Soil Fertility Status of NITI Aayog Aspirational Block Wadagera, Yadagiri District Karnataka, India

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Abstract

A critical perusal of the available literatures as revealed that there is no scientific documentation on the properties of the soils of Wadagera Taluka Yadgir district. In the present paper an attempt has been made to study the status of major and micronutrients in soils of Wadagera taluka Yadagiri district of Karnataka, India during the year 2024-25. Total 1295 soil samples were collected at 0-15 cm depth to assess the soil parameters (pH, EC, OC, available N, P, K, S, Zn, Cu, Fe, Mn and B). The results of the study indicated that, Soil reaction varied from acidic to Alkaline in nature. The distribution of soil organic carbon (47%), available phosphorous (80%) and potassium (92%) status was found to be medium in all five villages. The available Nitrogen status was found to be low (84%) in all villages. The available Sulphur, Zinc, Iron, Copper, Boron and Manganese status was found to be sufficient in majority of villages. Therefore, the study showed that, the soils of the Wadagera taluka were medium in fertility status. There is need of proper fertilizer recommendation and soil management practices can be made to increase soil fertility thereby, increasing the crop yield.

Key Words: Soil Fertility, Samples, Wadagera Taluka, Bhoosara

1. Introduction:

The major constraints for poor productivity in rainfed agriculture are poor soil fertility, erratic and low rainfall (Ncube et al., 2009). To achieve potential yields in rainfed soils, require appropriate nutrient management strategies for multi nutrient deficient soil (Sahrawat et al., 2008). The attention has to be paid to diagnose and take corrective measures for deficiencies of major and micro nutrients in various crop production systems (Rego et al., 2005; Sahrawat et al., 2007; Manna et al., 2012). In India several studies have assessed the soil fertility status of soils for recommending optimum soil management practices, crops and cropping systems to ensure sustainable yields in the rainfed regions (Prabhavathi et al. (2013). Hence, it is necessary to know the fertility (macro and micro nutrients) status of the soils for assessing the kind and amount of fertilizers required for each of the crop intended to be grown (Mahendra Kumar et al., 2015). Balanced use of organics, fertilizers and biofertilizers plays an important role to maintain soil fertility in long run (Singh et al., 2014). Soil testing is usually followed by collecting composite soil samples in the fields without geographic reference (Hegde et al., 2020). The results of such soil testing are not useful for site specific recommendations and subsequent monitoring (Pujari et al., 2016). Soil available nutrients constraint of an area using Global Positioning System (GPS) will help in formulating site specific balanced fertilizer recommendation and to understand the status of soil fertility spatially and temporally (Hegde et al., 2020). In India, low fertility of soils is the major constraint to achieving high productivity goals. Therefore, it is important to investigate the soil fertility status and it may provide valuable information relating crop research. Considering these facts, the study was initiated with the objective to assess the soil fertility status of Wadagera taluk of Yadagiri district of Karnataka, India.

2. Materials and Methods:

Description of Study Area: Wadagera taluka is situated in the northern part of Karnataka between 16.35 °N and 77.05°E. With an area of 704 square kilometer. Wadagera taluka was newly created in 2017 out of the Southern portion of Shahapur taluka. 23 km by road south of the city of Yadagir and 39 km southeast of the Shahapur town. The average population of taluka is 109752. The major soil types fall under the category of black cotton soils and red sandy loam. Annual rainfall is 617 mm. Cotton, Paddy, Jowar, Redgram and Groundnuts are the major crops in the taluka.

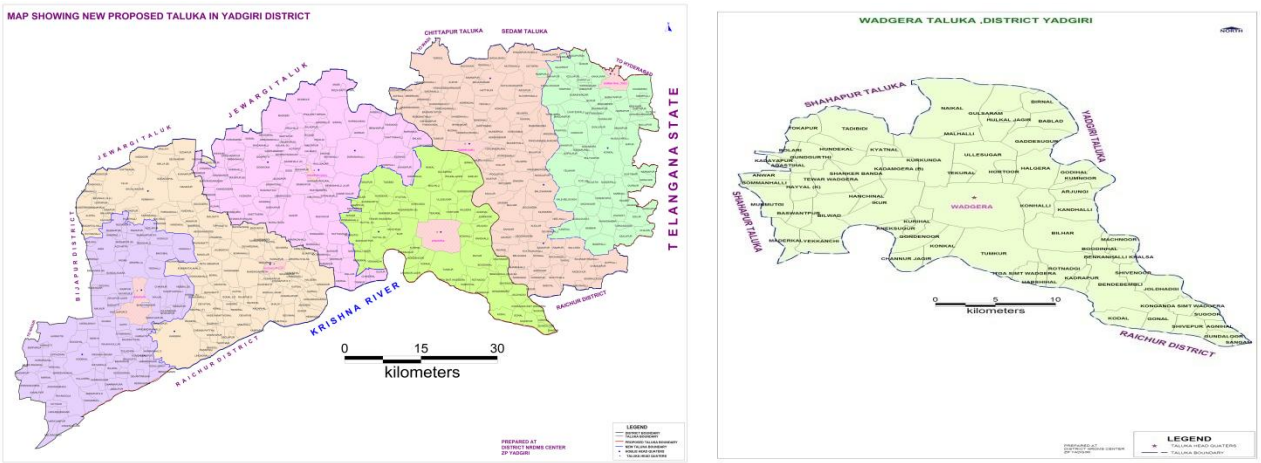


Figure. 1 Study Area location in maps.

Sample Collection Methods and Procedures:

For the purpose of studying fertility status of the soils of Wadagera taluka, 1295 locations have been identified based on different land uses. From these identified plots 500 grams of soil samples were collected as per the standard process through Bhoosaara Mobile app developed by KSRSAC (Karnataka State Remote Sensing Applications Centre), further the soil samples were analyzed at NABL Recognized Soil Health Centre, Yadagir lab for 12 parameters such as pH, Electric conductivity (EC), Organic carbon (OC), Nitrogen (N), Phosphorus (P), Potassium (K), Sulphur (S), Iron (Fe), Zinc (Zn), Copper (Cu), Manganese (Mn), and Boron (B) have been studied and the following procedure has been adopted for the analysis of each parameters.

Table.1 Details of Soil Samples Collected for Study

Sl.No	Names of Villages	No. of Soil Samples Collected Farmers Categories				
		General	Schedule Caste	Schedule Tribes	OBCs	Total
1	Wadagera	240	171	103	102	616
2	Hayyal (B)	255	98	28	165	546
3	Hayyal (K)	2	17	7	2	28
4	Bommanhalli	21	19	15	36	91
5	Ullesugar	4	7	2	1	14
	Total	**522**	**312**	**155**	**306**	**1295**

Soil pH and electrical conductivity was determined at 1:2.5 soil water suspensions by potentiometric and conductometry method (Jackson, 1973). Organic carbon was measured by wet digestion method (Walkley and Black, 1934). Available phosphorus was extracted by using Olsen's extractant (0.5 M $NaHCO_3$) for neutral and alkaline soils and Bray's extractant for acid soils was determined by spectrophotometer (Jackson, 1973). The available potassium was estimated by extracting the soil with 1 N NH_4OAC (pH 7.0) by using

flame photometer. Available sulphur was extracted from soil using 0.15% CaCl2 solution and determined by turbidometrically (Black, 1965). The micronutrients like Zn, Cu, Fe and Mn in the soil were extracted with DTPA extractant by using Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978). Available boron in soil was extracted with hot water (HWS-B) and determined calorimetrically using Azomethine-H reagent (Gupta, 1979).

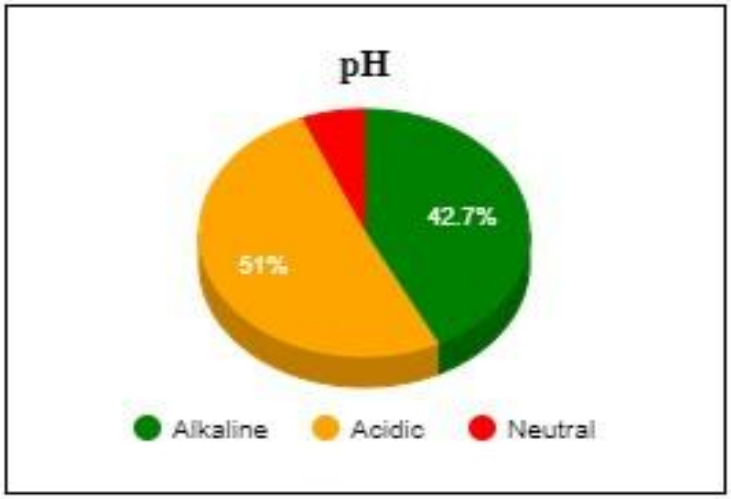
3. Result and Discussion:

pH: Soil could be either acidic or alkaline. Sometime it could be neutral also. In the present investigation pH of the soil sample varied from Acidic to Alkaline out of 1295 soil samples studied, 661 (57%) of the soil pH varied between 7&8 indicating that they are highly alkaline. 553 (39.19%) are neutral in nature and 81 (4.12%) samples are slightly acidic in nature. The variations in soil pH were due to the parent material, rainfall and topography (Thangasamy et al., 2005).

Table. 2 Status of Soil pH in Study area of Wadagera Taluka

Sl. No	Village	pH - Acidic		pH - Neutral		pH - Alkaline	
		No. of Samples	%	No. of Samples	%	No. of Samples	%
1	Wadgera	57	9.25	349	56.66	210	34.09
2	Hayyal (B)	23	4.21	168	30.77	355	65.02
3	Hayyal (K)	0	0	1	3.57	27	96.43
4	Bommanhalli	0	0	24	26.37	67	73.63
5	Ullesugar	1	7.14	11	78.57	2	14.29
	Total	**81**	**4.12**	**553**	**39.19**	**661**	**56.69**

Figure.2 Status of Soil pH

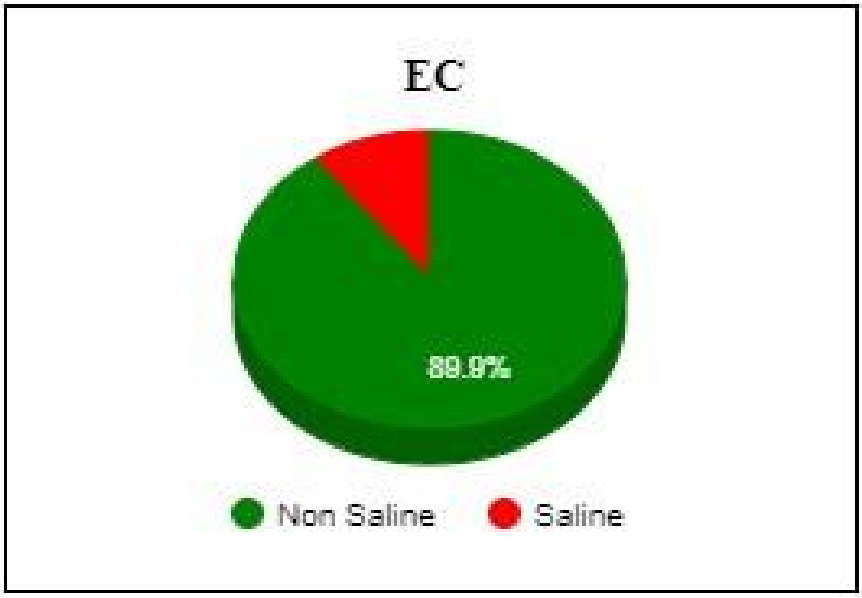


Electrical Conductivity: The concentration of ions present in the soil is directly related to the strength of electric current flowing through it. Higher the salt content, lower is the resistance offer by the solution for flow of current and higher in Electrical conductivity. Therefore, Electrical conductivity serves as the index of the salt content. In the present study Electrical conductivity of the 131(6.52%) soils samples are saline and 1164 (93.48%) soil sample are non Saline. as such the soils are non-saline in nature and could be attributed to excessive drainage of soils and consequently leaching of salts to downward layers resulting in low salt concentration.

Table. 3 Status of Electrical Conductivity in study area of Wadagera Taluka

Sl. No	Village	EC - Saline		EC - Non Saline	
		No. of Samples	%	No. of Samples	%
1	Wadgera	26	4.22	590	95.78
2	Hayyal (B)	95	17.40	451	82.60
3	Hayyal (K)	0	0.00	28	100
4	Bommanhalli	10	10.99	81	89.01
5	Ullesugar	0	0.00	14	100
	Total	**131**	**6.52**	**1164**	**93.48**

Figure.3 Status of Electrical Conductivity

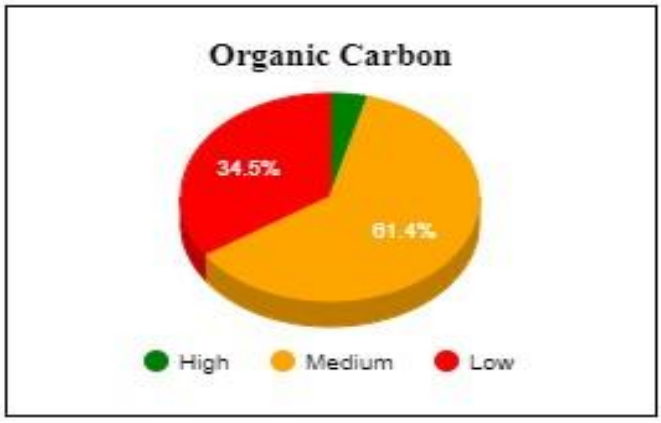


Organic Carbon: Soil Organic Carbon serves as a reservoir of plant nutrient in promoting water storage and regulations of microbial activity. Generally sandy soil samples showed very low content of Organic Carbon as compared to black soils, where commonly cotton is grown. The soil organic carbon content (an index of available nitrogen) in the soils of the study area was medium in a maximum samples 795 (47%), high in 53 (14.36%) samples and low in 447 (38.62%) samples. The medium to high organic carbon status of soils could be attributed to regular addition of organics in the form of FYM and compost.

Table. 4 Status of Organic Carbon in study area of Wadagera Taluka

Sl.No	Village	OC - High		OC - Medium		OC - Low	
		No. of Samples	%	No. of Samples	%	No. of Samples	%
1	Wadgera	30	4.87	462	75	124	20.13
2	Hayyal (B)	10	1.83	262	47.99	274	50.18
3	Hayyal (K)	1	3.57	4	14.29	23	82.14
4	Bommanhalli	4	4.40	63	69.23	24	26.37
5	Ullesugar	8	57.14	4	28.57	2	14.29
	Total	**53**	**14.36**	**795**	**47.01**	**447**	**38.62**

Figure.4 Status of Organic Carbon

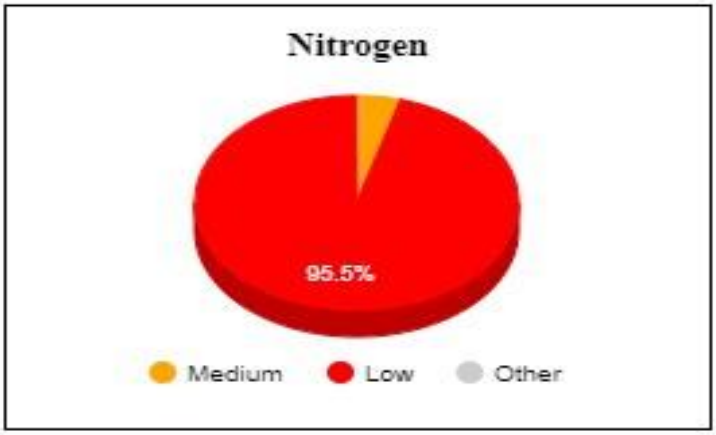


Nitrogen: Nitrogen is a major component of proteins, hormones, chlorophyll, vitamins and enzymes essential for plant life, as well as genetic material (nucleic acids). It plays a significant role in the soil fertility and also the crop yield. Naturally it is added to the soil through nitrogen fixation by microorganisms or it may be added into the soil as chemical fertilizer. In present study found the concentration of nitrogen in the soil samples is very low in 1237 (83.89%) soil sample collected and medium in 57 (16.%) in the soil samples.

Table.5 Status of Nitrogen in study area of Wadagera Taluka

Sl. No	Village	Nitrogen - High		Nitrogen - Medium		Nitrogen - Low	
		No. of Samples	%	No. of Samples	%	No. of Samples	%
1	Wadgera	1	0.16	32	5.19	583	94.64
2	Hayyal (B)	0	0.0	10	1.83	536	98.17
3	Hayyal (K)	0	0.0	1	3.57	27	96.43
4	Bommanhalli	0	0.0	5	5.49	86	94.51
5	Ullesugar	0	0.0	9	64.29	5	35.71
	Total	**1**	**0.03**	**57**	**16.08**	**1237**	**83.89**

Figure.5 Status of Nitrogen

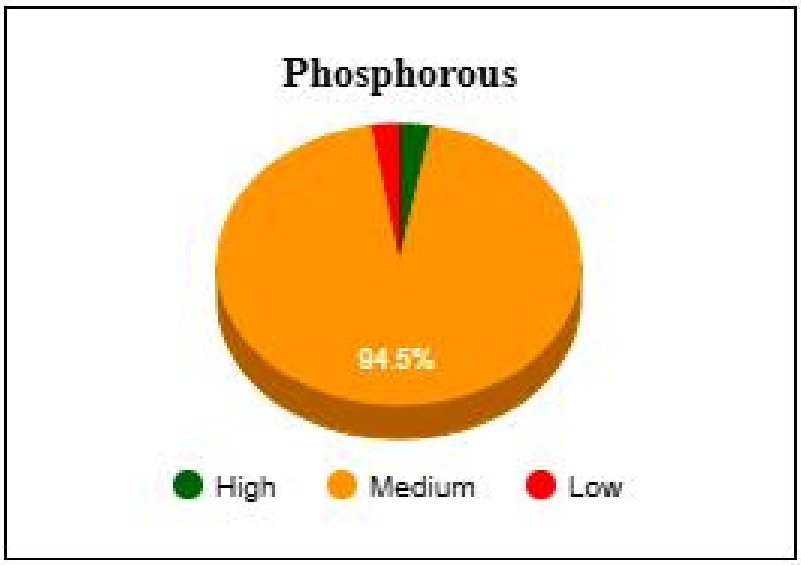


Phosphorous: Phosphorous is an essential nutrient and known to play a significant role in capturing and converting suns energy into useful plant compounds. It is one of 17 nutrients, essential for plant growth and plays a very significant role in protein synthesis. In the absence of phosphate, plants cannot complete their life cycle. The occurrence of phosphate in natural condition is generally very low. In the present study where phosphatic fertilizers are extensively used for better yield of crop found to contain little higher amounts of phosphates. However, it varied from a minimum of 19.5 Kg/hectare in the 33 (5.37%) soil samples collected and medium of 35.70 Kg/hectare in 1224 (80%) soil samples.

Table.6 Status of Available Phosphorous in study area of Wadagera Taluka

Sl. No	Village	Phosphorous - High		Phosphorous - Medium		Phosphorous - Low	
		No. of Samples	%	No. of Samples	%	No. of Samples	%
1	Wadgera	2	0.32	610	99.03	4	0.65
2	Hayyal (B)	6	1.10	514	94.14	26	4.76
3	Hayyal (K)	1	3.57	27	96.43	0	0.0
4	Bommanhalli	23	25.27	68	74.73	0	0.0
5	Ullesugar	6	42.86	5	35.71	3	21.43
	Total	**38**	**14.63**	**1224**	**80.01**	**33**	**5.37**

Figure 6. Status of Available Phosphorous



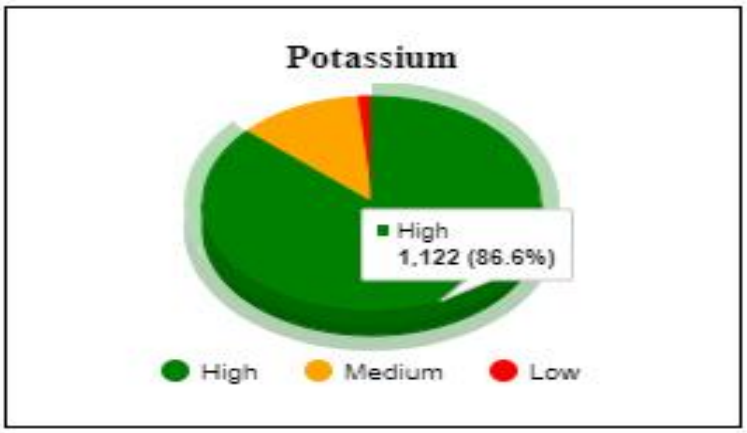
Potassium: Potassium is necessary for the formation of sugars and starch in the plant. It is involved in protein synthesis and cell division. Being a vital component of the cell wall, potassium enhances plant rigidity and hardiness.

Potassium is responsible for the opening and closing of stomata, hence necessary for adjustment of water balance in the plant. Available potassium content in soil was high in 1122 (92%) soil samples, medium in 154 (7%) soil samples and low in 19 (1.37%) of total samples analyzed.

Table. 7 Status of Available Potassium in study area of Wadagera Taluka

Sl.No	Village	Potassium - High		Potassium - Medium		Potassium - Low	
		No. of Samples	%	No. of Samples	%	No. of Samples	%
1	Wadgera	613	99.51	2	0.32	1	0.16
2	Hayyal (B)	384	70.33	145	26.56	17	3.11
3	Hayyal (K)	27	96.43	0	0.0	1	3.57
4	Bommanhalli	84	92.31	7	7.69	0	0.0
5	Ullesugar	14	100	0	0.0	0	0.0
	Total	**1122**	**91.72**	**154**	**6.91**	**19**	**1.37**

Figure 7. Status of Available Potassium



Micronutrients:

Micro nutrients are as important as major and secondary nutrients although the plants require them in lesser quantity. Nevertheless, lack of any one of the micronutrients in soil can limit the plant growth; even all other essential nutrients are presents in adequate quantity. In the present study, the following micronutrients are studied and their variations are documented.

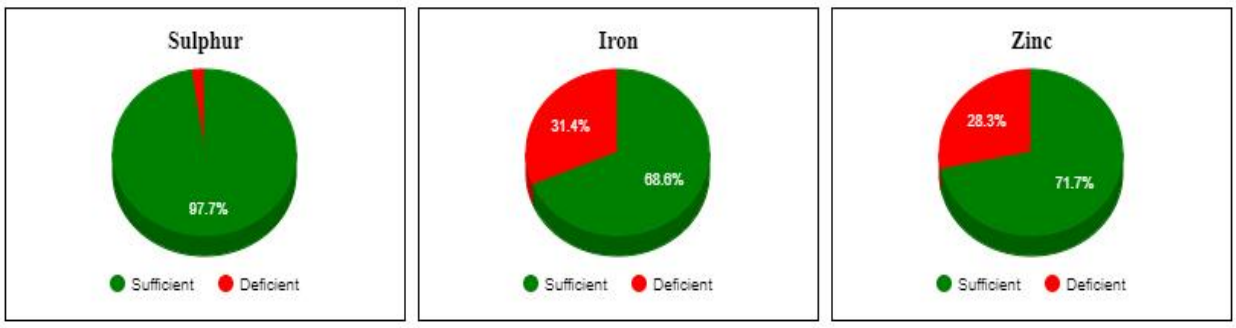
Sulphur: Sulphur is an essential micro nutrient required in very low concentration for plant metabolism activity as it catalyses more than 100 enzymes. In the present study Available sulphur is sufficient in 1265 (98.40%) soil samples and deficient in only 30 (1.60%) soil samples. Tawande et al. (1976) reported that sulphur content depends on the combined action of factors namely nature of parental material, rainfall, clay and organic matter content of soil.

Zine: Zinc is an essential micro nutrient required in very low concentration for plant metabolism activity as it catalyses more than 100 enzymes. Zinc deficiency results in many plant diseases. In the present study Available Zinc is sufficient in 928 (72%) soil samples and deficient in 367 (28.32%) soil samples.

Table. 8 Status of Available Sulphur and Zinc in study area of Wadagera Taluka

Sl. No	Village	S - Sufficient		S - Deficient		Zn - Sufficient		Zn - Deficient	
		No. of Samples	%	No. of Samples	%	No. of Samples	%	No. of Samples	%
1	Wadgera	605	98.21	11	1.79	481	78.08	135	21.92
2	Hayyal (B)	530	97.07	16	2.93	356	65.20	190	34.80
3	Hayyal (K)	28	100	0	0.0	27	96.43	1	3.57
4	Bommanhalli	88	96.70	3	3.30	56	61.54	35	38.46
5	Ullesugar	14	100	0	0.0	8	57.14	6	42.86
	Total	**1265**	**98.40**	**30**	**1.60**	**928**	**71.68**	**367**	**28.32**

Figure 8. Status of Available Sulphur, Iron and Zinc.



Iron: It is a very important micro nutrient that involves in the production of chlorophyll and it is also a component of many enzymes. In the present study Available iron content was sufficient in 888 (60%) samples and deficient in 407 (40%) soil samples collected for study. Prasad and Sakal (1991) were of the opinion that the sufficient amount of available iron might be due to the presence of organic matter indicating that organic matter influenced the solubility and availability of iron in the soil.

Copper: Copper is another important essential nutrient for plant growth and is required in very low quantity. In most of the soils, it is present in adequate amount that facilitates in getting optimum crop yields. Available copper content was sufficient in 1280 (99.51%) samples and deficient in Wadagera village only.

Table. 9 Status of Available Iron and Copper in study area of Wadagera Taluka.

Sl. No	Village	Iron - Sufficient		Iron - Deficient		Copper-Sufficient		Copper - Deficient	
		No. of Samples	%	No. of Samples	%	No. of Samples	%	No. of Samples	%
1	Wadgera	535	86.85	81	13.15	601	97.56	15	2.44
2	Hayyal (B)	311	56.96	235	43.04	546	100	0	0.0
3	Hayyal (K)	4	14.29	24	85.71	28	100	0	0.0
4	Bommanhalli	38	41.76	53	58.24	91	100	0	0.0
5	Ullesugar	0	0.0	14	100	14	100	0	0.0
	Total	**888**	**39.97**	**407**	**60.03**	**1280**	**99.51**	**15**	**0.49**

Boron: This micronutrient is important for cell wall formation, sugar transport, amino acids production, flowering, crop production, crop quality, fruiting and more. Available copper content was sufficient in 1221 (95%) soil samples and 74 (5%) samples were recorded low in available boron.

Manganese: It is an important micronutrient, as it is very much necessary for the photosynthesis and Nitrogen metabolism in plants. In the present study Available manganese content was sufficient in the 1273 (98%) samples and deficient in 22 (2.12%) samples. The sufficient amount of available manganese might be due to the presence of organic matter influenced the solubility and availability of manganese in the soil.

Table.10 Status of Available Boron and Manganese in study area of Wadagera Taluka

Sl. No	Village	Boron - Sufficient		Boron - Deficient		Manganese - Sufficient		Manganese - Deficient	
		No. of Samples	%	No. of Samples	%	No. of Samples	%	No. of Samples	%
1	Wadgera	557	90.42	59	9.58	598	97.08	18	2.92
2	Hayyal (B)	538	98.53	8	1.47	543	99.45	3	0.55
3	Hayyal (K)	28	100	0	0.0	28	100	0	0.0
4	Bommanhalli	85	93.41	6	6.59	91	100	0	0.0
5	Ullesugar	13	92.86	1	7.14	13	92.86	1	7.14
	Total	**1221**	**95.04**	**74**	**4.96**	**1273**	**97.88**	**22**	**2.12**

Figure 9. Status of Available Copper, Boron and Manganese

4. Summary &Conclusion:

Before any crop is grown in a particular land, knowledge of soil fertility is very important. A critical perusal of the available literature has revealed that no scientific investigation on the soil fertility status of Wadagera taluka is done. With this background, 1295 soil samples have been collected from different five villages and analyzed for certain soil parameters such as Soil pH, Electric conductivity (EC), Organic carbon (OC), Nitrogen (N), Phosphorus (P), Potassium (K), Sulphur (S), Iron (Fe), Zinc (Zn), Copper (Cu), Manganese (Mn), and Boron (B)

The results of the study indicated that, Soil reaction varied from acidic to Alkaline in nature. The distribution of soil organic carbon (47%), available phosphorous (80%) and potassium (92%) status was found to be medium in all five villages. The available Nitrogen status was found to be low (84%) in all villages. The available Sulphur, Zinc, Iron, Copper, Boron and Manganese status was found to be sufficient in majority of villages. Therefore, the study showed that, the soils of the Wadagera taluka were medium in fertility status. There is need of proper fertilizer recommendation and soil management practices can be made productive thereby, increasing the crop yield.

5. Acknowledgement

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