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Soil quality assessment of some turmeric growing areas in relation to root-knot Nematodes status of Nizamabad district of Telangana

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Abstract
An investigation was undertaken during *kharif*, 2018. Twenty eight surface soil samples representing seven turmeric (*Curcuma longa* L.) growing mandals of Nizamabad districts of Telangana namely Sirikonda, Armoor, Kammarpally, Velpur, Balkonda, Jakranpally and Dharpally were studied for their physico-chemical properties and fertility status in relations to study molecular investigations on root-knot nematode resistance in turmeric cultivars. The climate of the study area was semi arid and monsoonic climate. The sites selected were confined to nearly level to gently undulating slopes and have granular to sub angular blocky structures. All the soils showed well developed structural variation and exhibited granular to sub angular blocky structure. The soil texture varied from sandy loam to clay. The sand, silt and clay content ranges from 18.2 to 71.4, 4.4 to 18.7 and 20 to 68.2, per cent respectively. The, pH, EC, OC, $CaCO_3$, exchangeable $Ca^{2+}$and Mg^{2+} and available N, P, K 6.5 to 8.1, 0.12 to 0.36 dSm^{-1}, 4.6 to 7.0 gkg^{-1}, 1.1 to 5.0 gkg^{-1}, 6.2 to 21.8 c mol (p+) kg^{-1}, 2.9 to 14.7 c mol (p+) kg^{-1}, 198 to 285 kg ha^{-1}, 14.0 to 34.0 kg ha^{-1} and 232 to 393 kg ha^{-1} respectively. The soils are neutral to slightly alkaline in reaction and non-saline. The soils are low to medium in available nitrogen, medium to high in available phosphorus and potassium.

Keywords: Turmeric growing soils, soil quality, physico-chemical properties, *Meloidogyne*, parasitic nematode, available nutrients

Introduction
India is called the "Spice Bowl of the World" as it cultivates 63 spices out of total 107 spices identified. Among the spices turmeric (*Curcuma longa* L.) is one of the most important and ancient spice of India and also a traditional item of export. It is extensively used in the preparation of tasty curried dishes by all classes of people for its typical colour and flavor. It is used as a dye with varied application in drug and cosmetic industries. India is the largest producer of turmeric in the world accounting to 82 per cent of world turmeric production and 60 per cent of world export. In Telangana the major turmeric growing districts are Karimnagar and Nizamabad. Nizamabad is second largest producer of turmeric having an area of 11943 ha, with production of 97933 tons and productivity of 8200 kg/ha. The major varieties of turmeric cultivated in Nizamabad district are ACC-79, ACC-48, Armoor, Duggirala, Prathibha, Roma, and Nizamabad local.
Agriculture is the backbone of the Nizamabad district's economy and about 81% of the working population depends on agriculture. The important soils prevailing in the district are black and red chalka (Sandy loams) soils covering 55% and 45% respectively of the total area. The blocks of Armoor, Bheemgal are predominantly dominated with red chalka soils followed by black soils. To comprehend and understand the potential capability of turmeric growing soils, the systemic study of turmeric cultivated soils is important for better management and scientific utilization of its resources. The information available on these lines is meagre. Keeping in view the above facts, the present study was carried out to characterize surface soils physico-chemical properties and fertility status in relations to study the molecular investigations on root-knot nematode resistance in turmeric cultivars of Nizamabad district of Telangana.

Materials and Methods
Location and description of the study area
The Nizamabad district of Telangana, extending over an area of 7956 km^2 is bounded on the North by Adilabad District, East by Karimnagar District, South by Medak district and West by Bidar District of Karnataka and Nanded district of Maharashtra. It lies between 18-5' and 19' of the Northern latitudes, 77-40' and 78-37' of the Eastern longitudes.

As the District is situated at a considerable distance from the Sea coast, the climatic condition is tropical and temperature fluctuations are high in the district. The Normal mean minimum temperature is 13.7',and mean maximum is 39.9'C.
The climate is semi-arid which is comparatively equitable and although it is very hot in May with mercury rising up to 47 ºC. The temperature dips to 5 ºC in winters during the months of December and January. The mean maximum and minimum temperature vary from 38° to 25 °C. Mean humidity varies from 64 per cent in July to 75 per cent in December. The mean annual rainfall is 900 mm of which 75 per cent is received during the southwest monsoon (June to September), 15 per cent during the northeast monsoon (October to December) and 10 per cent during the premonsoon period (March to May). The rainfall is highest in the month of August. The natural vegetation existing in the study area are grasses, shrubs, thorny bushes such as *Cynodon dactylon, Cyprus rotundus, Butea frondosa, Dalbergia latifolia, Azadirachta indica, Tectona grandis, Terminalia tomertose and Acacia spp. Prosopis juliflora, Cacia sp,* broad leaf weeds such as *Selotia, Parthenium, Eucalyptus, Euforbia* sps., *etc*. The major crops grown are rice, sugarcane, maize, turmeric, cotton, groundnut, sunflower and pulses etc.

Collection Methods used for soil sample analysis

The major turmeric growing villages from different manadals were selected. Surface soil samples (0-15 cm depth) from 28 turmeric growing villages of seven mandals. The representative soil samples of the villages were characterized for their important physical, physico-chemical properties using standard procedures. Particle size analysis was done according to International Pipette method (Piper 1966) [9], bulk density (Blake and Hartze 1986) [2], water holding capacity (Sankaram, 1966) [15], soil pH and EC was determined in 1:2.5 soil water suspensions. exchangeable cations (Jackson 1973) [5], cation exchange capacity (Chapman, 1965) [4], organic carbon and free calcium carbonate were determined (Walkly and Black, 1934 and Piper 1966) [20, 9] respectively. The available nitrogen was determined by kjeldal method, available phosphorus was estimated by spectrophotometer and potassium by flame emission method (Jackson, 1973) [5].

Results and Discussion

Soil Morphology

Morphological characteristics of the surface soils of some turmeric growing areas of Nizamabad district is presented in (Tables 1). All the soils showed well developed structural variation and exhibited granular to sub angular blocky structure. The variation in soil structure is a reflection of physiographic position (Singh and Agarwal, 2003) [17] and Vara Prasad Rao *et al*. (2008) [18]. The textural classes of the surface and subsurface soils are sandy loam, sandy clay loam, clay loam and clay. These variations are caused by topographic position, nature of parent material, insitu weathering, translocation of clay and age of soils (Ram *et al*., 2010) [14].
The consistence of the surface and subsurface soils was varied from loose to hard, friable to firm, slightly sticky to very sticky, very plastic in dry, moist and wet conditions respectively (Kumar *et al*., 2001) [6]. Mild to moderate strong effervescences were observed with dilute HCl test in some surface and subsurface soils might be due to presence of calcium carbonate concretions (Rajeshwar and Mani, 2018) [10]

Physical Properties

Physical characteristics of the surface soils is presented in (Table 2). The sand, silt and clay content ranges from 18.2 to 71.4, 4.4 to 18.7 and 20 to 68.2, per cent respectively. In red soils coarse to medium texture was observed and fine texture was found in black soils. The texture of the soils varied from sandy loam to clay. The maximum clay content of 68.2 per cent was recorded in Nyavanandi village, while minimum clay content 20 per cent was noticed in Dubbaka village. The maximum silt content of 18.7 per cent was noticed in bhrahmanapalli village and minimum silt content of 4.4 per cent was noticed in Dubbaka village soils. The maximum sand content of 71.4 per cent was recorded in Konapur village soils, while minimum content 18.2 per cent was noticed in Nyavanandi village. Gravel was observed in all the surface soils and their distribution varied widely with soil types. The Gravel content ranges from 17.0 to 36.0 per cent. The maximum Gravel content of 36.0 per cent was recorded in division Dubbaka village, while minimum Gravel content of 17.0 per cent was noticed in Padgal village. The bulk density ranged from 1.32 to 1.65 Mgm^{-3} in surface soils, 1.34 to 1.69 Mgm^{-3} in subsurface soils at different moisture regimes respectively.
The maximum bulk density content of 1.73 Mgm^{-3} was recorded in Gadkole soils, while minimum content of 1.28 Mgm^{-3} was noticed in Laxmapur. Lower bulk density values of clay soil might be due to loose, porous nature and organic matter content (Walia and Rao, 1996) [19]. The maximum water holding capacity ranges from 22 to 58.0 per cent in surface soils. The maximum water holding capacity of 58.0 per cent was recorded in Nyavanandi village, while minimum water holding capacity of 22.0 per cent was noticed in Chinthalur and Govindpet villages. Water holding capacity of the surface soils vary with soil types due to the variation in clay, silt and organic carbon content (Rajeshwar *et al*., 2009) [13].

Physico-Chemical Properties

Physico-chemical properties of the surface and subsurface soils are presented in (Table 3). All the soil samples studied were extremely acidic to moderately alkaline in reaction. The soil pH ranged from 6.5 to 8.1. The lowest pH (6.5) was recorded in Dammanapet village which might be due to accumulation of exchangeable H^+, Fe and Al oxides, soil organic matter and clay minerals (Bipul Deka *et al.,* 2009). The highest pH values (8.1) were noticed in Nyavanadi village. Similar results were observed by Rajeshwar and Mani (2013) [12] and stated that the parent materials, rainfall and topography, were greatly influenced by the characteristics and behaviour of soil environs. The E.C ranges from 0.12 to 0.36 dS m^{-1} and all the soils falls under non saline in nature. The low amount of soluble salts in surface and subsurface soils could be attributed to loss of bases (Sidhu *et al.,* 1994) [16] due to heavy rainfall. The organic carbon content was found to be low to medium (4.6 to 7.0 g kg^{-1}) in surface soils of all the villages. The organic carbon content relatively medium in range in surface soils was attributed to the addition of farmyard manure and plant residues which resulted in higher organic carbon content in surface horizons. These observations are in accordance with results of Rajeshwar *et al.* (2009) [13].
The CEC values were ranged from 16.7 to 38.9 c mol (p+) kg^{-1}. The CEC values are indicating that the soils are moderately weathered (Buol *et al*., 1998) [3]. The exchangeable bases in were in order of $Ca^{+2} > Mg^{+2} > Na^+ > K^+$ on the exchange

complex. From the distribution of Ca^{+2} and Mg^{+2}, it is evident that Ca^{+2} shows the strongest relationship with all the species, comparing these ions (Ca^{+2}, Mg^{+2}, K^{+} and Na^{+}) it was clear that Mg^{+2} was present in low amount than Ca^{+2} because of its higher mobility. These results are in conformity with findings of Mahesh *et al.*, 2018 [10]. Low exchangeable Na and K percentage was noticed in all the soils as the exchange complex was dominated by divalent cations like Ca and Mg (Rajeshwar and Mani, 2018) [10].

The base saturation of the soils were moderate to high in range and varied from 52.6 to 86.8 percent. This could be due to the dominance of smectitic type of clays and moderate to strongly alkaline reaction. These results were in accordance with the findings of Rajeshwar and Mani (2018) [10]. The variation in difference of CEC, base saturation and water holding capacity between soils may ascribe largely due to the varied type or content of soil colloids and soil pH values. The soils were non calcareous and $CaCO_3$ content was ranged from 1.1 to 5.0 g kg^{-1}.

Soil Fertility status

The available macronutrients status of soils is presented in (Table 4). The available nitrogen status was found to be low to medium (198.0 to 285.0 kg ha^{-1}) in all the villages of surface soils. However, available N content of all the above soils was found to be low to medium in surface soils. The reason for the maximum available nitrogen content observed in the surface could be attributed to the fact that cultivation of crops are mainly confined to the surface horizon (Rhizosphere) only and at regular interval the depleted nitrogen content is supplemented by the external addition of fertilizers during crop cultivation (Rajeshwar and Mani, 2014) [11].

The available phosphorus status was found to be medium to high in surface soils (14.0 to 34.0 kg ha^{-1}) in all the villages. The reason for higher P in surface soils might possibly be the confinement of crop cultivation to the rhizosphere and supplementing of the depleted phosphorus through external fertilizers. Similar results were reported by Rajeshwar and Mani (2014) [11].

The available potassium was medium to high (232.0 to 393.0kg ha^{-1}) in soils of all villages.. The available K status was more in surface soils which 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) [8] and Mahesh *et al*., 2018 [7].

Nematode pests

In the study area of turmeric growing soils of Nizamabad district in some patches all the villages found that the parasitic root-knot nematodes (*Meloidogyne spp*.) are damaging to turmeric majorly by feed on tender rhizomes, roots and base of pseudostem causing stunting, chlorosis, poor tillering and necrosis of leaves are the common aerial symptoms. Characteristic root galls and lesions that lead to rotting are generally seen in roots. The infested rhizomes have brown, water soaked areas in the outer tissues. Nematode infestation aggravates rhizome rot disease. Nematodes survive in soil and infected rhizomes as primary inoculum. therefore, tissues from infected crops remaining in the field serve as a reservoir of the fungus.It spreads from infected plants or through soil.

Conclusions

Results revealed that all the soils showed well developed structural variation and exhibited granular to sub angular blocky structure. The soil texture varied from sandy loam to clay. The soils are neutral to slightly alkaline in reaction and non-saline. The exchangeable bases in were in order of $Ca^{+2} > Mg^{+2} > Na^{+} > K^{+}$ on the exchange complex. The soils are low to medium in available nitrogen, medium to high in available phosphorus and potassium.

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Table 1: Some morphological characteristics of turmeric growing soils of Nizamabad district

S. No	Manadal	Villages	Depth (cm)	Texture	Structure	Consistency			Effervescence	Pores	Roots
						Dry	Moist	Wet			
1	Sirikonda	Nyavanandi	0-15	c	m2abk	vh	fi	vs&vp	ms	ff	mf to cf
		Gadkole	0-15	scl	f1sbk	sh	fi	ss to sp	nil	ff	ff to ff
		Valgote	0-15	c	m2abk	h	fi	vs&vp	ms	ff	mf to cf
		Kondur	0-15	c	m2abk	h	vfi	vs&vp	ms	ff	ff to ff
2	Armoor	Ankapoor	0-15	scl	m1gr	l to h	fr	ss&sp	nil	ff	mf to cf
		Govindpet	0-15	scl	m1sbk	sh	fi	ss&sp	nil	ff	ff
		Pipri	0-15	c	m2 sbk	h	fi	s&p	ms	ff	mf to cf
		Mamidipally	0-15	scl	f1 sbk	sh	fr	Ss&p	nil	ff	mf to cf
3	Kammarpally	Konapur	0-15	scl	m1sbk	sh	fi	ss&sp	nil	ff	ff
		Choutapally	0-15	scl	M3gr	l	fr	ss	nil	ff	mf to cf
		Kammarpally	0-15	cl	c1abk	h	fi	vs&p	ms	ff	ff
		Narsapur	0-15	scl	m1 sbk	sh	fi	ss&sp	nil	ff	mf to cf
4	Velpur	Velpur	0-15	scl	m1abk	sh	fr	ss to sv	m	ff	ff
		Kothapally	0-15	scl	m1sbk	h	fi	ss to sv	nil	ff	mf to cf
		Kuknoor	0-15	scl	m1sbk	h	fi	ss to sv	nil	ff	ff
		Padgal	0-15	cl	c1 abk	h	fi	s&p	m	ff	mf to cf
5	Balkonda	Balkonda	0-15	scl	M1sbk	h	fi	sv&pv	m	ff	ff
		Mendora	0-15	scl	F2gr	sh	fr	ss	nil	f f	c f
		Bodepally	0-15	scl	f2gr	sh	fr	ss&sp	m	f f	f f
		Kothapalley	0-15	scl	f2gr	sh	fr	ss	nil	f f	f f
6	Jakranpally	Jakrampally	0-15	scl	M2gr-m1sbk	sh	fr	ss&sp	nil	f f	c f
		Lakshamapur	0-15	scl	F2sbk	sh	fr	ss	nil	f f	f f

		Brahmnapally	0-15	cl	m1sbk	sh	fr	ss&sp	m	f f	c f
		Chintalur	0-15	scl	m1sbk	sh	fr	ss	nil	f f	c f
7	Dharpally	Dharpally	0-15	scl	m1abk	sh	fr	ss to sp	m	ff	ff
		Dubbaka	0-15	sl	f2gr	sh	fr	ss&sp	nil	f f	f f
		Dammanapet	0-15	sl	F1gr	sh	fr	ss	nil	f f	c f
		Honnajipet	0-15	scl	F2gr	sh	fr	ss	nil	f f	c f

Soil texture	:	ls – Loamy sand,sl- Sandy loam, scl –Sandy clay loam, sc- Sandy clay, cl- Clay loam and c- Clay
Soil Structure	:	c-coarse, m- medium, f- fine, 1- weak, 2- moderate,3 - strong, gr- granular,abk- angular blocky, sbk- sub-angular blocky
Soil Consistence	:	l- loose, sh- slightly hard, h- hard,vh- very hard,vfr-very friable,fr- friable, fi- firm, vf- very firm, so – non sticky, ss – slightly sticky, s- sticky,vs- very sticky, po- non plastic, ps – slightly plastic, p-plastic, vp- very plastic
Pores	:	Size f-fine, m-medium, c-coarse; Quantity f-few, c-common, m-many
Roots	:	Size f-fine, m-medium, c-coarse; Quantity f-few, c-common, m-many
Effervescence	:	m-mild,ms-moderately strong s-strong vs-very strong
Boundary	:	c- clear, d- diffuse, s- smooth,w- wavy, g- gradual, a- abrupt
Cutans		T-Argillans;tn-thin; p-patchy

Table 2: Physical characteristics of turmeric growing soils of Nizamabad district

S. No	Mandal	Villages	Depth (cm)	Gravel (%)	Particle size distribution (%)			Pore space (%)	B.D (Mgm^{-3})	MWHC (%)
					Sand	Silt	Clay			
1	Sirikonda	Nyavanandi	0-15	20.0	18.2	14.0	68.2	59.0	1.19	58.0
		Gadkole	0-15	22.0	68.6	5.7	25.7	43.0	1.73	34.0
		Valgote	0-15	19.0	33.8	8.8	57.1	58.0	1.20	56.0
		Kondur	0-15	21.0	37.1	10.9	51.8	52.0	1.14	33.0
2	Armoor	Ankapoor	0-15	19.0	65.0	7.6	27.4	44.0	1.48	27.0
		Govindpet	0-15	25.0	66.7	4.8	28.6	45.0	1.65	20.0
		Pipri	0-15	12.0	25.0	11.0	63.8	55.0	1.12	56.0
		Mamidipally	0-15	19.0	63.8	7.1	29.0	45.0	1.64	28.6
3	Kammarpally	Konapur	0-15	22.0	71.4	7.1	21.4	50.0	1.63	28.0
		Choutapally	0-15	24.0	62.9	8.6	28.6	49.9	1.59	31.0
		Kammarpally	0-15	21.0	44.4	8.9	46.7	48.0	1.45	50.0
		Narsapur	0-15	26.0	55.2	9.9	34.6	46.0	1.61	29.0
4	Velpur	Velpur	0-15	24.0	62.9	8.6	28.6	49.9	1.59	31.0
		Kothapally	0-15	22.0	60.0	10.0	30.0	48.3	1.58	26.7
		Kuknoor	0-15	25.0	55.2	9.9	34.6	46.0	1.61	29.00
		Padgal	0-15	17.0	47.9	14.6	37.5	47.0	1.46	52.0
5	Balkonda	Balkonda	0-15	29.0	68.1	6.9	24.0	43.9	1.34	25.9
		Mendora	0-15	30.0	62.3	9.0	28.8	45.6	1.58	32.0
		Bodepally	0-15	24.0	63.1	11.0	27.0	47.1	1.59	28.0
		Kothapalley	0-15	23.0	65.2	10.1	29.5	45.0	1.56	27.0
6	Jakranpally	Jakrampally	0-15	34.0	67.7	9.0	23.2	53.97	1.60	54.9
		Lakshmapur	0-15	32.0	64.3	7.0	28.5	44.98	1.12	28.7
		Brahmnapally	0-15	20.0	38.7	18.7	42.3	54.98	1.15	47.5
		Chintalur	0-15	28.0	69.8	8.8	21.3	44.98	1.47	20.0
7	Dharpally	Dharpally	0-15	29.6	66.9	10.1	24.0	53.97	1.60	54.9
		Dubbaka	0-15	36.0	75.6	4.4	20.0	41.0	1.70	23.0
		Dammanapet	0-15	35.0	66.4	7.4	26.1	43.0	1.70	21.0
		Honnajipet	0-15	30.1	65.0	7.6	27.4	44.0	1.48	27.0

Table 3: Physico-chemical properties of turmeric growing soils of Nizamabad district

S. No	Mandal	Villages	Depth (cm)	pH (1:2.5)	EC (dSm^{-1})	OC ($g\ kg^{-1}$)	$CaCO_3$ ($g\ kg^{-1}$)	Ca	Mg	Na	K	Total Ex.Bases	BS (%)	CEC (c mol $(p+)\ kg^{-1}$)
								(c mol $(p+)\ kg^{-1}$)						
1	Sirikonda	Nyavanandi	0-15	8.1	0.29	5.5	5.0	22.6	7.3	0.95	0.64	31.6	71.6	31.0
		Gadkole	0-15	7.3	0.26	7.0	3.0	11.9	7.8	0.65	26.1	20.9	80.2	26.1
		Valgote	0-15	8.1	0.36	6.5	2.3	18.3	7.0	0.76	0.53	26.7	63.4	32.1
		Kondur	0-15	7.9	0.28	6.8	4.1	12.1	8.4	0.75	26.4	21.9	82.9	26.4
2	Armoor	Ankapoor	0-15	6.58	0.18	5.8	3.0	16.7	7.0	0.58	0.69	25.0	73.7	33.9
		Govindpet	0-15	7.00	0.14	4.2	2.5	17.6	6.7	0.67	0.53	25.7	77.3	33.3
		Pipri	0-15	7.50	0.18	5.9	4.8	18.1	6.5	0.47	0.61	25.7	73.2	35.1
		Mamidipally	0-15	7.03	0.22	5.6	1.8	12.4	8.7	0.87	28.2	22.7	80.5	28.2
3	Kammarpally	Konapur	0-15	7.40	0.29	2.0	2.0	11.2	7.8	0.61	25.3	20.1	79.5	25.3
		Choutapally	0-15	7.24	0.22	4.6	3.1	10.5	7.1	0.58	24.9	18.7	75.1	24.9
		Kammarpally	0-15	7.25	0.19	5.8	2.2	9.8	7.5	0.55	23.5	18.4	78.2	23.5
		Narsapur	0-15	7.50	0.22	5.7	1.9	11.4	7.5	0.69	25.0	20.0	79.1	24.0
4	Velpur	Velpur	0-15	7.50	0.25	5.9	1.5	7.6	3.0	0.59	0.63	11.5	56.8	20.3
		Kothapally	0-15	7.40	0.21	5.6	2.0	7.5	3.5	0.45	1.02	11.9	70.2	16.9
		Kuknoor	0-15	7.32	0.20	6.4	1.9	14.8	6.3	0.42	0.64	22.0	86.8	25.3
		Padgal	0-15	6.94	0.18	5.3	1.8	21.8	9.8	0.55	0.75	32.8	84.4	38.9

5	Balkonda	Balkonda	0-15	7.00	0.15	4.8	2.1	7.2	4.0	1.37	0.28	13.3	66.5	20.0
		Mendora	0-15	7.90	0.18	6.9	1.6	6.2	2.9	0.44	0.35	9.9	63.1	15.7
		Bodepally	0-15	7.36	0.21	5.0	4.0	8.1	3.3	0.28	0.33	12.1	55.6	21.8
		Kothapalley	0-15	7.90	0.20	5.7	1.5	7.8	2.9	0.61	0.36	11.7	56.1	20.9
6	Jakranpally	Jakrampally	0-15	6.99	0.22	5.5	2.1	7.3	2.9	0.48	0.32	11.2	66.8	16.7
		Lakshamapur	0-15	6.80	0.14	5.9	1.9	6.4	5.5	0.6	22.7	12.9	57.0	22.7
		Brahmnapally	0-15	6.70	0.22	5.4	2.5	11.6	7.9	0.68	26.0	20.8	80.1	26.0
		Chintalur	0-15	6.80	0.12	5.4	3.0	6.9	5.4	0.48	22.6	13.2	58.6	22.6
7	Dharpally	Dharpally	0-15	7.01	0.19	5.9	1.5	6.6	6.2	0.55	19.0	13.8	72.7	19.0
		Dubbaka	0-15	7.40	0.19	5.1	1.1	8.9	5.8	0.45	0.41	15.6	74.0	21.0
		Dammanapet	0-15	6.50	0.22	4.6	1.1	6.6	3.2	0.12	0.33	10.4	52.6	19.8
		Honnajipet	0-15	7.30	0.22	5.2	2.1	6.9	4.0	0.66	0.25	12.0	66.5	18.0

Table 4: Available major nutrient status of turmeric growing soils of Nizamabad district

S. No	Mandals	Villages	Depth (cm)	Available macronutrients (kg ha^{-1})		
				N	P	K
1	Sirikonda	Nyavanandi	0-15	240.0	22.0	315.0
		Gadkole	0-15	280.7	30.5	357.0
		Valgote	0-15	264.0	34.0	368.0
		Kondur	0-15	231.0	26.0	290.0
2	Armoor	Ankapoor	0-15	275.1	27.6	336.7
		Govindpet	0-15	277.0	15.0	282.0
		Pipri	0-15	201.9	19.9	341.3
		Mamidipally	0-15	263.0	26.0	262.0
3	Kammarpally	Konapur	0-15	259.7	20.8	393.0
		Choutapally	0-15	212.7	18.9	364.4
		Kammarpally	0-15	240.0	18.0	271.0
		Narsapur	0-15	271.4	26.1	381.9
4	Velpur	Velpur	0-15	184.0	14.0	296.0
		Kothapally	0-15	256.6	17.5	307.2
		Kuknoor	0-15	277.3	22.0	388.9
		Padgal	0-15	244.0	14.0	391.0
5	Balkonda	Balkonda	0-15	264.0	18.0	268.0
		Mendora	0-15	281.7	25.0	370.7
		Bodepally	0-15	269.7	17.8	293.0
		Kothapalley	0-15	208.1	18.1	372.7
6	Jakranpally	Jakrampally	0-15	285.0	28.1	355.3
		Lakshamapur	0-15	258.0	15.0	294.0
		Brahmnapally	0-15	263.2	19.6	326.4
		Chintalur	0-15	261.0	24.0	271.0
7	Dharpally	Dharpally	0-15	2450	18.0	232.0
		Dubbaka	0-15	266.5	15.6	295.0
		Dammanapet	0-15	198.0	20.0	275.0
		Honnajipet	0-15	278.0	26.7	355.7

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