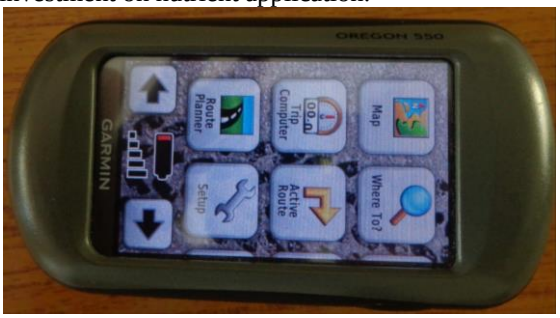

Figure: 1. GPS to measure coordinates.

Materials and methods:

The area selected for study is Tadepalligudem Tehsil of A.P., India. It lies between the latitudes 16.8333(N) and longitudes 81.5272(E) with an altitude of 27metres above the sea level. The mean annual rainfall is about 115 cm.

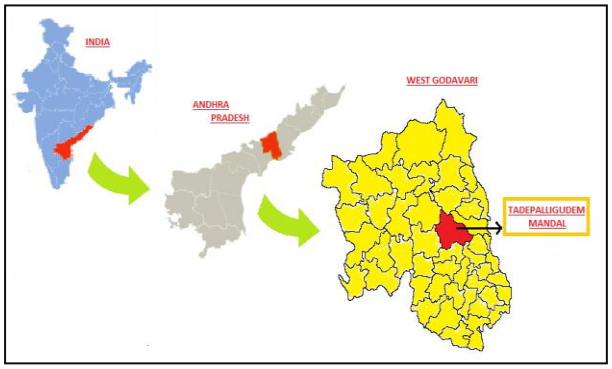

Figure: 2. Maps showing the study area.

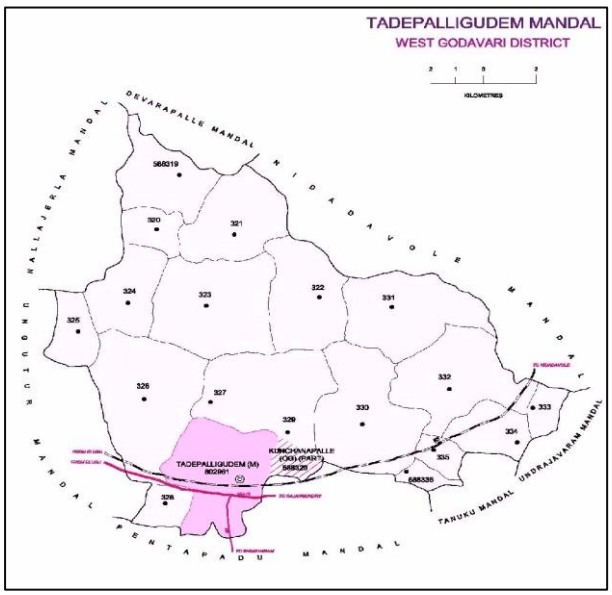

Figure: 3. Tadepalligudem mandal map.

Representative soil samples are collected from all the 19 settlements (one town and 18 villages) in the mandal during Nov – Dec 2015 (between Kharif and Rabi season) by following standard soil sampling procedures.

Figure: 4. Soil sample collection.

The soil samples numbering 38 are stored in polythene bags and analysed for physico-chemical characteristics.

The geographical parameters are measured using GPS instrument of Garmin make, model: Oregon 550 (Figure 1). pH measured by using Elico L1 120 pH meter, EC by conductivity meter of Systronics make, model MK-509, Organic carbon by rapid titration method, mineralizable nitrogen by alkaline permanganate method, estimation of available phosphorus was done on Olsen's extract by ascorbic acid method[17]. Estimation of available potassium is done by flame photometer method. Estimation of available micronutrients (Fe, Zn, Cu, Mn) is done by DTPA method using atomic absorption spectrophotometer (AAS) of Elico make, model: SL 194(Figure 5). In all these analyses, reagent grade waters are used and to the maximum possible extent analytical grade chemicals supplied by firms of international repute are used.

Figure: 5. Atomic absorption spectrophotometer.

Results and discussions:

pH:

Soil pH is the negative logarithm of the active hydrogen ion (H^+) concentration in the soil solution. It is a measure of soil sodicity, acidity or neutrality. Soil pH influences to a great extent the availability of

nutrients to crops. It also affects microbial population in soils. pH range of the soil samples is 7.1 to 7.7 (Table-1) which is moderately alkaline range and suitable for cultivation.

Soil Electrical Conductivity (EC):

It is a measure of the salt content. Crops vary to the degree of sensitivity to salts, but most crops tolerate levels of 1.1 or less with no effect on yield. Excess salinity may cause moisture stress within the plant. However, too pure of can also be detrimental. Water with too few salts can lead to surface soil dispersion and soil crusting. EC values of most of the soil samples studied is within the tolerable limit (Table-1).

Organic Carbon (OC):

Soil organic carbon content can be used as an index of nitrogen availability (potential of soil to supply nitrogen to plants). % OC < 0.5 % is considered low, between 0.5 and 0.75 medium and > 0.75 % as high. The results shows that %OC of the soil samples is on the higher side (Table-1) indicating that the availability of nitrogen to the cultivars is high.

Table: 1. Physico-chemical characteristics of soil samples of Tadepalligudem mandal.

S. No.	Sampling Location With coordinates	pH	EC mmhos cm^{-}	% OC	Soil Available Nutrients (kg/ha)			Micro-nutrients (ppm)			
					N	P	K	Fe	Mn	Cu	Zn
1.	Tadepalligudem 16.8147(N), 81.5272(E)	7.3	1.05	8.2	680	27.4	223	34	8.2	4.8	.67
2.	Apparaopeta 16.7467(N), 81.4240(E)	7.2	1.1	3.8	590	27.0	218	39	6.1	2.5	.44
3.	Arugolanu 16.8063(N), 81.5884(E)	7.1	1.05	7.8	495	28.8	270	36	6.9	3.8	.38
4.	Arulla 16.6564(N), 81.4507(E)	7.5	1.2	2.2	440	28.2	210	29	6.3	3.7	.53
5.	Jaggannapeta 16.7985(N), 81.4555(E)	7.2	1.02	3.8	490	29.2	274	32	7.5	3.5	.49
6.	Jagannadhapuram 16.7655(N), 81.4569(E)	7.5	1.02	10.2	590	28.6	288	36	7.4	3.8	.72
7.	Kadiyedda 16.7593(N), 81.4719(E)	7.3	0.9	2.8	440	27.5	198	36	7.4	3.8	.77
8.	Kommugudem 16.7918(N), 81.4521(E)	7.2	0.96	2.8	380	19.6	240	32	7.2	3.9	.85
9.	Krishnayapalem 16.7863(N), 81.5019(E)	7.3	0.95	3.7	510	12.7	238	38	7.7	4.1	.82
10.	Kunavaram 16.7888(N), 81.4444(E)	7.3	1.1	10.4	660	42.7	195	37	7.2	3.8	.58
11.	Kunchanapalle 16.7989(N), 81.4746(E)	7.7	1.15	11.2	670	32.0	210	33	6.8	4.7	.38
12.	Kondruprolu 16.7450(N), 81.4830(E)	7.7	1.12	9.4	595	23.8	215	38	7.9	3.6	.60
13.	Madhavaram 16.7432(N), 81.4812(E)	7.4	1.13	4.8	422	17.7	219	33	7.1	3.2	1.1
14.	Nandamuru 16.7468(N), 81.4756(E)	7.2	1.15	7.4	610	22.7	210	38	7.3	2.7	.77
15.	Nawabpalem 16.7288(N), 81.4935(E)	7.2	1.05	8.3	590	28.4	210	37	7.2	3.8	.93
16.	Padala 16.7729(N), 81.4869(E)	7.1	0.92	3.2	640	31.8	285	42	8.2	4.1	.74
17.	Tadepalle 16.7449(N), 81.5345(E)	7.5	0.88	9.2	648	14.3	272	38	6.4	3.8	.65
18.	Veerampalem 16.7548(N), 81.5169(E)	7.3	0.90	8.4	642	34.7	248	38	5.9	3.2	.65
19.	Venkataramannagudem 16.7310(N), 81.4993(E)	7.4	0.87	4.3	380	16.4	254	37	5.9	3.7	.45

The study shows that, overall the available NPK levels are to the higher side (Table-2).

Table: 2. Macronutrients (NPK)

Macro-Nutrient (Kg/ha)	Low	Medium	High
N	< 280	280-560	>560
P	<11	11-25.6	>25.6
K	<120	120-280	>280

Plant micronutrients:

Out or 17 nutrients established as essential for plant growth, 6 are required in small quantities and therefore called micronutrients. They are zinc, boron, iron manganese, molybdenum and copper. With the practice of intensive cultivation, using high yielding varieties and multiple crops, deficiencies of newer elements are becoming more crucial in crop nutrition management and production. Among these the deficiencies of micronutrients especially zinc have become more crucial. Critical levels of micronutrients in soils is the one below which economic response to the applied nutrient could be obtained and above which no economic response to added nutrient could be observed (Cate and Nelson, 1965). The critical levels of micronutrients in soils as observed by the Hyderabad center of AICRP are;

Table: 3. Micronutrient level

Element	Critical Level (mg/kg)
Zinc	0.70
Copper	0.30
Iron	5.00
Manganese	3.00
Boron	0.52
Molybdenum	0.20

In almost all the soil samples, the zinc levels is either low or below critical levels (Table -3). Zinc is required in protein synthesis and for ensuring seed quality and uniform maturity. In soils having zinc deficiency, appearance of rusty-brown spots and discoloration of older leaves beginning 2-3 weeks after transplanting is noticed. Under acute conditions leaf margins of older leaves dry up. New leaves are smaller in size. Crop maturity is non-uniform and delayed. In a typical example, it can be noted that rice crop removes 40 gm/ha. (Tandon 1989).

Zinc deficiency syndrome is regarded next to iron anaemia, as an important nutritional problem in the world (Alloway, B.J., 2008). Dietary zinc intake was found inadequate from cereals, pulses, vegetables grown on zinc deficient soils. Zinc is essential for the normal structure and functioning of more than 300 enzymes. Recent intervention trials showed that Zn supplementation decreases the rate of diarrhea and lower respiratory infections, which are the major causes of child mortality. Rice is a staple food that is highly sensitive to Zn deficiency commonly found in almost half of the soils of the study area. Rice grain grown on these low Zn soils had low Zn, thus compromising the Zn intake of young children and population.

Figure: 7. Paddy leaf showing zinc deficiency

Zinc sulphate heptahydrate (Zn – 21%) is recommended for soil application at the rate prescribed by the State Agricultural Universities/ Soil Testing Laboratories. The doses varies from 25 to 60 kg/ha depending on soil type, cropping intensity and crop productivity levels. In the absence of basal application, foliar spray of 0.5% solution of zinc sulphate heptahydrate for 15 days after transplanting of rice should be practiced. Care needs to be taken that zinc sulphate should not be mixed with phosphate fertilizers, as water soluble zinc is transformed to relatively insoluble zinc phosphate.

Conclusion:

Rice is a major cultivated crop in Tadepalligudem mandal. The soils are mainly of black alluvial type. The analytical results of soil samples has shown deficiency in micronutrients, especially zinc. Recent studies have shown that this trend will further increase in the coming years.

Figure: 8. Paddy fields showing the variation

Zinc deficiency has strong impact on human health as zinc content in edible parts is decreasing but antinutrients are increasing. Biofortification of crops by enriching micronutrient in seeds is a better option along with advanced agronomic fertilization and biofortification techniques. Several studies have reported a synergistic effect of N-Zn, N-K, S-Mo, N-B and antagonistic effect between P-Zn, Cu-Zn, etc., High

soil phosphate levels are one of the most common causes of zinc deficiency in crops by cations added with phosphate salts can inhibit zinc absorption from solution, H^+ ions generated by phosphate salts inhibit zinc absorption from solution and phosphorus enhances the adsorption of zinc into soil constituents. Knowledge of such synergy using micronutrient may be harnessed to enhance FUE (fertilizer use efficiency). Certain studies have also shown that application of zeolite and zinc under normal irrigation had a positive effect on evaluations. Hence farmers of this mandal are advised for soil test based fertilizer application since it helps to avoid wasteful expenditure and maximize the returns from investment on fertilization.

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References:

1. Alloway BJ (2008). Zinc in soils and crop nutrition, Second edition, published by IZA and IFA Brussels, Belgium and Paris, France.
2. APAU.1972-89. Annual Reports, AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture, Bapatla, Andhra Pradesh Agricultural University, Hyderabad.
3. APHA-AWWA-WEF, Standard Methods for the examination of water and wastewater, Washington DC, 1998.
4. Barber SA (1995) Soil nutrient bioavailability, 2nd edn. Wiley, New York
5. Chro´st RJ (1991) Environmental control of the synthesis and activity of aquatic microbial ectoenzymes. In: Chro´st RJ (ed) Microbial enzymes in aquatic environments. Springer-Verlag, New York, pp 29–59
6. CRIDA and Department of Agriculture, Hyderabad 1994. Fertilizer recommendations for crops in Andhra Pradesh. Central Research Institute for Dryland Agriculture and Department of Agriculture.
7. Datta, N.P., Khera, M.S. and Saihi, T.R. 1962. A rapid colorimetric procedure for the determination of the organic carbon in soils. Journal of Indian Soil Science 10. 67-74.
8. Dhaliwal SS, Sadana US, Khurana MPS, Manchanda JS (2010) Enrichment of rice grain with zinc and iron through fertilization. Indian J Fertil 6(7):28–35
9. El-Saady A.M., et al., International Journal of Agriscience, Vol.4 (6): 313-320, June 2014.
10. Ghose, A.B., Bajaj, J.C., Rehanul Hasan and Bhajan Singh, 1983. Soil and Water Analysis- A laboratory manual, STL Div. Soil Sci. And Agril. Chemi. IARI, New Delhi.
11. Graham RD (1984) Breeding for nutritional characteristics in cereals. Advances in Plant Nutrition 1:57–102
12. Graham RD (2008) Micronutrient deficiencies in crops and their global significance. In: Alloway BJ (ed) Micronutrient deficien-cies in global crop production. Springer, Dordrecht, pp 41–61
13. India J. Fert. Vol.5 (4). Pp. 11-16, 19-26 & 56.
14. J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, Vogel's text book of quantitative chemical analysis (6th edition), Pearson education limited, (2000).
15. John Peters, Soil and Water testing laboratory procedure and training manual for Mahindra samriddhi centres, version 2, July 2010.
16. Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA soil test for micronutrient. Soil Science Soc. Am. J. 42, 421-428.
17. Methods Manual, Soil Testing in India, Department of Agriculture & Cooperation, Ministry of Agriculture, New Delhi, January-2011.
18. Nannipieri P, Sequi P, Fusi P (1996) Humus and enzyme activity. In: Piccolo A (ed) Humic substances in terrestrial ecosystems. Elsevier Science B.V., Amster-dam, pp 293–328
19. Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Ire U.S. Dep. Agric.939.
20. Peters. J.B., editor, 2008, "Wisconsin Procedures for Soil Testing, Plant analysis and Feed & Forage Analysis". Soil Science Department, College of Agriculture and Life Sciences, University of Wisconsin-Extension-Madison.
21. Rao MA, Violante A, Gianfreda L (2000) Interaction of acid phosphatase with clays, organic molecules and organo-mineral complexes: kinetics and stability. Soil Biol Biochem 32:1007–1014
22. Reddy, K.C.K., Velayutham, M. and Maruthi Sankar, G.R., 1974. Soil test based fertilizer prescriptions for yield targets of crops: extensions bulletin (ICAR).
23. Reddy, R.S., Shiva Prasad, C.R., and Harindranath, C.S. 1996. Nbbs Publi.69. Soils of Andhra Pradesh for optimizing landuse.
24. Richards, L.A., 1954. Diagnosis and Improvement of Saline and Alkali Soils. Ist Edn., United States Salinity Laboratory Staff. US Department of Agriculture, Washington, USA.
25. S.S. Dara, A text book on experiments and calculations in engineering chemistry (7th revised edition). S. Chand & Company Ltd, New Delhi, pp.1-50 (2000).
26. Sarma. et al. Soil Analysis and Fertilizer Recommendations for Paddy Cultivars of Pentapadu Tehsil with Special Reference to Zinc. Int. J. Adv. Res. Sci. Technol. Volume 4, Issue 6, 2015, pp.409-413
27. Shahsavari N., Jais H.M., Shirani Rad A.H., "Responses of canola oil quality characteristics and fatty acid composition to zeolite and zinc fertilization under drought stress", International Journal of AgriScience, Vol. 4(1): 49-59, January 2014.
28. Shi R, Li H, Tong Y, Jing R, Zhang F, Zou C (2008) Identifica-tion of quantitative trait locus of zinc and phosphorus density in wheat (Triticum aestivum L.) grain. Plant Soil 306:95–104
29. Sillanpaeae M (1982) Micronutrients and the nutrient status of soils: a global study. FAO Soils Bulletin, no.48, Rome, Italy
30. Singh MV (2006). Micronutrients in crops and in soils of India. In: Alloway BJ (ed.) Micronutrients for global crop production. Springer. Business.
31. Singh MV (2008). Micronutrient deficiencies in crops in India. In: Micronutrients in global crops. (ed. Alloway Brown) Springer, New York.
32. Singh MV (2009). Micro nutritional problem in soils of India and improvement for human and animal health. Indian J. Fert. 5(4):11-16.
33. Singh MV (2010). Micronutrient deficiency in Indian soils and field usable practices for their correction.

AICRP (micronutrient) Annual Report, Indian Institute of Soil Science, Bhopal, India.
34. Soil test based fertilizer application. Indian Council of Agricultural Research, New Delhi. Acharya N.G. Ranga Agricultural University, Hyderabad and Dept. of Agriculture, A.P., Hyderabad.
35. Soils of India and their Management, FAI (1985).
36. Srivastava PC, Singh SK, Mishra B (2006) Crop response and profitability to applied secondary and micronutrients in cereals. Indian J Fertil 2(8):45–51
37. Steven D. Allison, Biogeochemistry (2006) 81:361–373.
38. Subbaiah, B.V. and Asija, G.L. 1956. A rapid procedure for the determination of available nitrogen in soils. Current Science 25: 259-60.
39. Swift RS (1996) Organic matter characterization. In: Sparks DL (ed) Methods of soil analysis, part III. Chemical methods. Soil Science Society of America and American Society of Agronomy, Madison, WI, pp 1011–1069
40. Takkar PN (2011) Zinc in human and animal health. Indian J Fertil 7(10):46–66
41. Venkatasubbaiah, V., Muralidharudu, Y., Patnaik, M.C. and Bhupal Raj, G., 1995. Micronutrients in soils of Andhra Pradesh – A monograph p. 197-224.
42. Walkley, A.J. and Black, I.A. 1934. Estimation of soil organic carbon by the chromic acid titration method. Soil Sci. 37: 29-38.
43. Watanabe, F.S. and Olsen, S.R. 1965. Test of ascorbic acid method for determining phosphorus in water and sodium bicarbonate extracts of soil. Proceedings of Soil Science Society of America 29: 677-78.
44. Waters BM, Sankaran RP (2011) Moving micronutrients from the soil to the seeds: Genes and physiological processes from a biofortification perspective. Plant Sci 180:562–574 Wissuwa M,
45. Wetzel RG (1991) Extracellular enzymatic interactions: storage, redistribution, and interspecific communica-tion. In: Chro´st RJ (ed) Microbial enzymes in aquatic environments. Springer-Verlag, New York, pp 6–28
46. Wissuwa M, Ismail AM, Graha RD (2008) Rice grain zinc con-centrations as affected by genotypes, native soil-Zn availability and zinc fertilization. Plant Soil 306:37–48