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R Himabindu
Department of Soil Science and Agricultural Chemistry, Professor Jayashankar Telangana State Agricultural University, College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

T Sukruth Kumar
Senior Scientist, Department of Soil Science and Agricultural Chemistry, AICRP on Forage crops and Utilization, ARI, Rajendranagar, Hyderabad, Telangana, India

T Anjaiah
Senior Scientist, Department of Soil Science and Agricultural Chemistry, AICRP on Micro Nutrients Institute of Soil Health Management, ARI, Rajendranagar, Hyderabad, Telangana, India

RVT Balazzii Naaiik
Principal Scientist, Department of Agronomy, AICRP on Forage crops and Utilization ARI, Rajendranagar, Hyderabad, Telangana, India

T Shashikala
Principal Scientist, Department of Genetics and Plant Breeding, AICRP on Forage crops and Utilisation, ARI, Rajendranagar, Hyderabad, Telangana, India

Corresponding Author:
R Himabindu
Department of Soil Science and Agricultural Chemistry, Professor Jayashankar Telangana State Agricultural University, College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

Soil fertility status of forage growing soils of Yadadri Bhuvanagiri district, Telangana

R Himabindu, T Sukruth Kumar, T Anjaiah, RVT Balazzii Naaiik and T Shashikala

Abstract
Livestock is an important asset and livelihood option for poor people in rain fed areas. Fodder crops are the plant species that are cultivated and harvested for feeding the animals in the form of forage, silage and hay. A survey was carried out in forage growing soils of Yadadri Bhuvanagiri district of Telangana state. Seventy five representative surface soil samples (0-15 cm) were collected and analysed for their salient characteristics *viz*., pH, EC, OC, free $CaCO_3$, available N, P_2O_5, K_2O and micronutrients (Zn, Fe, Cu and Mn). Soil fertility maps were prepared for macronutrients. Results revealed that, soil pH ranged from 6.14 to 8.55. The soils were non-saline (0.06 to 1.14 dS m^{-1}). The organic carbon ranged from 1.88 to 11.24 g kg^{-1}. Free Calcium Carbonate content ranged from 1.23 to 20.64 percent. With regard to available nutrients, the values varied from 100.3 to 260.8 kg N ha^{-1} for nitrogen, 8.6 to 88.5 kg P_2O_5 ha^{-1} for phosphorus, 86.9 to 394.5 kg K_2O ha^{-1} for potassium. Among the micronutrients 9.4, 10.6 soils Samples were deficient in available zinc and iron. Further, the soils were not deficient in Cu and Mn content.

Keywords: N, P_2O_5, K_2O, Zn, Fe, Cu and Mn

Introduction
In India, the total area under cultivated fodders is 8.3 million ha on individual crop basis. Sorghum amongst the *kharif* crops (2.6 million ha) and Berseem (*Egyptian clover*) amongst the *rabi* crops (1.9 million ha) occupy about 54% of the total cultivated fodder cropped area. Lucerne (*Alfa alfa)* occupies the highest productivity (60-130 tonnes ha^{-1}).
In Telangana, total area under fodder crops cultivation is 4,58,893 acres during the year 2020-21(GOI, 2021) Telangana state has very rich livestock resources. The total livestock population of the State is 264.5 lakhs, in which 48.8 lakh buffaloes, 128.3 lakh sheeps and 45.7 lakh goats. As per the 20th livestock census (2017) which is 4.6% over the year 2012.
Generally fodder crops grown in marginal to medium fertile soils. It effects the quality and productivity of the fodder. Quality of fodder (Protein and Fiber content) depends on the fertility of soils. Fertile soils produce high quality fodder. Feeding the quality green fodder to dairy animals yields high milk and meat production.
In Telangana approximate 20% of the state area is under fodder crops (92,230 acres) observed in erstwhile Nalgonda district with high livestock population (GOI, 2021). So it is highly essential to study the fertility status of the fodder growing soils of Bhuvanagiri district. This paper deals with nutrient status (Physico-chemical and chemical properties) of forage growing soils of Bhuvanagiri district.

Materials and Methods
Study Area and Sample Collection
The soil survey was carried out representing the forage growing soils of the Bhuvanagiri district (Fig. 1). A total of Seventy five soil samples (0-15 cm depth) were collected.
The soil samples were collected using GPS (Global Positioning System) and the longitude and latitude points of a particular location were recorded. The soil fertility maps for N, P_2O_5 and K_2O were prepared with the help of QGIS.3.22.9 software using GPS points. The soil samples were packed and labelled properly in polythene bags and brought to the laboratory for further analysis.

Laboratory Analysis: All the soil samples were air dried, grounded and passed through 2 mm sieve for chemical analysis.

The soils were analysed for salient characteristics *viz*., pH, EC, OC and free CaCO3 & available nutrients (N, P_2O_5, K_2O, Zn, Fe, Cu and Mn) following standard procedures. After analysis for available nutrient status, the soils were categorised as low, medium and high for N, P_2O_5 and K_2O. The available sulphur and micronutrients (Zn, Fe, Cu and Mn) were rated as deficient and sufficient based on the critical levels as given by Tandon (2005) [14].

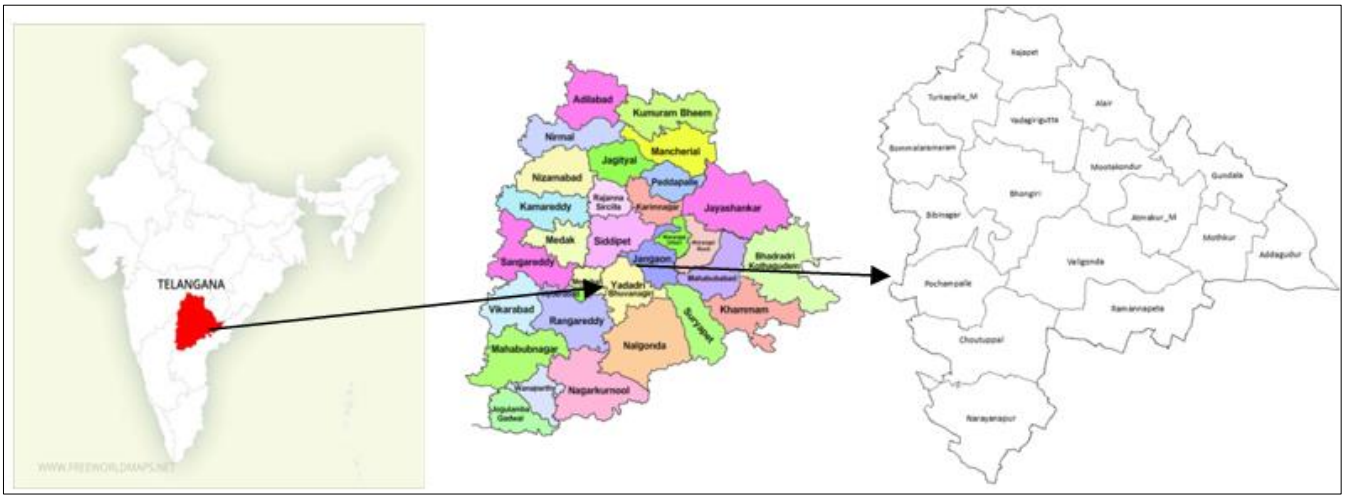

Fig 1: Location of the Study Area

Results and Discussion

Physico-chemical Characteristics

Soil reaction (pH) of the surface soils ranged from 6.14 to 8.55 indicating that, these soils are slightly acidic to alkaline in reaction. The observations on the soil pH revealed that, 6.6 per cent of soils were slightly acidic (<6.5) in nature, 33.4 per cent samples are neutral (6.5-7.5) and 60 per cent samples are alkaline (>7.5) in nature.

Electrical conductivity (EC) of surface soils ranged from 0.06 to 1.14 dS m^{-1} indicating that, these soils were non-saline to slightly saline in nature. The observations on EC revealed that, 93.4% of samples were non-saline, 6.6% of samples were slightly saline in nature.

With regard to the status of organic carbon (g kg^{-1}) the values found to vary from 1.88 to 11.24 g kg^{-1}. The observations on organic carbon revealed that, 49.4 per cent of soil samples were low (<5.0 g kg^{-1}), 37.33% of soils were medium (5.0-7.0 g kg^{-1}) and 13.33% (>7.0 g kg^{-1}) of soils were high in organic carbon. The reason for low organic carbon content in most of the soils may be attributed to the prevalence of semi-arid condition, where the degradation of organic matter occurs at a faster rate coupled with little or no addition of organic manures and low vegetation cover on the fields, there by leaving less chances of accumulation of organic carbon in the soils. Intensive cropping is also one of the reasons for low organic carbon content in soils. The similar results were also reported by Nalina *et al*. (2016) [5].

Free Calcium Carbonate content (%) the values found to vary from 1.23 to 20.64 per cent. About 58.6 per cent samples are calcareous in nature. The calcareous nature of soils may be due to semi-arid conditions because of relatively little leaching. Similar results were reported by Brady and Weil (1999) [1].

Available Nutrients

The available nitrogen content of the soils ranged from 100.3 to 260.8 kg ha^{-1} (Table 1 and depicted in Fig. 2). Out of the 100 samples analysed, all the soil samples found to have low (<280.0 kg N ha^{-1}) available nitrogen. From the survey data, previous history of the crops grown was taken which indicated that cotton is one of the major commercial crops grown in erstwhile Nalgonda district. As cotton is a heavy nitrogen feeder which may leads to nitrogen deficiency. Another reason may be due to high temperature and low organic matter content which fasten decomposition process as a result removal of organic matter can be observed which leads to N deficiency (Karthikeyan *et al*., 2014) [3].

The available phosphorus content of the soils varied extremely from one point to another point. The variation exists in between 22.9 to 228.2 kg P_2O_5 ha^{-1} (Table 1 and depicted in Fig. 3). The soils found to have low to very high available phosphorus. Among the soils analysed, 49.4, 29.3 and 21.3 per cent of soils registered low (<22.9 kg P_2O_5 ha^{-1}), medium (22.9 to 56.3 kg P_2O_5 ha^{-1}) and high available phosphorous (>56.3 kg P_2O_5 ha^{-1}), respectively. This may be due to continuous application of DAP to crops without soil testing might have resulted in phosphorus build up and led medium to high available phosphorus status in these soils (Sathish *et al*., 2018) [11]. Another reason for higher P in surface soils possibly might be due to P confinement to the rhizosphere due to its immobile nature in soils (Rajeshwar and Mani, 2014) [10].

The available potassium content of the soils varied from 86.9 to 394.5 kg K_2O ha^{-1} (Table 1 and depicted in Fig. 4). In analysed samples, about 12% samples recorded lower (<129.6 kg K_2O ha^{-1}), 37.4% samples recorded medium (129.6-336.0 kg K_2O ha^{-1}) and 50.6% of soils recorded high (>336.0 kg K_2O ha^{-1}) available potassium content. These soils may able to maintain a sufficient or even high level of exchangeable K and provide a good supply of K to plants for many years. High available K status in surface soils could be attributed to release of labile-K from organic residues, application of K fertilizers and upward translocation of K from lower depths along with capillary rise of ground water. Similar results were reported by Pal and Mukhopadyay (1992) [7].

Table 1: Available nutrient status in forage growing soils of Yadadri Bhuvanagiri District

S. No.	Village	Mandal	N Kg ha^{-1}	P_2O_5 Kg ha^{-1}	K_2O Kg ha^{-1}
B 1	Singaram (P)Veldevi	Addaguduru	183.2	15.5	235.6
B 2	Repaka (Dacharam)	Addaguduru	155.6	20.2	213.5
B 3	Kanchanapally	Addaguduru	181.4	18.4	196.8
B 4	Dharmaram	Addaguduru	180.0	10.6	286.9
B 5	Chirragoodur	Addaguduru	145.8	14.4	206.3
B 6	Kolluru	Alair	151.2	68.2	344.6
B 7	Tangutoor	Alair	168.9	62.0	338.2
B 8	Alair	Alair	171.5	75.4	348.5
B 9	Kolanpaka	Alair	160.2	82.6	369.5
B 10	Koratikal	Atmakur (M)	151.5	52.8	320.6
B 11	Parupally	Atmakur (M)	182.7	46.8	310.5
B 12	Kurella	Atmakur (M)	179.8	32.2	216.2
B 13	Raghavapuram	Atmakur (M)	260.8	30.8	208.6
B 14	Lingarajpally	Atmakur (M)	165.2	38.0	220.4
B 15	Penchikalapahad	Bhongir	101.8	18.6	198.6
B 16	Nagireddipalli	Bhongir	251.5	20.4	236.8
B 17	Bolepalle	Bhongir	161.4	21.2	212.6
B 18	Anajipuram	Bhongir	172.4	15.6	298.5
B 19	Gouse Nagar	Bhongir	200.2	8.6	218.6
B 20	Bhattugudem	Bibinagar	148.9	15.0	86.9
B 21	Gudur	Bibinagar	156.2	18.2	114.8
B 22	Venkiryala	Bibinagar	182.8	20.8	95.8
B 23	Rudraveli	Bibinagar	162.2	16.0	108.2
B 24	Jameelapet	Bibinagar	152.8	10.2	122.6
B 25	Bommalaramaram	Bommalaramaram	160.2	23.8	360.8
B 26	Hazipur	Bommalaramaram	183.4	26.0	364.5
B 27	Boinapalli	Bommalaramaram	217.9	48.8	385.4
B 28	Maliyala	Bommalaramaram	102.2	52.2	394.5
B 29	Chinnakondur	Choutuppal	195.5	35.6	216.1
B 30	Panthangi	Choutuppal	207.8	30.4	232.8
B 31	Ankireddigudem	Choutuppal	150.2	38.2	194.9
B 32	Kutlagudem	Choutuppal	212.5	26.4	268.4
B 33	Choutuppal	Choutuppal	160.4	44.4	362.4
B 34	Lakkaram	Choutuppal	204.0	18.6	385.4
B 35	Choutuppal	Choutuppal	165.2	20.4	364.8
B 36	Motakonduru	Motakonduru	165.0	20.0	364.5
B 37	Ikkurthi	Motakonduru	148.2	35.4	355.4
B 38	Matoor	Motakonduru	182.1	46.6	384.2
B 39	Chandepally	Motakonduru	120.5	50.8	365.4
B 40	Dursaganipally	Motakonduru	210.0	42.5	376.2
B 41	Bogaram	Ramannapet	222.8	12.8	355.6
B 42	Vellanki	Ramannapet	191.5	18.0	348.5
B 43	Dhubbak	Ramannapet	199.4	14.3	344.8
B 44	Palliwada	Ramannapet	154.8	13.6	367.5
B 45	Manipamula	Ramannapet	180.7	16.5	372.8
B 46	Thurkapally	Thurkapally	202.5	32.6	362.4
B 47	Malkapuram	Thurkapally	151.1	50.4	382.5
B 48	Mulkalapally	Thurkapally	166.9	24.5	346.8
B 49	Dathaipally	Thurkapally	132.5	28.6	365.8
B 50	Valigonda	Valigonda	120.2	18.8	185.6
B 51	Proddutur	Valigonda	181.5	12.6	157.8
B 52	Arruru	Valigonda	150.8	10.4	232.8
B 53	Vemulakonda	Valigonda	161.2	14.6	276.2
B 54	Lothakunta	Valigonda	197.9	20.4	222.6
B 55	Dathurpally	Yadagirigutta	184.2	88.5	110.4
B 56	Saidapur	Yadagirigutta	162.5	75.0	108.8
B 57	Jangampally	Yadagirigutta	205.5	63.4	100.8
B 58	Peddakondur	Yadagirigutta	160.2	56.8	122.5
B 59	Rajannagudem	Mothkur	186.5	18.6	268.8
B 60	Dharmapuam	Mothkur	147.6	14.8	192.8
B 61	Katepally	Mothkur	174.5	18.5	228.6
B 62	Anajipur	Mothkur	165.4	20.5	266.6
B 63	Mothkur	Mothkur	168.0	12.6	352.0
B 64	Puttapaka	Narayanpur	175.9	13.5	341.6

B 65	Janagam	Narayanpur	100.3	18.6	358.2
B 66	Kothaguda	Narayanpur	182.3	14.0	364.0
B 67	Gujja	Narayanpur	162.5	19.8	374.2
B 68	Muthapur	Pochampally	152.5	70.6	346.2
B 69	Revanpalle	Pochampally	140.7	68.8	340.0
B 70	Julur	Pochampally	156.4	62.4	354.8
B 71	Bheemanpally	Pochampally	148.1	81.5	369.2
B 72	Rajapet	Rajapeta	187.8	58.0	364.8
B 73	Bodugula	Rajapeta	198.2	66.2	367.5
B 74	Jala	Rajapeta	162.7	60.4	346.8
B 75	Singaram	Rajapeta	156.3	76.0	346.2
		Mean	170.7	34.1	283.1
		Minimum	100.3	8.6	86.9
		Maximum	260.8	88.5	394.5
		SD	29.2	22.1	92.4

Table 2: DTPA-extractable micronutrients (Zn, Fe, Cu & Mn)

S. No.	Zn (mg kg^{-1})	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Mn (mg kg^{-1})
B 1	4.8	10.4	2.8	12.2
B 2	0.6	5.5	0.5	2.4
B 3	3.7	6.4	1.9	11.2
B 4	4.9	11.3	2.5	5.8
B 5	3.8	8.1	1.6	13.4
B 6	0.4	3.2	0.3	2.6
B 7	0.9	0.6	0.2	1.6
B 8	3.9	6.2	1.7	16.3
B 9	4.7	13.3	2.6	5.8
B 10	4.3	6.9	2.2	3.2
B 11	5.6	18.2	2.5	4
B 12	4.3	10	2	15
B 13	3.8	8.2	1.6	3.3
B 14	3.3	6.9	1.8	6.2
B 15	3.4	6	0.8	8.4
B 16	5.9	8.3	3.2	4.6
B 17	4.2	7.1	2	13.3
B 18	4.4	5.2	2.6	17.8
B 19	3	3.2	0.6	2.3
B 20	5.1	8.2	2.8	6.4
B 21	4.3	6.3	2	13.3
B 22	3.9	5.3	1.7	11.2
B 23	3.7	6.4	1.6	12.3
B 24	3.3	4	0.8	7.8
B 25	2.9	5.6	0.4	6.2
B 26	3.1	5.9	1	4.8
B 27	2.6	4.3	1.2	2.2
B 28	3.8	5.1	0.3	3.5
B 29	2.8	6.3	1.6	2.5
B 30	2.5	5.3	2.8	0.2
B 31	3.5	6.8	0.8	5.8
B 32	5	20	2.2	12
B 33	4.2	18.3	4.2	6.8
B 34	4.8	13.2	2.2	13.2
B 35	4.9	10.3	2.3	7.8
B 36	1.9	5.8	0.9	5.3
B 37	3.5	6	1.5	6.3
B 38	3.3	11.3	5.1	23.2
B 39	2.9	6.8	0.8	3.3
B 40	2.8	13.3	0.7	2.8
B 41	1.9	5.5	0.5	5.9
B 42	3.7	6.3	1.3	6
B 43	4	7.2	1.9	8.8
B 44	3.3	5.9	1.6	6.4
B 45	2.9	6.8	0.8	5.9
B 46	1.8	3.3	1.5	4.3
B 47	0.8	5	0.5	0.2
B 48	2.8	7.3	1.9	6.8

B 49	0.4	22.5	4.3	12.1
B 50	2.3	36	1.7	8.4
B 51	0.3	5.8	0.5	6.5
B 52	3.6	7.2	0.3	5.2
B 53	3.5	12.3	3.1	20.3
B 54	4.2	9.3	2.3	10.9
B 55	2.7	5.5	0.7	5.8
B 56	2.9	3.3	0.9	6
B 57	0.2	0.9	0.1	1.2
B 58	3.3	5.9	1.2	5.9
B 59	3.4	5.2	1.4	4.3
B 60	4.9	15	3.4	2.8
B 61	3.9	9.3	2.1	3.3
B 62	2.7	5.3	1.5	3.2
B 63	4.3	22	2.2	5.5
B 64	4.8	12.5	2	4.5
B 65	3.8	10.4	4.2	10.4
B 66	4.3	8.3	2.4	5
B 67	2	5.8	0.8	5.4
B 68	0.3	4.5	0.2	2.3
B 69	3.6	5.9	0.8	13.4
B 70	3.7	6	1.5	15
B 71	4.2	6	1.3	9.3
B 72	0.2	4.9	0.3	5
B 73	3.5	5.8	1.5	10
B 74	0.5	5.5	0.3	5
B 75	2.5	14.4	1.7	6.2
Mean	3.2	8.3	1.6	7.2
Minimum	0.2	0.6	0.1	0.2
Maximum	5.9	36	5.1	23.2
SD	1.4	5.5	1.1	4.7

Bhuvanagiri district samples are analysed for micronutrients shown variation in the content from Soil to Soil. Zinc content which is extracted by using DTPA solution varied from 0.2 mg kg^{-1} to 5.9 mg kg^{-1} (Table 2). About 9.4% samples are deficient in zinc content (<0.6 mg kg^{-1}) and 90.6% samples are sufficient in zinc content (>0.6 mg kg^{-1}).Soil samples analysed for iron content varied from 0.6 mg kg^{-1} to 36.0 mg kg^{-1} (Table 2). About 10.6% samples are deficient in iron content (<4.5 mg kg^{-1}) and 89.4% samples are sufficient in iron content (>4.5 mg kg^{-1}). Since, most of the soils are neutral to alkaline, low in organic carbon, there is a possibility of deficiency of Zn and Fe in these soils. Similar results were observed by Patil *et al*. (2016) [8].

Available copper and manganese deficiency is negligible (Table 2) in all the soils collected from forage growing areas of Bhuvanagiri district. Similar results were also reported by Surendra Babu *et al*. (2019) [13].

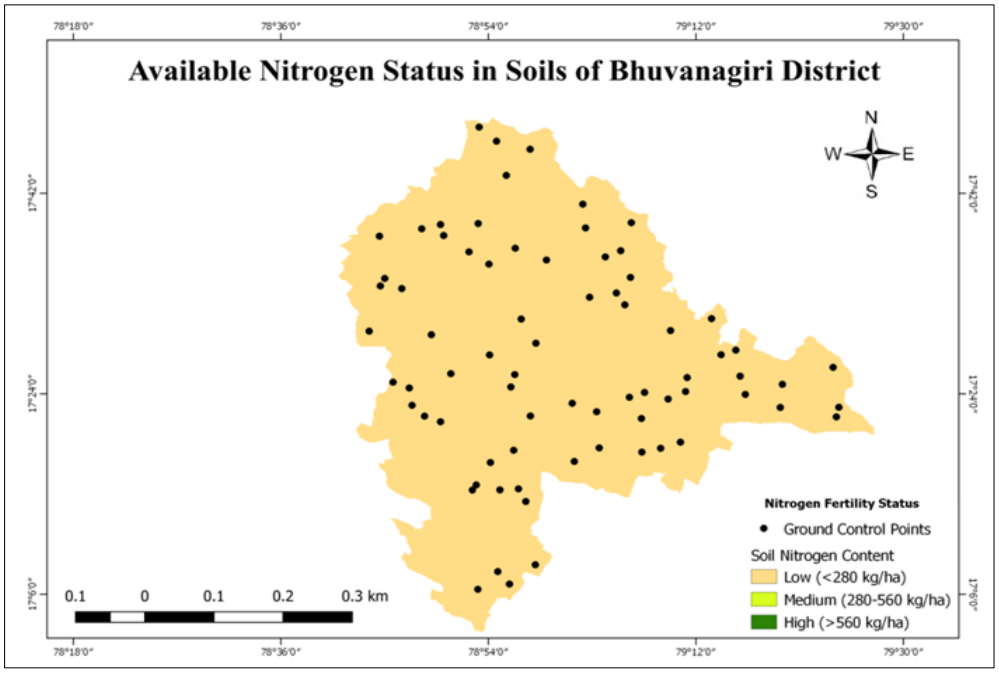

Fig 2: Available Nitrogen content in Forage grown soils of Yadadri Bhuvanagiri district

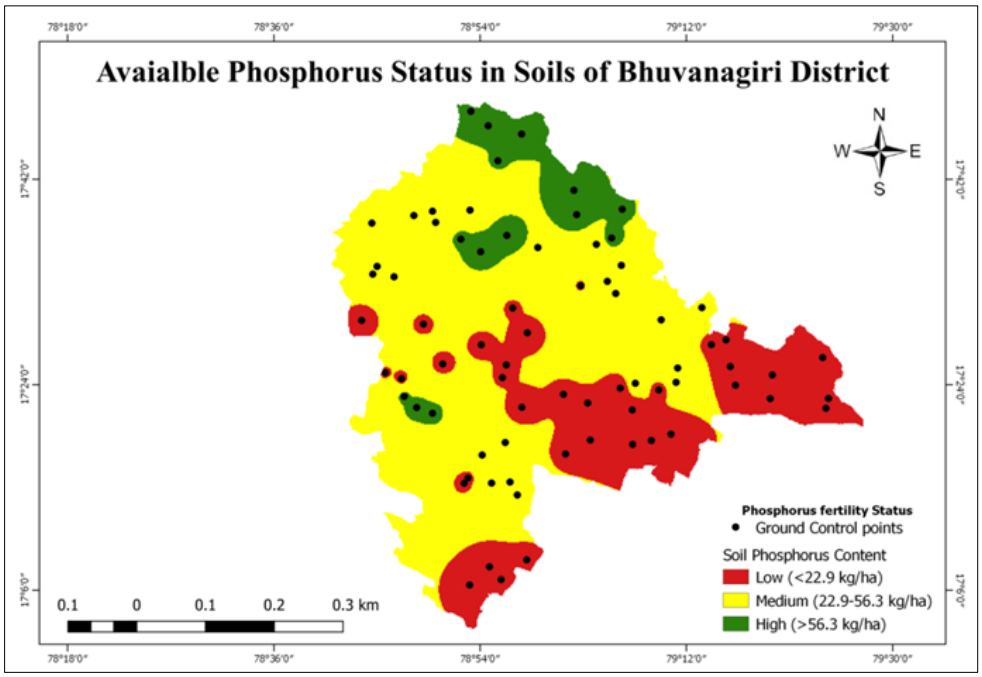

Fig 3: Available P_2O_5 content in forage grown soils of Yadadri Bhuvanagiri district

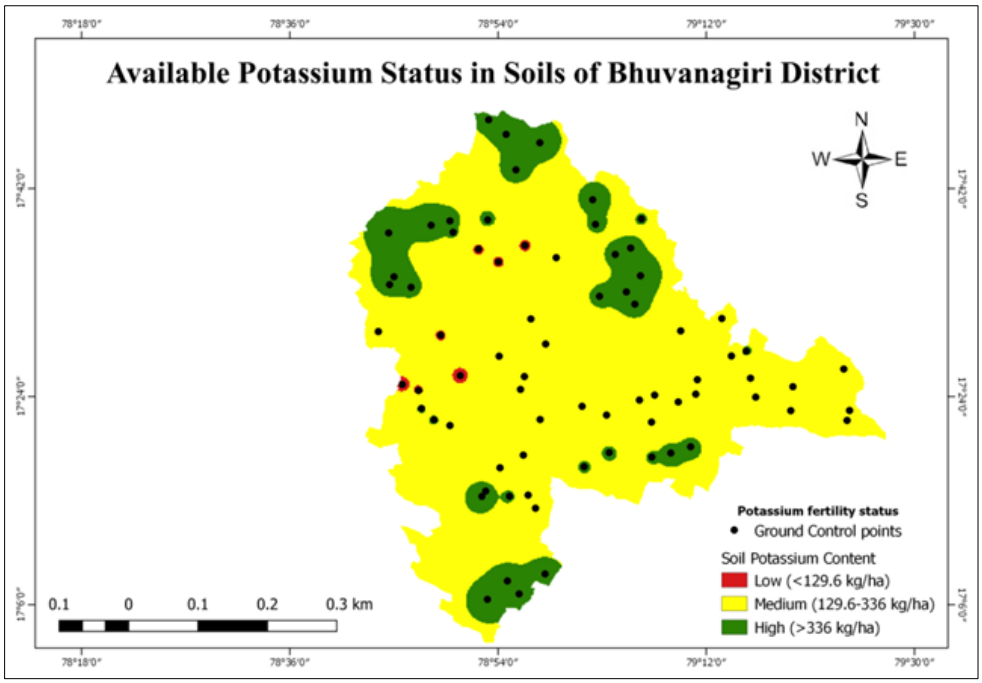

Fig 4: Available K_2O content in Forage grown soils of Yadadri Bhuvanagiri district

Conclusions

1. The soils of Yadadri Bhuvanagiri district were alkaline in reaction and very little are acidic. 49.4% soils are low in organic carbon and only in few pockets are high in ^{O}C (13.3%).
2. Electrical conductivity of soils in Yadadri Bhuvanagiri district ranged from 0.06-1.14 dSm^{-1} and the calcium content was high in these soils.
3. Nitrogen content in the soil found to be low in almost all the samples. The available N ranged from
4. 49.4% of samples collected in the district has shown high phosphorous content and 29.3% samples are medium in phosphorous in content. It shows 21.3% of soils in the district are medium to high in phosphorous level.
5. 88% samples in the district are medium to high in potassium content.
6. In Yadadri Bhuvanagiri district 9.4% samples are deficient in Zinc nutrient, while the other micro nutrient like cu and Mn are sufficient in soils and Fe is deficient in 10.6% soils.
7. Deficiency levels in micro nutrient content as follows Fe>Zn>Mn>Cu in Yadadri Bhuvanagiri district.

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