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Soil fertility status of forage growing soils of Suryapet district, Telangana

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Abstract
Livestock are 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 Suryapet 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 5.28 to 8.13. The soils were non-saline to slightly saline (0.05 to 1.04 dSm^{-1}). The organic carbon ranged from 0.22 to 2.20 per cent. Free Calcium Carbonate content ranged from 1.04 to 18.82 per cent. With regard to available nutrients, the values varied from 132.9 to 277.0 kg N ha^{-1} for nitrogen, 9.6 to 97.5 kg P_2O_5 ha^{-1} for phosphorus, 78.0 to 384.6 kg K_2O ha^{-1} for potassium. Among the micronutrients 17.33 and 9.33 percent soils were deficient in available zinc and iron respectively. Further, the soils were not deficient in Cu and Mn.

Keywords: Soil fertility, forage growing soils, livelihood

1. 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 highest productivity (60-130 tonnes ha^{-1}).
In India, the requirement of green fodder was 611.99 Mt against the availability of 224.08 Mt (Anonymous. 2006). 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 Suryapet district. This paper deals with nutrient status (Physico-chemical and chemical properties) of forage growing soils of Suryapet district.

2. Materials and Methods
2.1 Study Area and Sample Collection
The soil survey was carried out representing the forage growing soils of the Suryapet 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 Arc GIS v 10.2 software using GPS points. The soil samples were packed and labelled properly in polythene bags and brought to the laboratory for further analysis.

2.2 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 $CaCO_3$ & 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) [16].

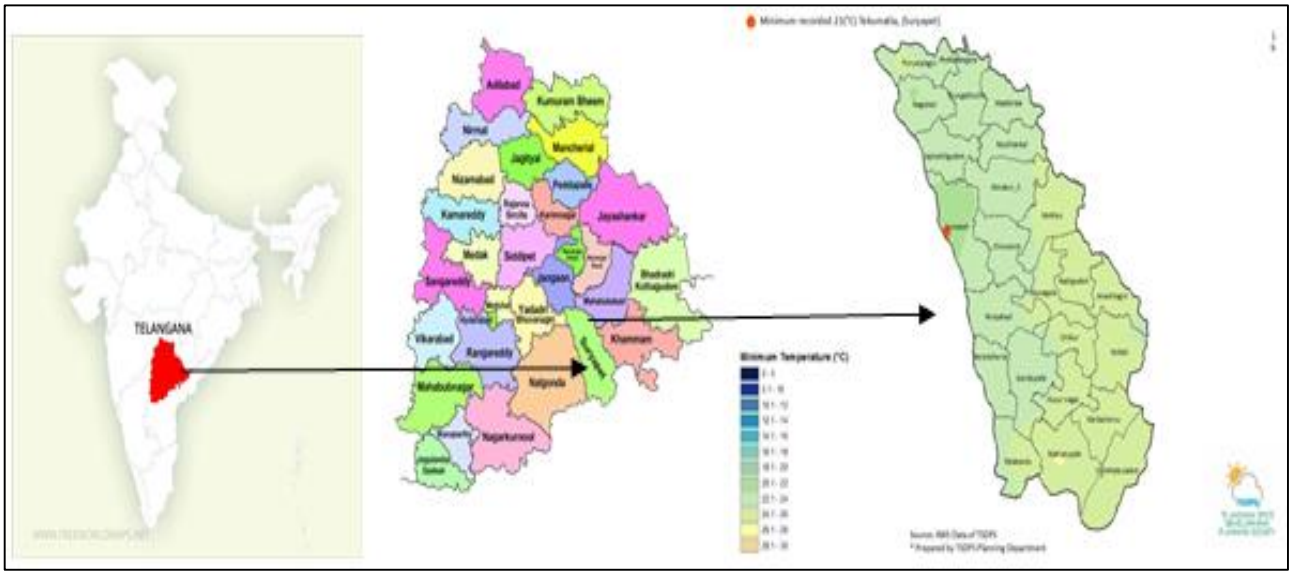

Fig 1: Location of the Study Area

3. Results and Discussion

3.1 Physico-chemical Characteristics

Soil reaction (pH) of the surface soils ranged from 5.28 to 8.13 indicating that, these soils are slightly acidic to alkaline in reaction. The observations on the soil pH revealed that, 4 percent of soils were slightly acidic (<6.5) in nature, 36 per cent samples are neutral (6.5-7.5) and 60 percent samples are alkaline (>7.5) in nature.

Electrical conductivity (EC) of surface soils ranged from 0.05 to 1.04 dS m^{-1} indicating that, these soils were normal in EC and is suitable for cultivation of crops. The observations on EC revealed that, 96% of samples were non-saline, 4% of samples were slightly saline in nature.

With regard to the status of organic carbon (%) the values found to vary from 0.22 to 2.20%. The observations on organic carbon revealed that, 70.6 per cent of soil samples were low (<0.5%), 20% of soils were medium (0.5-0.75%) and 9.4% (>0.75%) 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 1.04 to 18.8 per cent. About 52 per cent samples are calcareous in nature.

3.2 Available Nutrients

The available nitrogen content of the soils ranged from 132.9 to 277.0 kg ha^{-1} (Table 1 and depicted in Fig. 2). About 100 per cent samples are low in available nitrogen content (<280 kg N ha^{-1}).The reason may be due to high temperature which facilitates faster degradation and removal of organic matter which may leads to N deficiency (Karthikeyan *et al*., 2014.) [3]

The available phosphorus content of the soils of Suryapet district varied from one point to another point. The variation ranges from 9.6 to 97.5 kg P_2O_5 ha^{-1} (Table 1 and depicted in Fig. 3). The soils are found to have low to very high in available phosphorus content. Among the soils analysed, 13.3% soils registered low available phosphorous content (<22.9 kg P_2O_5 ha^{-1}), 45.3% samples registered medium available phosphorous content (22.6 to 56.3 kg P_2O_5 ha^{-1}) and 41.4% samples are high available phosphorous content (>56.3 kg P_2O_5 ha^{-1}). This may be due to continuous application of DAP fertilizer to crops without any soil testing leads to phosphorus build up and led medium to high available phosphorus content in the soils (Sathish *et al*., 2018) [12]. Another reason for higher P content in surface soils may be possibly due to P confinement to the rhizosphere and its immobile nature in soils (Rajeshwar and Mani, 2014) [10].

The available potassium content of the soils varied from 78.0 to 368.5 kg K_2O ha^{-1} (Table 1 and depicted in Fig. 4). In analysed samples, about 22.66% samples recorded lower (<129.6 kg K_2O ha^{-1}) potassium content, 33.4% samples recorded medium(129.6-336 kg K_2O ha^{-1}) potassium content and 44.0% of soils recorded high (>336 kg K_2O ha^{-1}) available potassium content. These soils may able to maintain sufficient or even high level of exchangeable K and provide a good supply of K to plants for many years. High available K content in surface soils could be attributed to release of labile-K from organic residues, application of K containing fertilizers and upward translocation of K from lower depths along with capillary ground water rise. Similar results were also reported by Pal and Mukhopadyay (1992) [7].

Suryapet district samples are analysed for micronutrients which shown variation in micronutrient content from Soil to Soil. Zinc content which extracted using DTPA-extractant solution varied from 0.1 mg kg^{-1} to 4.3 mg kg^{-1} (Table 2).

About 17.33% samples are deficient in zinc content (<0.6 mg kg^{-1}) and 82.66% samples are sufficient in zinc content (>0.6 mg kg^{-1}). Lower content of zinc was may be due to higher pH values which resulted in formation of insoluble zinc containing compounds (Tandon, 1995) [15]. Another reason for lower zinc content in soils may be due to higher calcium and phosphorous content in soil solution (Alloway., 2009) [1].

Soil samples which were analysed for Iron content varied from 1.0 mg kg^{-1} to 29.0 mg kg^{-1} (Table 2). About 9.33% samples are deficient in iron content (<4.5 mg kg^{-1}) and 9.066% samples were sufficient in iron content (>4.5 mg kg^{-1}). Since, most of the soils were neutral to alkaline in nature, low in organic carbon content, there may be possibility of deficiency of Fe and Zn content in these soils. Similar observations made by Patil *et al*. (2016) [8].

Manganese content in soil extracted by using DTPA-extractant solution ranged from 0.5 to 30.3 mg kg^{-1} (Table 2). All the samples collected are sufficient in manganese content. In general, free calcium carbonate content may decrease the availability of micronutrients results in formation of insoluble hydroxides at higher pH conditions (Sahoo *et al*., 1995) [11].

Available copper deficiency is negligible (Table 2) in all the soil samples collected from forage growing areas of Suryapet district. Similar results are also reported by Surendra Babu *et al*. (2019) [14].

Table 1: Available Nutrient Status in Forage growing Soils of Suryapet District

S. No	Village	Mandal	N Kg ha^{-1}	P_2O_5 Kg ha^{-1}	K_2 Kg ha^{-1}
S 1	Eklakshanpet	Nadigudem	202.5	15.5	344.2
S 2	Vallapuram	Nadigudem	132.9	20.2	365.2
S 3	Nadigudem	Nadigudem	268.4	18.4	342.5
S 4	Durajpalle	Chivvemla	200.7	10.6	350.8
S 5	Undrugonda	Chivvemla	145.2	14.4	364.2
S 6	Chivvemla	Chivvemla	164.0	68.2	346.8
S 7	Singireddypalem	Penpahad	148.2	62	338.0
S 8	Macharam	Penpahad	180.2	75.4	340.0
S 9	Dupahad	Penpahad	174.8	82.6	364.8
S 10	Kothagudem	Thungathurthi	213.6	52.8	220.8
S 11	Thungathurthi	Thungathurthi	145.2	46.8	198.6
S 12	Annaram	Thungathurthi	173.9	32.2	233.5
S 13	Mamidyala	Thirumalagiri	187.0	30.8	220.5
S 14	Thirumalagiri	Thirumalagiri	150.6	38	268.2
S 15	Gundepuri	Thirumalagiri	166.2	18.6	165.4
S 16	Thalagadda	Suryapet	151.0	20.4	112.8
S 17	Balemla	Suryapet	156.4	21.2	120.8
S 18	Imampet	Suryapet	189.2	15.6	108.8
S 19	Yerkaram	Suryapet	163.1	8.6	116.4
S 20	Kothapally	Nagaram	177.8	15	356.0
S 21	Panigiri	Nagaram	277.0	18.2	347.0
S 22	Mamidipally	Nagaram	241.0	20.8	365.9
S 23	Mukkudeudevipally	Atmakur (S)	157.7	16	341.2
S 24	Atmakur (S)	Atmakur (S)	142.2	10.2	182.6
S 25	Naseempet	Atmakur (S)	195.2	23.8	200.2
S 26	Aipur	Atmakur (S)	175.6	26	230.8
S 27	Nemmikal	Atmakur (S)	186.6	48.8	288.6
S 28	Enubamla	Atmakur (S)	200.7	52.2	190.8
S 29	Maddirala	Maddirala	168.2	35.6	368.5
S 30	Maddirala	Maddirala	176.0	30.4	350.4
S 31	Kukkadam	Maddirala	167.2	38.2	364.7
S 32	Nuthankal	Nuthankal	165.2	26.4	366.2
S 33	Miryala	Nuthankal	184.5	44.4	355.0
S 34	Yerrapahad	Nuthankal	150.0	18.6	376.0
S 35	Chilukuru	Chilukuru	133.0	20.4	95.6
S 36	Jerripothulagudem	Chilukuru	164.8	20	98.2
S 37	Bethavolu	Chilukuru	182.5	35.4	83.9
S 38	Chilukuru	Chilukuru	179.5	46.6	113.5
S 39	Arvapally	Jajireddigudem	160.2	50.8	356.0
S 40	Uyyalawada	Jajireddigudem	262.8	42.5	374.0
S 41	Velpucherla	Jajireddigudem	258.0	12.8	356.8
S 42	Kamalacheruvu	Garidepally	162.2	18	186.6
S 43	Garidepally	Garidepally	176.5	14.3	193.8

S 44	Ponugodu	Garidepally	180.2	13.6	255.6
S 45	Gaddipally	Garidepally	163.4	16.5	228.0
S 46	Ganugabanda	Garidepally	155.3	32.6	293.8
S 47	Akupamula	Munagala	180.2	50.4	339.0
S 48	Bharakhathgudem	Munagala	167.6	24.5	378.5
S 49	Taduvai	Munagala	162.5	28.6	342.8
S 50	Kodad	Kodad	179.2	18.8	123.8
S 51	Kuchipudi thanda	Kodad	192.5	12.6	114.6
S 52	Redlakunta	Kodad	159.2	10.4	78.0
S 53	Yerravaram	Kodad	184.2	14.6	94.0
S 54	Dirsincharla	Neredcherla	163.3	20.4	83.4
S 55	Kalluru	Neredcherla	180.2	88.5	115.0
S 56	Penchikaldinne	Neredcherla	213.2	75	120.8
S 57	Huzurnagar	Huzurnagar	166.5	63.4	285.0
S 58	Sitharamapuram	Huzurnagar	156.6	56.8	220.8
S 59	Gopalapuram	Huzurnagar	200.0	18.6	171.8
S 60	Burugadda	Huzurnagar	176.0	14.8	139.5
S 61	Palakeedu	Palakeedu	163.0	18.5	102.6
S 62	Sajiapuram	Palakeedu	168.5	20.5	118.0
S 63	Nagireddygudem	Palakeedu	235.2	12.6	156.8
S 64	Venkatrampuram	Ananthagiri	225.0	13.5	354.8
S 65	Yasanthapuram	Ananthagiri	192.1	18.6	344.0
S 66	Kistapuram	Ananthagiri	202.5	14	219.0
S 67	Mattampalle	Mattampalle	213.2	19.8	185.8
S 68	Chotapally	Mattampalle	182.6	70.6	208.6
S 69	Pedaveedu	Mattampalle	149.0	68.8	175.8
S 70	Revuru	Mellacheruvu	220.0	62.4	338.4
S 71	Ramapuram	Mellacheruvu	198.2	81.5	364.2
S 72	Kandibanda	Mellacheruvu	152.2	58	342.8
S 73	Dondapadu	Chinthalapalem	240.0	66.2	384.6
S 74	Nakkagudem	Chinthalapalem	156.0	60.4	364.9
S 75	Thammaram	Chinthalapalem	169.0	76	375.8
		Mean	165.4	34.1	251.8
		Minumum	48.9	8.6	78.0
		Maximum	260.8	88.5	384.6
		S D	37.4	22.0	104.7

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

S. No	Zn mg kg^{-1}	Fe mg kg^{-1}	Cu mg kg^{-1}	Mn mg kg^{-1}
S 1	1.2	4.8	0.6	6.8
S 2	0.7	5.7	1.8	3.2
S 3	0.4	6.3	0.3	2.1
S 4	2.7	7.2	1.9	13.2
S 5	2.0	5.8	1.3	9.3
S 6	0.9	5.2	0.2	2.0
S 7	0.7	8.2	0.3	5.0
S 8	0.9	4.6	0.2	4.3
S 9	0.3	3.3	0.2	1.5
S 10	0.8	5.6	0.4	10.3
S 11	3.2	6.2	1.3	8.2
S 12	3.6	7.5	2.5	13.3
S 13	0.7	10.2	0.4	11.9
S 14	1.8	12.6	1.7	6.8
S 15	1.9	15.2	0.9	7.3
S 16	2.4	5.8	0.8	1.8
S 17	3.3	17.3	6.2	30.3
S 18	1.2	13.9	0.7	3.5
S 19	1.6	6.8	1.2	8.4
S 20	1.5	7.2	0.5	4.2

S 21	3.4	11.8	2.5	18.2
S 22	1.4	6.5	0.3	2.1
S 23	3.8	18.4	5.3	18.2
S 24	0.8	4.9	0.4	3.0
S 25	1.2	5.7	0.4	4.8
S 26	1.7	6.3	2.3	2.8
S 27	2.8	6.6	3.5	11.3
S 28	1.2	5.9	4.3	3.5
S 29	0.9	7.5	1.8	11.9
S 30	0.8	4.7	0.7	2.2
S 31	0.7	1.3	0.4	2.6
S 32	0.2	1.0	0.2	1.9
S 33	1.9	7.0	2.8	13.2
S 34	3.6	9.8	1.7	6.4
S 35	0.8	4.9	0.6	2.3
S 36	0.8	5.8	0.7	3.5
S 37	1.3	4.8	0.7	3.9
S 38	0.9	10.2	0.4	3.5
S 39	3.6	22.5	5.3	17.4
S 40	2.6	6.8	1.8	10.2
S 41	1.3	7.9	1.2	11.0
S 42	1.8	4.3	0.3	0.5
S 43	0.9	4.9	0.4	7.7
S 44	3.4	12.7	3.6	13.2
S 45	1.6	5.3	1.3	3.7
S 46	0.3	5.8	0.7	1.5
S 47	1.8	16.3	0.6	9.3
S 48	2.0	15.3	2.6	8.1
S 49	1.8	13.1	0.9	3.8
S 50	0.5	4.2	0.3	5.2
S 51	1.4	4.8	0.4	3.6
S 52	3.6	6.2	1.8	3.0
S 53	2.2	6.8	5.2	8.2
S 54	0.7	29.0	2.6	4.4
S 55	0.9	9.4	4.2	5.5
S 56	0.6	2.3	0.5	2.3
S 57	1.1	5.3	0.3	2.8
S 58	1.2	10.8	0.8	12.5
S 59	2.3	4.6	1.3	2.2
S 60	0.8	5.4	1.0	3.8
S 61	0.2	1.8	0.2	1.9
S 62	1.3	8.2	2.1	2.6
S 63	1.5	9.7	1.0	4.4
S 64	0.9	4.8	3.0	1.3
S 65	0.8	4.8	0.2	2.2
S 66	4.3	6.2	0.4	3.9
S 67	0.5	5.0	0.6	2.6
S 68	0.3	6.2	0.4	3.6
S 69	0.4	6.2	0.9	2.6
S 70	0.6	4.6	0.4	3.8
S 71	0.5	5.8	0.3	5.4
S 72	1.6	6.8	0.4	12.8
S 73	0.2	5.2	0.6	5.2
S 74	0.1	6.8	0.4	9.5
S 75	0.5	8.4	0.1	4.6
Mean	3.2	8.3	1.6	7.3
Minumum	0.2	0.6	0.1	0.2
Maximum	5.9	36.0	5.1	23.2
S D	1.3	5.4	1.06	4.7

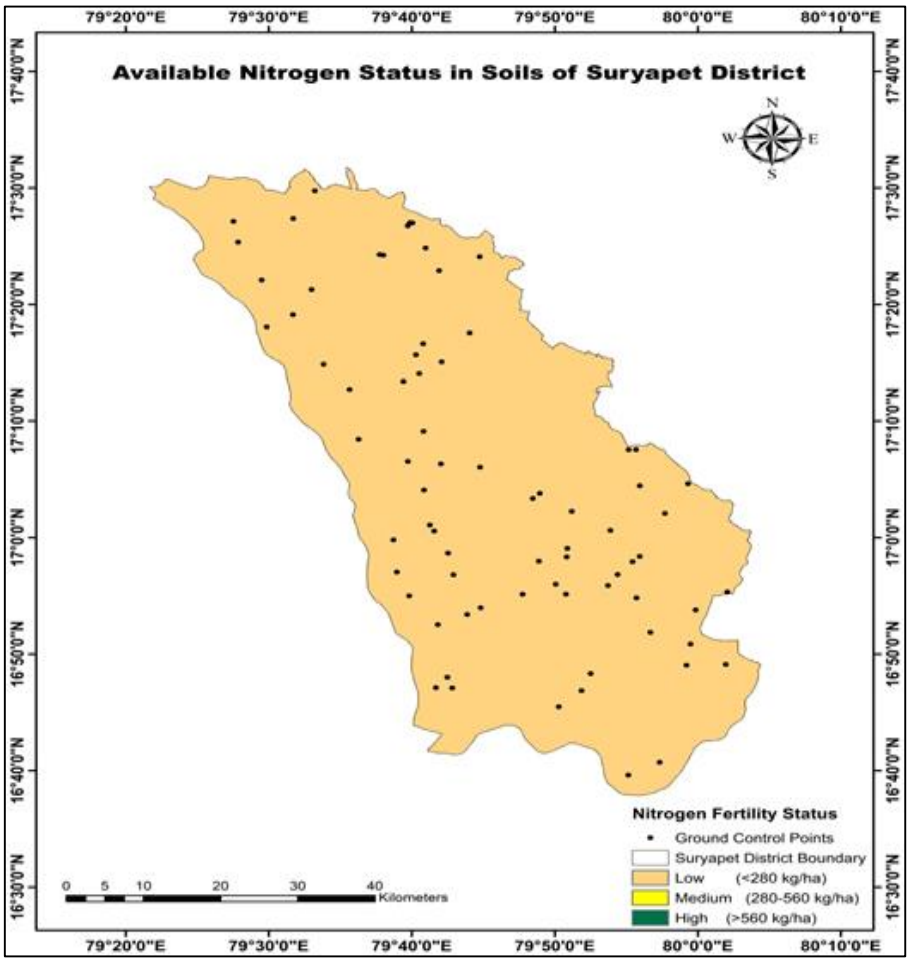

Fig 2: Available Nitrogen status in forage growing soils of Suryapet district

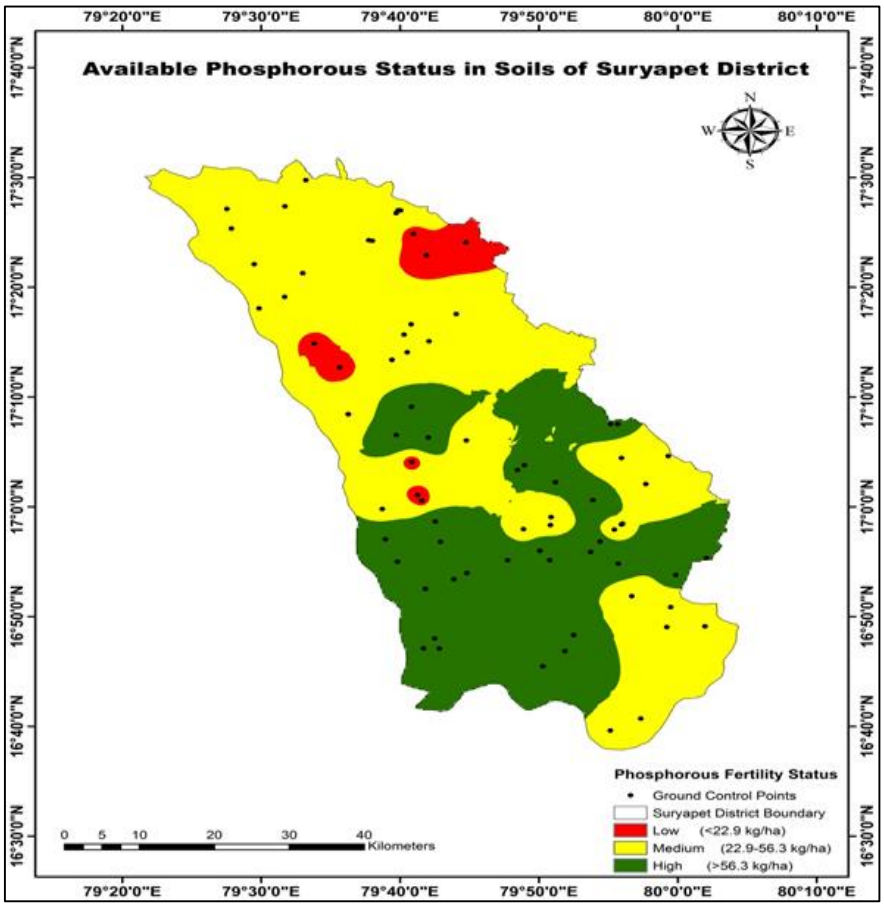

Fig 3: Available Phosphorous status in forage growing soils of Suryapet district

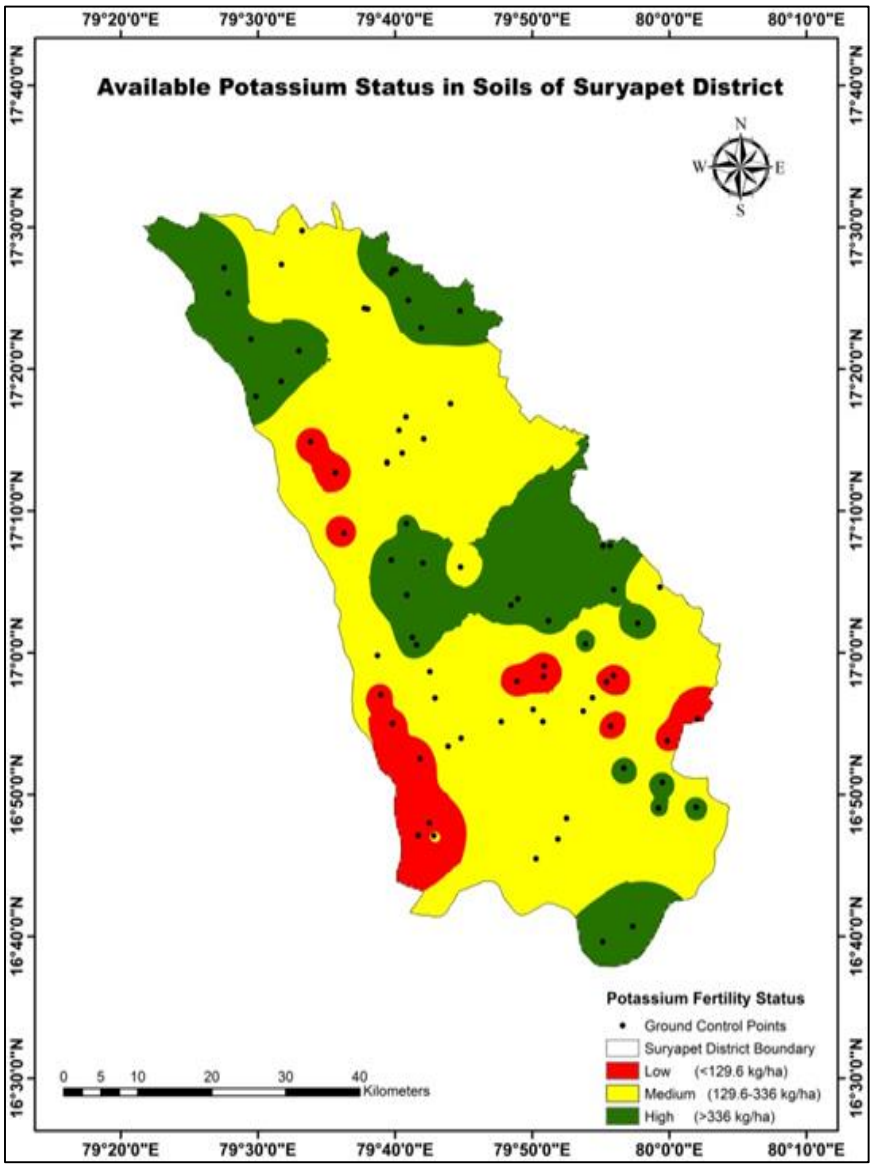

Fig 4: Available potassium status in forage growing soils of Suryapet district.

4. Conclusions

1. The soils of Suryapet district were alkaline in reaction and very little are acidic. 70% soils are low in organic carbon and only in few pockets are high in OC (9.4%).
2. Electrical conductivity of soils in Suryapet district ranged from 0.05-1.04 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. 41% of samples collected in the district has shown high phosphorous content and 46% samples are medium in phosphorous in content. It shows 90% of soils in the district are medium to high in phosphorous level.
5. 77% samples in the district are medium to high in potassium content.
6. In Suryapet district 17.3% samples are deficient in Zinc nutrient, while the other micro nutrient like cu and Mn are sufficient in soils and Fe is deficient in 9.34% soils.
7. Deficiency levels in micro nutrient content as follows Zn>Fe>Cu=Mn in Suryapet district.

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