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Physico-chemical properties and NPK status in soils under different horticultural land use systems, Hiriyur Taluk

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Abstract
The study was conducted to know the soil properties and NPK status under different horticultural land use systems in Hiriyur Taluk, Chitrdurga district during 2015-16. Six horticultural land use systems *viz* coconut, arecunut, pomegranate, banana, onion and chilli were identified. The soils were analyzed for physic-chemical properties and NPK status in 120 composite samples include 60 surface (10-15 cm) and 60 subsurface (15-30 cm) samples. The texture of soils of varied sandy loam to clay and highest mean value of clay was observed in pomogranate land use system compare to other land use system. Low bulk density values were recorded in surface soils compare to sub soils and arecanut land use system recorded highest bulk density (1.68 Mg m^{-3}) and lowest was in banana land use system (1.30 Mg m^{-3}). Soils of different land use systems were alkaline in reaction, highest mean value was recorded onion land use system and lowest was in pomegranate land use systems. The mean salt content in soils varied from 0.19 to 0.88 dSm^{-1} under different land use system indicating normal range for growing of different crops. Soils under coconut land use system recorded lowest electrical conductivity (0.19 dSm^{-1}) and highest was in areca nut land use system (0.88 dSm^{-1}) compared to soils under other land use systems. The soil organic carbon content was significantly higher under chilli land use system (8.88 g kg^{-1}) and lowest was in under pomegranate land use system (6.15 g kg^{-1}) compared to other land use systems. Higher available nitrogen (365.28 kg ha^{-1}) was observed under coconut land use system and lowest available nitrogen under onion land use system (245.57 kg ha^{-1}) compared to other land use systems. Among the different land use systems, highest available phosphorus (32.66 kg ha^{-1}) was observed under coconut land use system and lowest available phosphorus (24.24 kg ha^{-1}) under chilli land use system. Available potassium was highest under coconut land use system (325.20 kg ha^{-1}) and lowest under areca nut land use system (266.82 kg ha^{-1}) among all the land use systems. Among different land use system, soils were sandy clay loam to clay in texture and clay content higher in subsurface than surface soils. The bulk density was medium to high and increased with increasing depth. Soils were slightly alkaline to alkaline in reaction and electrical conductivity and organic carbon were medium to high. The available NPK status in soils recorded low to medium in soil fertility.

Keywords: Physical and chemical properties, soil reaction, electrical conductivity, organic carbon

Introduction

The increasing demand for high quality crops (protein content of cereals, technological quality of sugar beet, nitrate rate of vegetables) and protection of the environment (minimizing nitrate leaching and gaseous losses) on one hand, the evolution of agricultural practices with increasing and diversification of organic applications on the other hand, require an adaptation of reasoning and a rigorous management of the nitrogen, phosphorus and potassium fertilization, as well as an evaluation of environmental impacts. An important reason for undertaking this study was to determine, in the soils, the response initiated by NPK fertilization, particularly the initial and residual effects of NPK application. Knowledge of soil properties and NPK distribution in soil. This in turn, may suggest possible routes or paths by which applied NPK becomes available or unavailable. As the fertilizers are increasingly available they can improve the yield and quality of crops. Major concern about the present day’s farmer is to effectively manage the fertilizers for maximum efficiency and minimum pollution.

Hence, knowledge regarding the NPK availability is of importance in an appraisal of available nutrient status of the soil and to evaluate the available NPK and their relationship with soil characteristics under different land use system was undertaken.

Materials and methods

The study was conducted at college of Horticulture, Hiriyur in the year 2014-15. Soil samples were collected from identified selected land use systems in different villages of Hiriyur Taluk, Chitradurga district. In order to study the nutrient status in major horticultural land use systems such as coconut, arecanut, pomegranate, banana, onion and chili were identified. Soil samples were collected in surface and sub surface depth at 0-15 cm and 15-30 cm, respectively in 10 locations selected randomly for each land use system. The methods followed for analysis of physical and chemical properties of soil and available NPK using standard procedure.

Table 1: Methods adopted for estimation of properties

Soil parameters	Methods adopted
Particle size distribution	Piper, 1966 [7]
Bulk density	Piper,1966 [7]
Soil reaction	Jackson, 1973 [4]
Electrical conductivity	Jackson, 1973 [4]
Organic carbon	Walkey and Black, 1934 [17]
Available nitrogen	Subbaiah and Asija, 1956 [13]
Available phosphorus	Jackson, 1973 [4]
Available potassium	Jackson, 1973 [4]

Results and discussion

Physical properties of soils

Highest mean clay content was observed in subsurface soils compared to surface soil. It varied from 20.1to 35.9 and 21.138.1 per cent in surface and subsurface, respectively. The textural class of the soils varied from sandy loam to clay in texture (Table2). These soils are formed under semi-arid conditions, have varied soil texture, Clay was the dominant fraction since the soils formed is on the basalt parent material, the surface accumulation of sand with finer fractions accumulated at lower horizons might have been caused due to the translocation or removal of finer particle by illuviation or surface horizon the soils were alkaline in reaction (Singh *et al*. 1998) [15]. The increase in clay content with depth might be attributed to continuous tillage operations which make finer particles to move down behind the coarser particles on the surface (Sahu *et al*. 1990) [9].

Bulk density of soils varied from 1.30 to 1.56 and 1.43 to 1.68 Mg m^{-3} in surface and sub surface soils, respectively (Table 2).Low value of Bulk density was observed in surface soils compared to subsoil and in all the land use systems bulk density was increased with increase in soil depth. This might be due to high organic matter in surface soils compared to sub soils (Walia and Rao (1996) [16].

Table 2: Physical properties of soils under different land use system at two depths

Land use system	Clay (%)		Texture		Bulk density (Mgm^{-3})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Coconut						
Range	20.4-44.6	21.4-45.6	Scl-sc	Scl-sc	1.12-1.72	1.26-1.75
Mean	29.2	30.2	-		1.36	1.48
Arecanut						
Range	13.4-32.3	14.4-33.3	Sl-c	Sl-c	1.37-1.80	1.49-1.92
Mean	20.1	21.1	-	-	1.56	1.68
Pomogranate						
Range	21.7-45.6	22.1-48.4	Scl-c	Scl-c	1.14-1.59	1.28-1.73
Mean	35.9	38.1	-	-	1.34	1.48
Banana						
Range	14.1-59.5	10.1-62.7	Scl-c	Scl-c	1.12-1.51	1.25-1.64
Mean	32.1	33.02	-	-	1.30	1.43
Onion						
Range	14.2-36.5	15.6-65.6	Scl-c	Scl-c	1.23-1.59	1.35-1.71
Mean	27.2	38.6	-	-	1.38	1.50
Chilli						
Range	14.0-55.0	16.3-57.2	Sl-c	Sl-c	1.25-1.76	1.37-1.88
Mean	31.56	34.26	-	-	1.41	1.53

Chemical properties of soils under different land use systems

The pH and electrical conductivity are the two important electrochemical properties of soils. In all the land use systems, the pH values were alkaline in reaction (Table 3). Mean pH values of surface soils was slightly lower than the subsurface soil. Among the different land use systems, the mean pH values varied from 7.92 to 8.21 in surface soils and subsurface it varied from 8.16 to 8.38. High value of PH in surface soils which might be due to leaching of bases to the sub surface soils. Similar findings were made by Walia and Rao (1996) [16] in salt affected soils of vanivilas command area

The electrical conductivity of soils under different land use systems did not vary significantly. The electrical conductivity was low to medium in both the surface and sub surface, and it increased with depth in all the land use systems. Electrical conductivity in different land use system varied from 0.19 to 0.88 dSm^{-1} (table 3) and showed increasing trend with depth. This may be due to undulating nature of the terrain coupled with fairly good drainage conditions, which favored the removal of released bases by the percolating drainage water. This is in conformity with the observations made by Shivaprasad *et al*. (1998) [14]. It might be due to leaching of salts from the soil surface to lower depths due to irrigation and their accumulation in lower depths (Dasog and Hadimani, 1980) [3].

The soil organic carbon content indifferent land use system varied from 1.77 to 8.61 g Kg^{-1} (Table 3. Organic carbon content decreases with increase in soil depth in all the land use systems. The mean value of organic carbon recorded highest in chilli land use system (8.88 to 6.39 g kg^{-1}) in surface and sub surface soils, respectively. and lowest organic carbon recorded in areca nut land use system (6.47 to 4.49 g kg^{-1}) in surface and sub surface soils, respectively. The soil organic carbon trend under different land use systems were in the order of chilli > pomegranate > coconut > banana > onion > areca nut land use systems, respectively. Low to medium organic carbon content might be due to continuous cultivation and scarce availability of FYM due to which organic matter in soil decreased exponentially. The decreasing trend in organic carbon followed the observation made by Sathisha (2001) [12]. The organic carbon content decreased with depth. Similar findings are made by Sarkar *et al*. (2002) [10].

Table 3: Chemical properties of soils under different land use system at two depths

Land use system	PH (1:2.5)		EC (dSm^{-1})		Organic carbon (g kg^{-1})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Coconut						
Range	7.80-8.40	8.02-8.92	0.10-0.32	0.22-0.44	6.38-10.39	3.88-6.38
Mean	8.13	8.38	0.19	0.31	8.21	6.32
Arecanut						
Range	7.80-8.50	8.00-8.80	0.17-1.32	0.64-1.58	8.61-12.32	1.77-3.25
Mean	8.21	8.37	0.45	0.88	6.47	4.49
Pomogranate						
Range	7.80-8.20	8.00-8.30	0.10-0.53	0.45-0.88	8.46-12.72	3.99-5.32
Mean	7.92	8.16	0.20	0.55	8.56	6.15
Banana						
Range	8.00-8.80	8.10-9.10	0.14-1.17	0.28-1.31	8.61-12.47	3.32-4.45
Mean	8.17	8.36	0.46	0.60	7.69	6.42
Onion						
Range	7.70-8.60	7.80-8.60	0.10-1.31	0.22-1.43	8.14-8.73	3.43-8.14
Mean	8.22	8.33	0.46	0.58	6.96	6.21
Chilli						
Range	7.70-8.60	7.90-8.60	0.10-0.42	0.22-0.54	8.61-12.72	1.77-8.61
Mean	8.08	8.19	0.20	0.32	8.88	6.39

Available N, P_2O_5, K_2O in soils under different land use systems

Available nitrogen in different land use system varied from 178 to 449 and 159 to 410 kg ha^{-1} (Table 4 and fig 1) in surface and sub surface soils, respectively. Mean values ranged from276 to 365 kg ha^{-1} in surface sols and 261 to 286 kg ha^{-1} in sub surface soils. High values are recorded in surface soils compared to sub soils. Highest mean vale was observed in chilli land use system and lowest was in onion land use system. Available nitrogen The nitrogen content decreased with increasing the depth (Fig. 1) may be due to low organic carbon level in sub surface soils (Mruthunjaya and Kenchana Gouda 1993) [5]. Available nitrogen follow similar trend as that of organic carbon. A relatively higher content of nitrate nitrogen in surface soils is due to high nitrification. In general, the surface soils recorded higher nitrogen than subsurface soils. The variation in N content may be related to soil management, application of FYM and fertilizer to previous crop etc. (Ashok Kumar, 2000) [1]. Pulakeshi. (2010) [6] reported that the nitrogen content in the soils was influenced by the temperature rainfall and altitude. The semi arid climate, low organic carbon status might have been resulted in low N content.

Available phosphorus varied from 20.6 to 34.6 and 20.2 to 37.3 kg ha^{-1} in surface and sub surface soils, respectively. Highest mean available phosphorus recorded in coconut and lowest inchilli land use system at surface soils where as in subsurface soils highest was in arecanut and lowest was in chilli land use system. Its content increased with increase in soil depth in all land use systems. Low to medium available phosphorus status in almost all the land use systems and there is no much variation of available phosphorus with the depth was observed. However surface soils recorded slightly low available phosphorus as compared to sub surface (Fig. 2) which might be due to its higher removal than replenishment and phosphorus fixation capacity of soil (Satisha and Badrinath, 2001.) [12].

Available potassium varied from 276.29 to 414.31 and 273.78 to 411.80 kg ha^{-1} in surface and sub surface soils, respectively. Highest mean available potassium was recorded in coconut land use system and lowest was in arecanut land use system. Its content decreased with increase in soil depth in all land use systems. Range of available potassium is low to medium in all the land use systems, coarse textured soils recorded low potassium than the heavy textured soils. This might be due to faster and deeper leaching, similar observation made by Badrinath *et al*. (1996) [2]. The surface soils contained higher potassium than sub surface soils (Fig. 3). This could be attributed to more intense weathering, release of potassium from organic residues, application of potassium fertilizers and upward translocation of potassium from lower depth along with capillary rise of ground water. Similar findings are made by Rao *et al*. (2008) [4].

Table 4: Available NPK status of soils under different land use system under two depths

Land use system	Available Nitrogen (Kg ha^{-1})		Available phosphorus(Kg ha^{-1})		Available potassium (Kg ha^{-1})	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Coconut						
Range	276-449	173-352	28.8-33.4	28.3-37.3	276-414	274-412
Mean	365	274	31	32	325	323
Arecanut						
Range	211-433	173-372	23.1-34.6	30.1-35.0	205-398	203-381
Mean	320	261	30.1	32.5	277	267
Pomogranate						
Range	230-439	172-410	20.2-32.1	20.2-35.1	224-427	222-425
Mean	340	273	26.2	28.5	308	307
Banana						
Range	256-439	178-372	21.5-34.5	24.6-35.5	243-402	239-399
Mean	322	282	27.1	29.7	311	308
Onion						
Range	178-378	159-352	20.6-30.9	23.5-33.3	229-360	224-356
Mean	276	246	25.3	28.4	307	303
Chilli						
Range	240-440	174-373	20.8-28.5	22.6-32.1	259-317	256-314
Mean	364	286	24.2	27.6	291	288

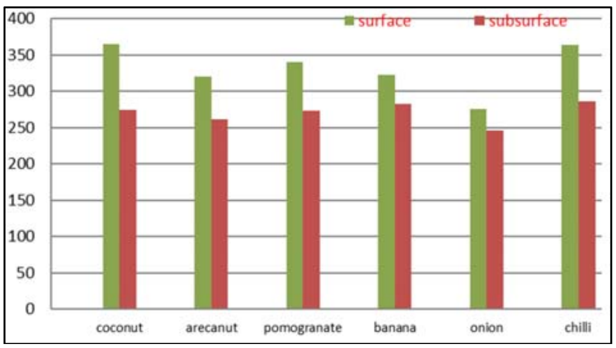

Fig 1: Available nitrogen in surface and surface soils under different land use system (kg/ha)

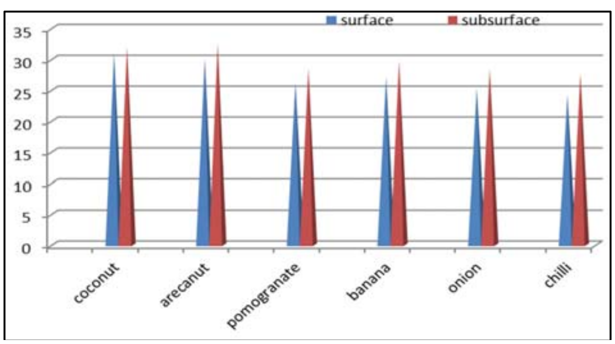

Fig 2: Available phosphorus in surface and surface soils under different land use system (kg/ha)

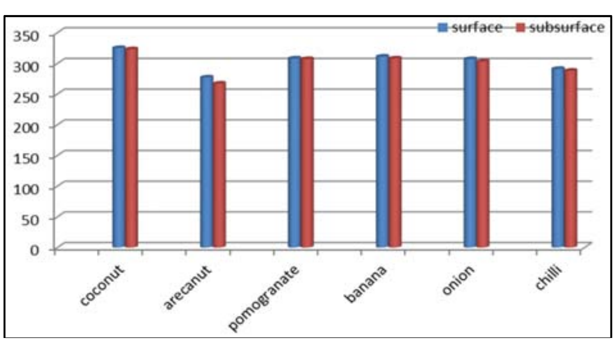

Fig 3: Available potassium in surface and surface soils under different land use system (kg/ha)

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