The Ecoscan 10(3&4): 449-455, 2016
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.com

EVALUATION OF FERTILITY STATUS OF SELECTED Bt COTTON GROWING SOILS OF NORTHERN TRANSITION ZONE (ZONE 8) OF KARNATAKA

T. V. JYOTHI* AND N. S. HEBSUR
Department of Soil Science and Agricultural Chemistry,
University of Agricultural Sciences, Dharwad - 580 005, Karnataka, UAS, Dharwad, INDIA
e-mail: veeranna.jyothi@gmail.com

ABSTRACT

A survey study was carried out to evaluate the fertility status of selected Bt cotton growing soils of northern transition zone of Karnataka. Twenty soil samples (10 samples from Vertisols and 10 samples from Alfisols) were collected using GPS from 0 - 22.5 cm depth from each taluk before sowing of crop. The study revealed that Bt cotton growing both Vertisols and Alfisols of Belagavi, Dharwad and Haveri districts were observed acidic to alkaline in soil reaction, non saline and low to high status in organic carbon content. The Vertisols and Alfisols of Belagavi, Dharwad and Haveri districts recorded low, low to medium and medium to high in available N, P_2O_5 and K_2O status, respectively. The data indicated that the available nitrogen, phosphorus and potassium contents ranged from 101.80 to 270.20 kg ha^{-1} and 19.60 to 40.29 kg ha^{-1}, 245 to 551 kg ha^{-1}, respectively in Vertisols and 80.44 to 146.3 kg ha^{-1}, 12.56 to 32.40 kg ha^{-1} and 211 to 426 kg ha^{-1}, respectively in Alfisols of all the studied taluks. Among the soils studied, all the available micronutrients (Cu, Fe and Mn) were present above critical limit except zinc.

KEY WORDS
Bed planting
Zero tillage
Soil physical health

Received : 30.05.2016
Revised : 11.08.2016
Accepted : 21.09.2016

*Corresponding author

INTRODUCTION

Cotton is a "White Gold" premier cash crop contributing 26% of the total cotton growing area in the world with a share of 15% of global production (Nagaraja *et al.*, 2014). The cotton plant is unique because it is a perennial with an indeterminate growth habit (Oosterhuis, 2001). Cotton being deep rooted crop removes large quantities of nutrients from the soil profile. Nutrient management in cotton is complex due to the simultaneous production of vegetative and reproductive structures during the active growth phase. Soil characterization in relation to evaluation of fertility status of soils of an area or region is an important aspect in context of sustainable agricultural production. Nitrogen, phosphorus, potassium, sulphur, boron and zinc are important soil elements that control its fertility and yields of the crops (Sujatha and Vijayalakshmi, 2013). Previous studies reported that many farmers do not apply the required quantity of fertilizers and the application was non-uniform. This has led to lower yields and creation of lot of spatial variation in nutrients under the similar management situation. The development of information for managing soils and the use of needed inputs will establish reasonable expectations for productivity of fields and increase profits through efficient use of inputs. Therefore assessment of fertility status of soils that are being intensively cultivated with high yielding crops need to be carried out. It is important to monitor the fertility status of soil from time to time with a view to monitor the soil health. Soil available nutrients status 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 (Mamaledesai *et al.*, 2012). Soil test values are most essential to obtain higher yields of high quality cotton with greater fertilizer use efficiency. This would provide larger profits for farmers and stimulate local economies. In the light of the above, the proposed survey study was planned with an objective of identifying soil fertility constraints of some selected Bt cotton growing soils of northern transition zone of Karnataka.

MATERIALS AND METHODS

Bt cotton growing areas located in Belagavi and Bailhongal taluks of Belagavi district, Hubballi taluk of Dharwad district and Shiggaon taluk of Haveri district coming under Zone 8 were selected to evaluate the fertility status with respect to major and micronutrients. Twenty soil samples (10 samples from Vertisols and 10 samples from Alfisols) from 0 - 22.5 cm depth soil were collected using GPS from each taluk predominantly planted to cotton during the month of April 2012 (before sowing of crop). Soil samples were first air-dried in shade, then powdered and sieved through 2 mm sieve then stored in clean polyethylene bags. Processed soil samples were analyzed in the laboratory for various physico-chemical parameters (pH and EC), organic carbon and available major (N, P_2O_5, K_2O) and micronutrients (Fe, Zn, Mn and Cu) status by adopting standard analytical techniques.

The soil pH was measured in 1:2.5 soil water suspension using pH meter and EC (dS m^{-1}) was measured in the supernatant solution of 1:2.5 soil water extract using conductivity bridge (Sparks, 1996). Organic carbon was estimated by Walkley and Black's wet oxidation method in which, the soil (0.2 mm sieved) was treated with a known but excess volume of potassium dichromate and concentrated H_2SO_4. The reaction was facilitated by the heat (120ºC) of dilution of H_2SO_4. The unreacted $K_2Cr_2O_7$ was back titrated against standard ferrous ammonium sulphate solution in the presence of phosphoric acid using ferroin indicator (Sparks, 1996). Available nitrogen was estimated by modified alkaline $KMnO_4$ method (Sharawat and Burford, 1982). In this method, organic matter in the soil was oxidized with hot alkaline $KMnO_4$ solution in the presence of NaOH. The ammonia (NH_3) evolved during oxidation was distilled and trapped in boric acid containing mixed indicator solution. The amount of NH_3 trapped was estimated by titration with standard sulphuric acid. Available phosphorus was extracted with Olsen's and Bray's reagent depending on their pH and the amount of P in the extract was estimated by chlorostannous reduced phosphomolybdate blue colour method using spectrophotometer at wavelength of 660 nm (Sparks, 1996). Available phosphorus was extracted with sodium bicarbonate (0.5 M) at pH 8.5 (Olsen's reagent) and the amount of phosphorus was estimated by chlorostannous reduced phosphomolybdate blue colour method using spectrophotometer at wavelength of 660 nm (Sparks, 1996). For soils having acidic pH, the soil was extracted with ammonium fluoride (0.03 N) + hydrochloric acid (0.025 N) reagent (Bray's method) and the amount of phosphorus was estimated by chlorostannous reduced phosphomolybdate blue colour method using spectrophotometer at wavelength of 660 nm (Sparks, 1996). Available potassium was extracted with neutral normal ammonium acetate extract and determined by using flame photometer as described by Sparks (1996). The micronutrients were extracted with DTPA extractant and the aliquot was assessed by using Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978).

RESULTS AND DISCUSSION

The results of the investigation carried out to assess the status of primary nutrients *viz.,* N, P, K and micronutrients (Zn, Fe, Mn and Cu) of both Vertisols and Alfisols of different villages of studied taluks are presented as mean, minimum, maximum, standard deviation and co-efficient of variation in respective tables.

Fertility status of Bt cotton growing soils of Belagavi district

Bailhongal taluk

The data pertaining to physico-chemical properties and available nutrients status of selected Vertisols and Alfisols under Bt cotton of Bailhongal taluk of Belagavi district is

Table 1: Physico-chemical properties, available macro and micronutrients status of selected villages of Bt cotton growing Vertisols and Alfisols of Bailhongal taluk

Vertisols Location	GPS readings	pH (1:2.5)	EC (d Sm^{-1}) (1:2.5)	OC (g kg^{-1})	Available macronutrients (kg ha^{-1}) N	P_2O_5	K_2O	Available micronutrients (mg kg^{-1}) Zn	Fe	Mn	Cu
0-22.5 cm depth											
Belavadi	N- 15º41'986'' E- 74º54'999''	8.02	0.52	6.45	183.3	23.92	419	0.42	11.16	3.44	2.59
	N- 15º42'838'' E- 74º53'768''	8.19	0.93	5.65	182.4	24.16	485	0.43	10.27	3.37	2.62
Okkunda	N- 15º45'773'' E- 74º52'305''	8.08	0.93	5.8	172.2	24.47	410	0.33	8.29	2.92	1.62
Anagola	N- 15º46'457'' E- 74º52'174''	7.77	0.79	5.75	179.3	20.13	483	0.34	9.15	1.72	2.51
Devlapur	N- 15º46'708'' E- 74º49'113''	8.05	0.94	6.85	193.4	28.11	551	0.47	12.31	3.95	3.76
Neginhal	N- 15º45'521'' E- 74º47'268''	8.54	0.82	5.6	163.2	25.01	472	0.34	8.35	1.88	1.95
Nanagundi koppa	N- 15º39'167'' E- 74º58'816''	8.03	0.61	5.85	176.9	27.23	466	0.3	5.64	1.81	1.6
Budihal	N- 15º44'535'' E- 74º56'450''	7.64	0.72	6.5	185.1	25.72	470	0.29	11.05	2.77	1.35
Jalikoppa	N- 15º44'674'' E- 74º52'636''	8.06	0.87	6.7	165.5	20.21	409	0.44	11.49	2.67	2.47
Bailhongal	N- 15º46'128'' E- 74º52'228''	7.66	0.81	5.45	153.5	19.6	377	0.23	7.36	1.39	1.02
	Mean	80.79	6.06	175.5	23.85	454	0.36	9.5	2.59	2.15	
	Minimum	7.64	0.52	5.45	153.5	19.6	377	0.23	7.36	1.39	1.02
	Maximum	8.54	0.94	6.85	193.4	28.11	551	0.47	12.31	3.95	3.76
	SD	0.27	0.14	0.51	11.96	2.98	50.6	0.08	2.11	0.86	0.8
	CV (%)	3.34	17.67	8.41	6.82	12.5	11.15	21.95	22.17	33.12	37.37

Table 1: Cont.......

Alfisols											
Location	GPS readings	pH (1:2.5)	EC (d Sm^{-1})	OC (1:2.5)	Available macronutrients (g kg^{-1})	(kg ha^{-1})		Available micronutrients (mg kg^{-1})			
					N	P_2O_5	K_2O	Zn	Fe	Mn	Cu
0 – 22.5 cm depth											
Anigol	N- 15°48′419″ E- 74°51′851″	7.08	0.25	3.73	130	17.81	229	0.24	10.51	6.84	1.57
Bailhongal	N- 15°47′625″ E- 74°50′284″	6.89	0.25	3.59	125.9	16.39	226	0.23	10.93	9.84	1.21
Neginhal	N- 15°44′608″ E- 74°46′152″	6.05	0.2	3.31	122.5	15.25	218	0.28	11.21	12.4	1.55
Sangolli	N- 15°42′779″ E- 74°49′899″	6.14	0.26	3.34	124.6	13.2	220	0.25	11.32	13.07	1.53
Savatgi	N- 15°42′198″ E- 74°50′789″	5.63	0.15	3.16	116.2	17.25	211	0.32	14.99	12.51	2.92
Patyal	N- 15°42′176″ E- 74°52′645″	5.8	0.18	3.46	122.8	14.25	217	0.32	13.8	13.76	1.5
	N- 15°42′102″ E- 74°52′674″	6.39	0.22	3.58	122.8	12.56	224	0.26	10.43	21.56	1.09
Sakinanana gundikoppa	N- 15°39′431″ E- 74°58′686″	7.71	0.26	4.21	131.3	21.01	231	0.22	10.41	6.87	2.4
Nanagundi koppa	N- 15°39′541″ E- 74°58′461″	7.81	0.29	4.3	135.4	20.13	229	0.19	9.5	6.26	1.21
Gudikatti	N- 15°39′043″ E- 74°57′486″	7.92	0.3	4.79	146.3	23.23	241	0.22	9.53	5.98	1.09
	Mean	6.74	0.23	3.74	127.77	17.11	224.6	0.25	11.26	10.91	1.61
	Minimum	5.63	0.15	3.16	116.2	13.2	211	0.19	9.5	5.98	1.09
	Maximum	7.92	0.3	4.79	146.3	23.23	241	0.32	14.99	21.56	2.92
	SD	0.86	0.05	0.52	8.45	3.5	8.55	0.04	1.78	4.84	0.6
	CV (%)	12.8	20.84	13.93	6.62	20.47	3.81	16.57	15.82	44.37	37.25

presented in Table 1.

In Bailhongal taluk, the pH of Vertisols of 0-22.5 cm depth varied from 7.64 to 8.54 with a mean of 8.00. On the other hand, in Alfisols, the pH values for surface (0-22.5 cm) ranged between 5.63 and 7.92 with a mean of 6.74. Soils were acidic in nature may be due to excessive leaching due to heavy rainfall leaving behind iron and aluminium oxides on the surface soil (Pati *et al.,* 2014). The present results are also in close proximity with the findings of Nanjundaswamy (1996), who recorded pH values ranging from 5.4 to 7.40 in the Alfisols of agro-climatic zone 8. The Vertisols and Alfisols of Bailhongal taluk were non saline with EC values ranging from 0.52 to 0.94 dS m^{-1} with an average of 0.79 dS m^{-1} and 0.15 to 0.30 dS m^{-1} with a mean of 0.23 dS m^{-1} at the surface, respectvely. In general, the Vertisols have higher soluble salts than Alfisols. It may be due to the restricted drainage in Vertisols which causes accumulation of salts. Whereas, in Alfisols extensive leaching of salts resulted in lower EC values (Nanjundaswamy, 1996).

In Vertisols, organic carbon content in surface soils was in medium status which ranged from 5.45 to 6.85 g kg^{-1} with an average of 6.06 g kg^{-1}. Alfisols of Bailhongal taluk registered lower organic carbon than Vertisols which varied from 3.16 to 4.79 g kg^{-1} with a mean of 3.74 g kg^{-1} in surface soils, low organic carbon in the soil might be due to low input of FYM and crop residues as well as their rapid rate of decomposition under high temperature. The organic matter degradation and removal takes place at faster rate particularly under low vegetation cover resulting in less accumulation of organic matter in the soil. Similar observations were also made by Nayak *et al.* (2002) in loamy sand soils of Central Research Station, Bhubaneswar. The available nitrogen status of both Vertisols and Alfisols of Bailhongal taluk was low. The available nitrogen content of Vertisols in surface ranged from 153.5 to 193.4 kg ha^{-1} with a mean of 175.5 kg ha^{-1} and in Alfisols it varied from 116.2 to 146.3 kg ha^{-1} with a mean of 127.77 kg ha^{-1}. According to Ramamoorthy and Bajaj (1964), the soils of majority states of India belong to lower status of available nitrogen. The low available N status in Alfisols could be attributed to the lower organic carbon status of these soils.

The available phosphorus status of surface soils varied from 19.60 to 28.11 kg ha^{-1} with an average of 23.85 kg ha^{-1} and 12.56 to 23.23 kg ha^{-1} with a mean of 17.11 kg ha^{-1} in Vertisols and Alfisols, respectively. Thus, the available phosphorus status of Vertisols and Alfisols of Bailhongal taluk was under low to medium status. Motsara (2002) reported that majority of soils in Karnataka state were medium in available phosphorus. This medium status could be also due to the tendency of farmers to apply more DAP fertilizer as source of N and P. The available potassium status of Vertisols surface soils of Bailhongal taluk ranged from 377 to 551 kg ha^{-1} with a mean of 454 kg ha^{-1} and 211 to 241 kg ha^{-1} with an average of 224.60 kg ha^{-1} in Alfisols.

Alfisols recorded comparatively low available potassium status than Vertisols. The higher K values in Vertisols could be due to predominance of K rich micaceous and feldspars minerals in these soils. These results are in agreement with the findings of Ravikumar (2006) who recorded higher available potassium status in Vertisols compared to Alfisols.

The DTPA extractable zinc content in Vertisols ranged from 0.23 to 0.47 mg kg^{-1} with a mean of 0.36 mg kg^{-1}, iron content ranged from 7.36 to 12.31 mg kg^{-1} with a mean of 9.50 mg kg^{-1}, manganese content ranged from 1.39 to 3.95 mg kg^{-1} with an average of 2.59 mg kg^{-1} and copper content ranged from 1.02 to 3.76 mg kg^{-1} with a mean of 2.15 mg kg^{-1} in surface soils. In Alfisols, the available zinc, iron, manganese and copper contents ranged from 0.19 to 0.32, 9.50 to 14.99, 5.98 to 21.56 and 1.09 to 2.92 mg kg^{-1} with average values of 0.25, 11.26,10.91 and 1.61 mg kg^{-1} in surface soils, respectively. The available micronutrients status (Fe, Mn and Cu) in both Vertisols and Alfisols exceeded the critical limit except zinc. These results corroborate the findings of Chakraborty *et al.* (1981) and Vinay Singh and Tripathi (1983) who reported higher available micronutrients status in soils barring zinc of citrus growing soils of Agra region.

Belagavi taluk

The data regarding physico-chemical properties and available nutrients status of selected Vertisols and Alfisols under Bt cotton of Belagavi taluk of Belagavi district is presented in Table 2.

The pH of Vertisols of Belagavi taluk ranged from 8.11 to 8.30 with a mean of 8.24 in surface (0-22.5 cm) soils. In Alfisols, the pH values varied from 5.19 to 7.65 with an average of 6.04. The impact of parent material such as granite, gneiss *etc.*, leaching down of basic minerals and high organic matter contents were the reasons for low pH values particularly in some of the red soils (Gajanan *et al.,* 1978). Bache (1988) opined that carboxylic and phenolic hydroxyl groups of organic matter increases H^+ ion concentration in soil solution by deprotonation thereby soil acidity increases. Moreover, Belagavi comes under transitional belt (Zone 8) which often receives heavy rainfall which makes soils acidic. The electrical conductivity of Vertisols and Alfisols ranged from 0.21 to 0.29 dS m^{-1} with a mean of 0.25 dS m^{-1} and 0.10 to 0.19 dS m^{-1} with a mean of 0.15 dS m^{-1}, respectively in surface soils. Alfisols recorded lower EC values compared to Vertisols, obviously due to their coarse texture nature and higher rate of leaching of salts from soil.

The organic carbon content of Vertisols in surface soils ranged from 5.07 to 8.77 g kg^{-1} with a mean of 7.15 g kg^{-1} and in Alfisols it ranged from 4.10 to 8.39 g kg^{-1} with an average of 5.97 g kg^{-1} in surface soils. The soil samples of Belagavi taluk under study recorded low to high status for organic carbon in both Vertisols and Alfisols. It could be attributed to the addition of farm yard manure and crop residues to the surface. Similar findings were also reported by Mruthunjaya and Kenchanagowda (1993) and Shadaksharappa *et al.* (1995) in soils of Vanivilas and Malaprabha command areas, respectively. The available nitrogen content of Vertisols and Alfisols ranged from 91.60 to 142.80 kg ha^{-1} with a mean of 118.30 kg ha^{-1} and 86.80 to 122.50 kg ha^{-1} with a mean of 102.69 kg ha^{-1}, respectively. Both Vertisols and Alfisols were low in available nitrogen status. The low available N status in Alfisols was attributed to the lower organic carbon status of these soils and also intensive cultivation of exhaustive crop like cotton.

The soils of Belagavi taluk recorded low to medium available phosphorus status in both Vertisols and Alfisols. The available phosphorus status of Vertisols varied from 20.77 to 34.47 kg ha^{-1} with a mean of 27.62 kg ha^{-1} and it ranged from 20.75 to 31.30 kg ha^{-1} with an average of 26.40 kg ha^{-1} in Alfisols. The Alfisols registered lower values of available phosphorus compared to Vertisols which might be due to acidic reaction of these soils (Anon., 2003). The available potassium status in surface Vertisols and Alfisols of Belagavi taluk varied from 245 to 337 kg ha^{-1} with a mean of 296.70 kg ha^{-1} and 222 to 254 kg ha^{-1} with a mean value of 233.70 kg ha^{-1}, respectively. The Vertisols recorded medium to high and Alfisols recorded medium status for available potassium. The higher content in Vertisols compared to Alfisols might be due to the predominance of potash rich micaceous and feldspar minerals in parent rocks (Ravikumar, 2006). Shivaprasad *et al.* (1998) also reported medium to high K status in some black soils of Karnataka.

In Vertisols, the DTPA extractable zinc, iron, manganese and copper contents ranged from 0.64 to 0.92 mg kg^{-1} with a mean of 0.74 mg kg^{-1}, 5.41 to 18.34 mg kg^{-1} with a mean of 7.89 mg kg^{-1}, 13.21 to 32.55 mg kg^{-1} with a mean of 20.57 mg kg^{-1} and 1.73 to 2.67 mg kg^{-1} with a mean of 2.21 mg kg^{-1} in surface soils. The Vertisols were sufficient with respect to all the micronutrients. In Alfisols, the available zinc, iron, manganese and copper contents ranged from 0.46 to 2.22 mg kg^{-1} with an average of 1.20 mg kg^{-1}, 31.75 to 92.56 mg kg^{-1} with an average of 60.39 mg kg^{-1}, 32.93 to 94.67 mg kg^{-1} with an average of 66.83 mg kg^{-1} and 1.73 to 2.07 mg kg^{-1} with an average of 1.92 mg kg^{-1}. The Alfisols were also sufficient with respect to all the micronutrients except zinc in few soils. Pulakeshi (2010) reported that available copper content in North Karnataka soils ranged from 0.01 to 5.12 mg kg^{-1}. The higher available manganese content in soils was attributed to its higher content in granite-gneiss parent material (Rajkumar, 1994). Many researchers reported reduced solubility and availability of zinc under alkaline soil conditions (Vijayasekhar *et al.*, 2000; Thangasamy *et al.*, 2005 and Ravikumar *et al.*, 2009). Dasog and Patil (2011) reported low zinc status in the soils of the north Karnataka. However, available iron content was higher in Alfisols than Vertisols of the study area. This might be due to the formation of these soils from granite-gneiss parent material, which are known to posses higher iron content (Rajkumar, 1994).

Fertility status of Bt cotton growing soils of Dharwad district

Hubballi taluk

The data on physico-chemical properties and available nutrients status of selected Vertisols and Alfisols under Bt cotton of Hubballi taluk of Dharwad district is presented in Table 3.

In Hubballi taluk the pH of Vertisols varied from 8.02 to 8.85 with a mean value of 8.51 in surface soils (0-22.5 cm). On the other hand in Alfisols, the pH value ranged between 7.08 and 8.03 with a mean of 7.70. The high pH of Vertisols compare to Alfisols might be due to calcareous nature and accumulation of bases in solum as they are poorly leached (Satyanarayana and Biswas, 1970). The Vertisols of Hubballi taluk were non saline with EC values ranging from 0.21 to 0.32 dS m^{-1} with an average of 0.26 dS m^{-1} in surface soils. The electrical conductivity of Alfisols varied from 0.09 to 0.17 dS m^{-1} with a mean of 0.14 dS m^{-1} in surface soil and were non saline. It might be due to the restricted drainage in Vertisols which causes accumulation of salts. Whereas, in Alfisols extensive leaching of salts resulted in lower EC values (Nanjundaswamy, 1996).

In Vertisols, the organic carbon content ranged from 6.29 to 9.73 g kg^{-1} with a mean 8.21 g kg^{-1}. Alfisols of Hubballi taluk registered lower organic carbon than Vertisols which varied from 2.79 to 4.23 g kg^{-1} with a mean of 3.59 g kg^{-1} in surface soils. The Vertisols under study showed medium to high organic carbon status. Alfisols recorded low in organic carbon status. This increase in organic carbon content might be attributed to the use of fertilizers which contributes biomass to the soil in the form of crop stubble and residues. However, the difference in the organic carbon content due to application of fertilizers might be the result of differential rate of oxidation of organic matter by microbes (Kusro *et al.,* 2014). The lower organic carbon content in Alfisols may be attributed to the poor management practices such as lack of addition of crop residues and organic manures. Intensive cropping is also one of the reasons for low organic carbon content. Soils of semi-arid region have low organic carbon than sub-humid soils (Jagadish Prasad and Gajbhiye, 1998). The available nitrogen status of both Vertisols and Alfisols of Hubballi taluk was low. The available nitrogen in surface Vertisols and Alfisols ranged from 216.80 to 270.20 kg ha^{-1} with an average of 238.06 kg ha^{-1} and 82.80 to 107.40 kg ha^{-1} with a mean of 95.90 kg ha^{-1}, respectively. Alfisols recorded lower available nitrogen compared to Vertisols. The available nitrogen content was low which might be due to low organic matter content in red soils as reported by Mamaledesai *et al.* (2012).

The available phosphorus status varied from 29.71 to 40.29 kg ha^{-1} with a mean of 33.06 kg ha^{-1} and 19.42 to 26.20 kg ha^{-1} with an average value of 23.48 kg ha^{-1} in the surface Vertisols and Alfisols of Hubballi taluk, respectively. The Vertisols and Alfisols recorded medium and low to medium status, respectively. The present results are in corroboration with the findings of Manju (2003) and Ravikumar *et al.* (2007) who reported that majority of soils in Karnataka were medium in phosphorus content. Jibhakate *et al.* (2009) also observed medium available phosphorus in Vertisols of Katol Tahasil in Nagpur district. The available potassium status of surface Vertisols and Alfisols of Hubballi taluk ranged from 434 to 524 kg ha^{-1} with a mean value of 478.80 kg ha^{-1} and 342 to 426 kg ha^{-1} with a mean 387.60 kg ha^{-1}, respectively. Among the soils of different villages studied in Hubballi taluk, both Vertisols and Alfisols recorded high status in available potassium content. The higher content of available potassium in Vertisols could be ascribed to the predominance of potash rich micaceous and feldspar minerals in parent materials. The results of present investigation are in conformity with the findings of Ravikumar (2006) who reported that the Vertisols maintain a sufficient or even high level of exchangeable K to provide a good supply of K to plants for many years (Finck and Venkateshwarlu, 1982).

The DTPA extractable zinc content in Vertisols ranged from 0.59 to 0.64 mg kg^{-1} with a mean value of 0.61 mg kg^{-1}, iron ranged from 5.15 to 7.29 mg kg^{-1} with an average value of 6.26 mg kg^{-1}, manganese content ranged from 19.35 to 29.27 mg kg^{-1} with an average value of 22.20 mg kg^{-1} and copper varied from 1.05 to 2.39 mg kg^{-1} with a mean value of 1.85 mg kg^{-1}. In Alfisols, the available zinc, iron, manganese and copper contents ranged from 0.61 to 0.82 mg kg^{-1} with a mean of 0.74 mg kg^{-1}, 4.02 to 6.01 mg kg^{-1} with a mean of 4.85 mg kg^{-1}, 27.75 to 33.07 mg kg^{-1} with a mean of 29.61 mg kg^{-1} and 0.83 to 1.21 mg kg^{-1} with a mean of 1.08 mg kg^{-1}, respectively in surface soils. Both Vertisols and Alfisols were sufficient with respect to all the micronutrients except zinc in some soils. The Vertisols exhibited higher content of DTPA copper than Entisol (Katyal and Sharma, 1991). Arora and Sekhon (1981) and Raghupathi (1989) opined that surface soils contained highest quantity of available copper and this was attributed to the availability of organic matter.

Fertility status of Bt cotton growing soils of Haveri district

Shiggaon taluk

The data pertaining to physico-chemical properties and available nutrients status of selected Vertisols and Alfisols under Bt cotton of Shiggaon taluk of Haveri district is presented in Table 4.

The pH of Vertisols of Shiggaon taluk ranged from 7.25 to 8.08 with a mean value of 7.82 and in Alfisols it varied from 5.26 to 7.22 with an average of 5.87 in surface soil (0-22.5 cm depth). The low pH of some of Alfisols could be attributed to high rainfall received in these areas. The Vertisols and Alfisols of Shiggaon taluk were non saline and the electrical conductivity of these soils ranged from 0.11 to 0.29 dS m^{-1} with a mean value of 0.18 dS m^{-1} and 0.07 to 0.15 dS m^{-1} with a mean of 0.10 dS m^{-1}, respectively. Similar results were obtained by Nanjundaswamy (1996) in Alfisols of agro-climatic zone 8 (0.11 to 0.20 dS m^{-1}). In Vertisols, the organic carbon in surface ranged from 6.19 to 8.13 g kg^{-1} with an average of 6.87 g kg^{-1}. Organic carbon content of Alfisols varied from 4.39 to 7.66 g kg^{-1} with an average of 5.71 g kg^{-1}. The Vertisols recorded medium to high in organic carbon status. The Alfisols recorded low to high in organic carbon status. The variation in the organic carbon content in soils might be due to variation in rates of application of organic manures by the farmers.

The available nitrogen content of Vertisols and Alfisols in surface ranged from 101.80 to 153.33 kg ha^{-1} with an average of 119.25 kg ha^{-1} and 80.44 to 120.90 kg ha^{-1} with a mean value of 97.23 kg ha^{-1} in surface soils, respectively. Both Vertisols and Alfisols showed low status in available nitrogen content. The low available N status in Alfisols was attributed to intensive cultivation of cotton being an exhaustive crop (Sudha, 2011). The available phosphorus status of Vertisols varied from 29.44 to 39.20 kg ha^{-1} with a mean value of 33.52 kg ha^{-1} in surface soils. With respect to Alfisols, the available phosphorus status ranged from 20.74 to 32.40 kg ha^{-1} with a mean value of 26.37 kg ha^{-1}. The Vertisols recorded medium status in available phosphorus content. Whereas, the Alfisols recorded low to medium status of available phosphorus. Yadav and Pathak (1963) reported that total phosphorus content of soils is governed by the presence of organic matter and clay content. In Shiggaon taluk, the Vertisols and Alfisols recorded high and medium in available potassium status, respectively. The available potassium status of Vertisols varied from 345 to 446 kg ha^{-1} with an average value of 392.50 kg ha^{-1} whereas, for Alfisols it ranged from 261 to 331 kg ha^{-1} with a mean of

304.70 kg ha^{-1}. The higher content of available potassium in Vertisols could be ascribed to the predominance of potash rich micaceous and feldspar minerals in parent materials. Sanatan Behra *et al.* (2015) reported that available potassium was significantly and positively correlated with pH and organic carbon under different land use systems in some soil series of West Bengal.

In Vertisols, the DTPA extractable zinc, iron, manganese and copper contents ranged from 0.63 to 1.21 mg kg^{-1}, 2.86 to 12.43 mg kg^{-1}, 21.82 to 35.50 mg kg^{-1}, 1.35 to 2.30 mg kg^{-1} with mean values 0.86, 6.32, 29.07 and 1.72 mg kg^{-1}, respectively. In Alfisols, the available zinc, iron, manganese and copper contents ranged from 0.75 to 1.41 mg kg^{-1} with a mean value of 0.99 mg kg^{-1}, 24.94 to 67.17 mg kg^{-1} with a mean value of 38.40 mg kg^{-1}, 21.44 to 48.39 mg kg^{-1} with a mean value of 36.29 mg kg^{-1} and 2.82 to 4.15 mg kg^{-1} with a mean value of 3.60 mg kg^{-1} in surface soils, respectively. Based on the results, it can be noted that both Vertisols and Alfisols were in sufficiency range with respect to micronutrients content. Higher available iron and manganese contents in Alfisols might be due to the granite-gneiss parent material which is known to posses higher iron content (Rajkumar, 1994).

REFERENCES

Anonymous 2003. *Malaprabha Command Area: Annu. prog. Rep. of AICRP on Water Managamenet*, Belvatagi, *Univ. Agril. Sci.*, Dharwad, Karnataka (India).

Arora, C. L. and Sekhon, G. S. 1981. Influence of soil characteristics on DTPA extractable micronutrient cations in some soil series of Punjab. *J. Indian Soc. Soil Sci.* **29:** 453-462.

Bache, B. W. 1988. Measurement and mechanisms in acid soils. *Commun. in Soil Sci. and Pl. Anal.* **19:** 775-792.

Chakraborty, S. K., Sinha, H. C. and Prasad, R. N. 1981. Zinc status of soils of Assam. *J. Indian Soc. Soil Sci.* **29(3):** 377-378.

Dasog, G. S. and Patil, P. L. 2011. Genesis and classification of Vertisol, red and lateritic soils of north Karnataka. In: *Special publ. on Soil Science Research in North Karnataka, 76th Annual Convention of ISSS*, Dharwad Chapter of ISSS (ed.), pp.1-10.

Finck, A. and Venkateshwarlu, J. 1982. Vertisols and rice soils of tropics. *Symposia of 12th Int. Congress of Soil Science*, New Delhi held on 8-16, Feb. 1982.

Gajanan, G. N., Upadyaya, G. S. and Deshpande, P. B. 1978. Factors affecting the lime requirement of coastal acid soil of Karnataka. *J. Indian Soc. Soil Sci*. **26(3):** 301.

Jagadish Prasad and Gajbhiye, K. S. 1998. Vertical distribution of micronutrients cations in some Vertisol profiles occurring in different eco-regions. *J. Indian Soc. Soil Sci.* **47:** 151-153.

Jibhakate, S. B., Bhende, S. N., Kharche, V. K. and Selvalakshmi, V. 2009. Physicochemical status of soils of Katol Tahasil in Nagpur district, June 2009. *J. Soils and Crops*. **19(1):** 122-128.

Katyal, J. C. and Sharma, B. D. 1991. DTPA-extractable and total Zn, Cu, Mn and Fe in Indian soils and their association with some soil properties. *Geoderma*. **49:** 165-169.

Kusro, P. S., Singh, D. P., Paikra, M. S. and Deepak Kumar, 2014. Effect of organic and inorganic additions on physico-chemical propertiese in Vertisol. *American Intern. J. Res. Formal*, Applied and Natural Sci. **14:** 51-53.

Lindsay, W. L. and Norvell, W. A. 1978. Development of a DTPA-soil test for Zn, Fe, Mn and Cu. *Soil Sci. Soc. American J.* **42:** 421-428.

Mamaledesai, N. R., Patil, P. L., Chandrashekar, C. P., Potdar, M. P., Astaputre, S. A., Desai, S. R. and Hanumantha Swamy. 2012. Assessment of nutrients status in cotton growing area of Haveri district in Northern transitional zone of Karnataka and response of cotton to applied nutrients at different yield targets. In: *Proc. Agro-Informatics and Precision Agric.* pp. 42-46.

Manju, M. 2003. Studies on soil fertility in relation to soil series and fertility mapping using GIS of a portion of Malaprabha command. *M. Sc. (Agri.) Thesis, Univ. Agric. Sci. Dharwad, Karnataka (India).*

Manjunathaiah, H. M. 1981. Investigations of physical, chemical and mineralogical properties of Vertisols derived from different parent material. *Ph. D. Thesis, Univ. Agric. Sci., Bangalore, Karnataka (India).*

Motsara, M. R. 2002. Available nitrogen, phosphorus and potassium status of Indian soils as depicted by soil fertility maps. *Fertilizer News*. **47:** 15-21.

Mruthunjaya, S. and Kenchanagowda, S. K. 1993. Physico-chemical properties of some salt affected soils of Vani Vilas Command Area of Karnataka. *Mysore J. Agric. Sci.* **27:** 349-355.

Nanjundaswamy, M. J. 1996. Status and distribution of secondary and micronutrients in research farms of agro-climatic zone eight of Karnataka. *M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka (India).*

Nagaraja, M. V., Gabapathi, T. and Rajakumar, G. R. 2014. Evaluation of Bt cotton with local hybrid cotton variety in Haveri district of Karnataka. *Intern. J. Scientific Res*. **3(10):** 1-2.

Nayak, R. K., Sahu, G. C. and Nanda, S. S. K. 2002. Characterization and classification of the soils of Central Research Station, Bhubaneswar. *Agropedology*. **12:** 1-8.

Oosterhuis, D. 2001. Physiology and nutrition of high yielding cotton in the USA. *Informacões Agronômicas Piracicaba*. **95:** 18-24.

Pati, S., Thingujam, U., Badole, S. P., Pal, B., Das, H. and Saha, A. K. 2014. Nature and distribution of soil acidity in different land use pattern of Terai region of west Bengal. *The Ecoscan.* **8(3&4):** 353-357.

Pulakeshi, H. B. P. 2010. Characterization and classification of soil resources of Mantagani village in Haveri district. M. Sc. (Agri.) Thesis, Univ. *Agric. Sci., Dharwad, Karnataka (India).*

Raghupathi, H. B. 1989. Investigations on soil copper and crop response in selected soils of Karnataka. *Ph. D. Thesis, Univ. Agric. Sci., Dharwad, Karnataka* (India).

Rajkumar, G. R. 1994. Studies on forms and distribution of micronutrients in paddy soils of Tungabhadra Project area, Karnataka. *M. Sc. (Agri.) Thesis Univ. Agric. Sci., Dharwad (India).*

Ramamoorthy, B. and Bajaj, J. C. 1964. Available nitrogen, phosphorous and potassium status of Indian soils. *Fertilizer News*. **14:** 25-36.

Ravikumar, M. A. 2006. Soil resource characterization of 48A distributary of Malaprabha right bank command for sustainable land use planning. *M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka, India*.

Ravikumar, M. A., Patil, P. L. and Dasog, G. S. 2007. Mapping of nutrient status under 48A distributary in Malaprabha Right Bank Command of Karnataka by Geographic Information Technique-I: Major nutrients. *Karnataka J. Agric. Sci.* **20(4):** 735-737.

Ravikumar, M. A., Patil, P. L. and Dasog, G. S. 2009. Soil resource characterization, classification and mapping of 48A distributary of Malaprabha right bank command, Karnataka for land use planning. *Karnataka J. Agric. Sci.* **22(1):** 81-88.

Sanatan Behera, Krishna Chaitanya, A., Ghosh, S. K. and Patra, P. K. 2015. Distribution of potassium fractions in different land use systems in some soil series of West Bengal. *The Bioscan.* **10(4):** 1549-1553.

Satyanarayana, T. and Biswas, T. D. 1970. Chemical and mineralogical studies of associated black and red soils. *Mysore J. Agric. Sci.* **8:** 253-264.

Shadaksharappa, G. S. and Patil, C. V. and Hebsur, N. S. 1995. Irrigation induced changes in soil properties of Malaprabha Command Area. *J. Maharashtra Agric. University.* **20:** 283-284.

Sharawat, K. L. and Burford, J. R. 1982. Modification of alkaline permanganate method for assessing the availability of soil nitrogen in upland soils. *Soil Sci.* **133:** 53-57.

Shivaprasad, Reddy, R. S., Sehgal, J. and Velyutham, M. M. 1998. Interpretation for soil and land resource management. *Annu. Rep., NBSS and LUP.* **47:** 65-68.

Sparks 1996. *Methods of soil analysis, Part -3: Chemical Methods,* Soil Science Society of America, USA.

Sudha, T. 2011. Studies on performance of Bt cotton genotypes in different soils of Northern transition zone of Karnataka under rainfed situation through farmers participatory approach. *Ph. D. Thesis, Univ. Agric. Sci., Dharwad, Karnataka (India).*

Sujatha, T. and Vijayalakshmi, K. 2013. Soil Fertility status of Bt cotton Cultivated fields and other Soils of Khammam region in relation with available macro, micro nutrients and Microbial count. *IOSR J. Environ. Sci. Toxicology and Food Techn.* **6:** 13-18.

Thangasamy, A., Naidu, M. V. S., Ramavatharam, N. and Raghava Reddy, C. 2005. Characterization, classification and evaluation of soil resources in Sivagiri micro-watershed of Chittoor district in Andhra Pradesh for sustainable land use planning. *J. Indian Soc. Soil Sci.* **53:** 11-21.

Vijayasekhar, R., Vittal Kuligod, B., Basavaraj, P. K., Dasog, G. S. and Salimath, S. B. 2000. Studies on micronutrient status in important black soil series of UKP command, Karnataka. *Andhra Agric. J.* **47(1&2):** 141-143.

Vinay Singh and Tripathi, B. R. 1983. Available micronutrient status of citrus growing soils of Agra region. *J. Indian Soc. Soil Sci.* **31:** 310-312.

Yadav, J. S. P. and Pathak, J. C. 1963. Phosphorus status of certain forest soils of India. *J. Indian Soc. Soil Sci.* **11:** 181-187.