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Physical, chemical and biological characterization of soil samples under alfisols of finger millet growing area of Bangalore rural district, Nelamangala, Karnataka

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Abstract
Physical, chemical and biological properties of surface soil samples were analysed at university of agricultural sciences, Bangalore during 2013 in order to categorize soils falls under alfisols of Bangalore rural district, Nelamangala, Karnataka. The predominant finger millet growing area Nelamangala of Bangalore rural district was selected for the present study. Ten surface samples (0-15cm) were collected from area and analysed. This study leads us to the conclusion of the nutrient's quantity of soils of Nelamangala taluk, Bangalore rural district, Karnataka State. Result showed that overage all the soils of Nelamangala taluk have various physical, chemical and biological parameters. This information will help farmers to decide the problems related to soil nutrients and also amount of fertilizers to be added to soil to make production economic.

Keywords: Physical, chemical and biological characterization, alfisols, Nelamangala

Introduction
Alfisols form a major order of soils of Karnataka and finger millet is a staple food crop grown on these soils (Malinda *et al*., 2015) [22]. These soils are low in organic matter content and their ability to retain moisture is also low. The structural instability of these soils leads to reduction in surface roughness and enhance surface sealing. These properties induce excessive runoff under high intensity rain and affects the seedling emergence particularly the small seeded crops like finger millet, pearl millet and sorghum. Due to intensive cultivation involving adoption of high yielding varieties, continuous use of high analysis fertilizers and imbalanced use of fertilizers without organic manures or organic residues, soils are becoming deficient in available nutrients (Ramakrishna parama and Atheefa, 2012) [32]. Many workers have reported the deficiency of micronutrients particularly boron in soils of India (Maha Singh, 2008) [20]. Therefore, it has become very much essential to know the available nutrient status in soils in order to achieve sustainability in production. Soil plays a major role in macro and micronutrients management and also availability of these nutrients in soil is known to be influenced by soil factors such as nature of parent material from which soil has been derived, texture, pH, organic matter status. Hence, a study was under taken to know the available nutrient status in soils belonging to Nelamangala taluk, Bangalore rural district of Karnataka. This study leads us to the conclusion of the nutrient's quantity of soils of Nelamangala taluk, Bangalore rural district, Karnataka State. Result show that overage all the soils of Nelamangala taluk have various physical, chemical and biological parameters. This information will help farmers to decide the problems related to soil nutrients and also amount of fertilizers to be added to soil to make production economic.

Resource and Research Methods
A total of 10 soil samples at 0-15cm depth were collected from the major finger millet growing area of Nelamangala taluk of Bangalore rural district, Karnataka and characterized for physical (% of sand, silt and clay), chemical (pH, EC, organic matter, macro and micronutrients, phosphorus and potassium fractions) and biological (acid and alkaline phosphatase activity) properties of the soil. The location, farmer's details and other relevant information on where the samples were collected are given in Table 1.

Table 1: Location details.

S. No.	Farmer's name	Village name	Taluk
1	Rangaswamaih	Makenahalli	Nelamangala
2	Venkatagiriyappa	Bugudihalli	Nelamangala
3	Siddarajappa	Adivasagalli	Nelamangala
4	Naveen R.S	Thyamagondlu	Nelamangala
5	Siddalingappa	Mylayahalli	Nelamangala
6	Hanumantharayappa	Basavanahalli	Nelamangala
7	Thimmahanumaiah	Mallumghatteri	Nelamangala
8	Sriramaih	Kundanahalli	Nelamangala
9	Narayanaswamy	Thyamagondlu	Nelamangala
10	Srinivas, V	Enchenahalli	Nelamangala

Determination of various forms of soil phosphorus

Fractions of phosphorus are divided into three active fractions and two relatively inactive fractions. The active fractions are calcium phosphate, aluminum phosphate and iron phosphate, while inactive fractions include reductant soluble-P and occluded-P.

Calcium P is present as discrete particles whereas Aluminium-P and Iron-P occur as films and/or adsorbed on clay or silt surfaces. The occluded P consists of Fe-P and Al-P fractions surrounded by an inert coat of another material that prevents the reaction of these phosphates with the soil solution. Reductant soluble forms occur with an inert material that may be partially or totally dissolved under anaerobic conditions. Phosphorus fractions were determined as outlined by Jackson, (1973) [14].

Aluminium phosphorus (Al-P)

The soil residue left in the centrifuge tube after extraction of Sal-P was shaken for one hour with 25 ml 0.5 M NH_4F (pH 8.2). The suspension was centrifuged to get a clear solution. Phosphorus in the solution was determined by chloromolybdic-boric acid method using stannous chloride as reductant. The intensity of blue color developed was read in a spectrophotometer at 660 nm (Jackson, 1973) [14].

Iron phosphorus (Fe-P)

The soil sediment from Al-P estimation was washed twice with 25 ml portion of saturated NaCl by shaking and centrifuging. The soil was then treated with 0.1 M NaOH and shaken for 17 hours and centrifuged. The supernatant was then treated with five drops of concentrated H_2SO_4. Phosphorus free activated carbon was used to remove color and filtered to remove suspended organic matter. Phosphorus in the solution was determined by chloromolybdic-boric acid method using stannous chloride as reductant. The intensity of blue color developed was read in a spectrophotometer at 660 nm (Jackson, 1973) [14].

Reductant soluble phosphorus (RS-P)

The soil residue from the Fe-P estimation washed twice with 25ml of saturated NaCl solution by shaking and centrifuging. Soil was then suspended in a 15ml of 0.3 M sodium citrate solution and shaken for 15 min with 0.5g of sodium dithionite. The suspension was heated in a water bath at 80 ^{0}C for few min and the clear supernatant solution was decanted into a 50ml volumetric flask after centrifuge. Soil was then washed with saturated NaCl and the washing return to a sodium citrate dithionite extract which was taken for reductant soluble P determination. Excess of citrate and dithionite was oxidized by adding 1.5ml of 0.25N $KMnO_4$ solution and reductant soluble P was estimated by chloromolybdic-boric acid method using stannous chloride as reductant after taking extractant to a 10ml isobutyl alcohol. The intensity of blue color developed was read in a spectrophotometer at 660 nm (Petersen and Corey, 1966) [30].

Occluded phosphorus (Occl-P)

The soil residue left after the estimation of RS-P was added with 25 ml of 0.1N NaOH and shaken for one hour. Supernatant solution after centrifugation was taken for estimation of Occl-P by Phosphorus in the solution was determined by chloromolybdic-boric acid method using stannous chloride as reductant (Jackson, 1973) [14].

Calcium phosphorus (Ca-P)

The soil sample after extraction of Occl-P was washed twice with 25 ml saturated NaCl and washings were discarded after centrifuging. Ca-P was then extracted by using 0.25 M H_2SO_4 and shaking for one hour and centrifuging for five minutes. Supernatant solution after centrifugation was taken for estimation of Ca-P by phosphorus in the solution was determined by chloromolybdic-boric acid method using stannous chloride as reductant (Jackson, 1973) [14].

Total phosphorus (Total P)

One gram of 0.5 mm sieved soil was weighed and transferred to a 300 ml platinum crucible and 30 ml of 60 percent $HClO_4$ was added and digestion was carried out on sand bath at 130 ^{0}C till the dense fumes of $HClO_4$ evolved. When digestion was completed the flask was removed and cooled. 50 ml of distilled water was added to the flask and solution was filtered into a 100 ml volumetric flask and volume was made with distilled water. An aliquot from this was used for estimation of total P by using vanadomolybdophosphoric acid reagent and the intensity of yellow colour was read at 470 nm in spectrophotometer (Jackson, 1967) [13].

Determination of various forms of soil potassium

Water-soluble potassium

Water-soluble potassium was determined in 1:2 soil water suspensions after shaking for two hours and allowing the suspension to stand for an additional 16 hours (Mc Lean, 1961) [24]. The potassium in the extract was determined by flame photometer.

Exchangeable potassium

Exchangeable potassium was determined by extracting with neutral N NH_4OAc solution as outlined by Knudsen *et al*. (1982) [17]. Ten gram of soil sample was shaken with 25 ml of neutral N NH_4OAc solution for ten minutes and then centrifuged.

The clear supernatant liquid was decanted into 100 ml volumetric flask. Three more additional extractions were made in the same manner and the combined extract was diluted to volume with NH_4OAc. The K content in the extract was determined, by flame photometer. The water-soluble potassium content was subtracted from NH_4OAc-K to get the exchangeable potassium content of the soil.

Non exchangeable potassium

The boiling 1N HNO_3 method as outlined by Knudsen *et al*. (1982) [17] was followed for the determination of non-exchangeable K in the soil.

Two and half gram of finely ground soil was boiled gently with 25 ml of 1N HNO_3 for 10 minutes. The content was filtered and the filtrate was collected in a 100ml volumetric flask. The soil was then washed four times with 15 ml portions of 0.1N HNO_3.

After making up volume and mixing, the potassium content in the extract was determined using flame photometer. The quantity of K obtained with the NH_4OAc extract was subtracted to get the non-exchangeable potassium content in the soil.

Total potassium

Total potassium content was determined by digesting the samples with hydrofluoric acid in a closed vessel (Lim and Jackson, 1982) [19]. 200 mg of finely ground soil sample was transferred into 250 ml wide mouth polypropylene bottle. Two ml of aqua regia was added to disperse the samples. Later 10 ml of hydrofluoric acid was added by means of plastic pipette and after capping the bottle the contents were shaken to dissolve the sample for a period of 8 hours. The white residue remaining after the treatment was dissolved in 100ml of saturated H_3BO_3 solution. The contents were diluted and final volume was made to 250 ml and subsequently used for analysis of total potassium by flame photometer.

Biological properties

Acid and alkaline phosphatase activity

Acid and alkaline phosphatase activities were estimated as per the procedure given by Eivazi and Tabatabai (1977) [11]. For this one gram of soil sample (<2mm) was placed in wide mouth test tube and 0.2ml of toluene, 4ml of modified universal buffer (pH 6.5 for assay of acid phosphatase or pH 11.0 for assay of alkaline phosphatase), 1ml of p-nitro phenyl phosphate solution made in the same buffer were added. Tubes were swirled for a few seconds to mix the contents. Then tubes were stoppered with cork and placed in an incubator at 30 ^{0}C. after 1 hr stoppers were removed and 1ml of 0.5 M $CaCl_2$, 4ml of 0.5 M NaOH was added. The suspension was centrifuged at 3000 rpm, filtered and the intensity of yellow colour of the supernatant was measured using spectrophotometer at 420 nm wavelength. p-nitro phenol content of the supernatant was calculated by referring to a calibration graph plotted from the results obtained with standards containing 0, 10, 20, 30, 40 and 50 µg of p-nitro phenol. Control was performed with each soil analyzed to allow for colour not derived from p-nitro phenol released by phosphatase activity.

Statistical analysis

The methods outlined by Panse and Sukhatme (1985) [28] were made used for statistical analysis of the data for drawing conclusion on different parameters studied.

The results obtained from the present investigations well as relevant discussion have been summarized under following heads:

Results

Status of physico-chemical properties of soils of Nelamangala taluk, Bangalore rural district

The results pertaining to physico-chemical properties of the soils collected from different villages of Nelamangala taluk, Bangalore rural district are presented in Table 2. Results indicated that the sand, silt and clay varied from 45.10 to 82.40, 3.01 to 20.40 and 12.40 to 45.90 percent respectively. These soils belong to sandy clay loam, sandy loam and sandy in texture. This suggests that more number of the soils are coarse texture. High percent of sand fraction in the soils under study is probably due to the granite type of parent material from which these soils have been derived. This is in conformity with the results of Bhavitha, (2013) [5] and Sathyanarayana and Biswas (1970) [37] who reported that soils developed from granite type of parent material had a coarse texture.

Out of ten samples, two are recorded (7.56 and 8.12) more than 7.50 pH and rest of the samples were acidic to neutral in nature (4.94 to 6.67). The electrical conductivity of these soils were in the range of 0.02 to 0.16 dS m^{-1}. Hence, variation in the pH of these soils from 4.02 to 8.12 (acidic to alkaline) may be attributed to the nature of parent material and also the amount of clay and organic matter content in soils. The soluble salts concentration were found to be low and also within the normal range in soils of Nelamangala taluk. Shivaprasad *et al*. (1998) [41] while characterizing the soils of Karnataka observed that soils derived from granite-gneiss material were found to be slightly acidic to neutral in reaction. According to Mahapatra *et al*. (2000) [21], soils of sub humid ecosystem of Kashmir region were generally slightly acidic to neutral in reaction, which was associated with high level of organic matter and leaching of bases due to slopy landscape and fluvial actions whereas high pH reported in some areas was due to $CaCO_3$ accumulation. Acharya *et al*. (1988) [3] and Roopa *et al*. (2014) [33] observed that significant decrease in pH of an Alfisol as a result of continuous manuring over the initial value. Bhavitha (2013) [5] reported that the lower amounts of soluble salts in soils of Krishnarajpet (T), Mandya district may be attributed due to the leaching loss of salts. Further organic carbon status in soils varied from 0.47 to 0.99 percent with a mean value of 0.81 percent and one out of 10 samples recorded low status (0.47 percent) of organic carbon and remaining samples had medium to high status.

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Status of secondary and micro nutrients in soils of Nelamangala taluk, Bangalore rural district

The results pertaining to status of secondary and micronutrients of the soils collected from different villages of Nelamangala taluk, Bangalore rural district are presented in Table 3. That available calcium content ranged from 1.25 to 9.25 c mol (P+) kg^{-1} with a mean value of 4.05 c mol (P+) kg^{-1} in soils coming under Nelamangala taluk. All these soils had sufficient amount of calcium. Available magnesium ranged from 0.75 to 4.25 c mol (P+) kg^{-1} with a mean value of 1.78 c mol (P+) kg^{-1}. Four out of 10 samples are under below the critical level and remaining soils had sufficient amount of magnesium. The available sulphur content varied from 11.53 to 28.64 mg kg^{-1} with a mean value of 19.21 mg kg^{-1}. Low and medium level of available sulphur in soils of the area may be due to lack of sulphur addition, use of di-ammonium phosphate fertilizer (DAP) and continuous removal of S by crops (Balanagoudar, 1989) [4]. This may be attributed to the coarse textured soils which are more prone to leaching and low to medium organic carbon status. The hot water extractable boron content varied from 0.11 to 3.10 mg kg^{-1} with0.46 mg kg^{-1} as mean value. All soils of Nelamangala taluk are below the critical value of boron. Bhavitha (2013) [5] reported that available boron increased with increase in fineness of soils.

The available zinc status in these soils ranged from 0.50 to 6.25 mg kg^{-1} with a mean of 2.15 mg kg^{-1}. Further it was noticed that one out of 10 samples analyzed were deficient (0.50 mg kg^{-1}) and remaining nine samples recorded sufficient Zn. This may be attributed to the reason that organic matter acts as a source of zinc in soils and also during its decomposition, the released chelating substances complex the zinc and keeps it in soluble and mobile form in soil by preventing its fixation by soil constituents. Mathur *et al.* (2006) [23], Chidanandappa (2003) [8] and Yadav (2008) [40] who got a positive and significant correlation between available zinc and organic carbon status of soils and also increase in the availability of zinc due to organic manures application. Available iron ranged from 8.98 to 30.24 mg kg^{-1} with a mean of 16.56 mg kg^{-1}. All the soils were found to contain high amount of iron. Rajkumar *et al*. (1990) [31] reported that soils derived from granite gneiss parent rocks exhibited medium values for available iron and results of the present investigation is in conformity with the findings of Katyal and Sharma (1991) [16] and Patiram *et al*. (2000) [29]. Available copper was in the range of 0.69 to 2.95 mg kg^{-1} and 50 percent of soils were found to be deficient and remaining 50 percent soils showed sufficient in copper content. Organic matter acts as a source of copper and also during its decomposition, the released organic compounds act as chelating agents for copper and prevents it from fixation by other soil constituents. Similar findings have been reported by Chidanandappa (2003) [8] and Bhavitha (2013) [5]. The available manganese status in soils ranged from 6.36 to 32.95 mg kg^{-1} with a mean of 17.84 mg kg^{-1}. All the soils were found to contain high amount of manganese. Similar results were reported by Yadav (2008) [40], Ibrahim *et al*. (2011) [12] and Roopa *et al*. (2014) [33] also.

Table 2: Status of physico-chemical properties of soils of Nelamangala taluk, Bangalore rural district scl-Sandy clay loam sl-Sandy loam s-sandy

S. No.	Farmer's name	Village name	Sand	Silt	Clay	Textural class	pH (1:2.5)	EC (dS m^{-1})	OC (%)	Avail. N	Avail. P_2O_5	Avail. K_2O
			(%)							(kg ha^{-1})		
1	Rangaswamiah	Makenahalli	81.30	4.75	13.12	sl	5.21	0.10	0.74	282.24	27.91	243.26
2	Venkatagiriyappa	Bugudihalli	80.95	6.10	12.44	sl	5.02	0.04	0.87	363.77	29.77	206.98
3	Siddarajappa	Adivasagalli	48.13	16.67	34.64	scl	5.52	0.08	0.47	257.10	35.92	166.66
4	Naveen, R.S	Thyamagondlu	80.90	3.01	15.57	sl	5.05	0.07	0.74	326.14	48.56	427.39
5	Siddalingappa	Mylayahalli	82.40	3.80	13.60	sl	4.94	0.05	0.87	294.70	25.93	263.42
6	Hanumantharayappa	Basavanahalli	45.10	20.40	33.82	scl	8.12	0.03	0.99	357.50	34.83	631.68
7	Thimmahanumaiah	Mallumghatteri	52.45	4.47	42.25	s	6.67	0.16	0.74	269.60	51.85	251.33
8	Sriramaih	Kundanahalli	53.78	3.24	42.02	s	5.93	0.09	0.87	351.20	26.92	282.24
9	Narayanaswamy	Thyamagondlu	55.80	4.20	39.80	s	7.56	0.02	0.97	275.96	23.62	563.14
10	Srinivas, V	Enchenahalli	47.80	5.45	45.90	s	6.08	0.06	0.80	326.14	22.74	698.88
Range			45.10-82.40	3.01-20.40	12.40-45.90	-	4.94-8.12	0.02-0.16	0.47-0.99	257.10-363.77	22.74-51.85	166.66-698.88
Mean			62.86	7.20	29.31	-	6.01	0.07	0.81	310.44	32.81	373.50
SD			16.24	6.10	13.92	-	1.12	0.04	0.15	39.38	10.14	192.71

Status of phosphorus and potassium fractions in soils of Nelamangala taluk, Bangalore rural district

The result given in Table 4 indicate the phosphorus fractions (Al-P, Fe-P, Ca-P, Occl-P, Red-P and total-P) status in soils coming under Nelamangala taluk, Bangalore rural district. The results indicated that aluminium phosphorus in soils varied from 17.55 to 89.67 mg kg^{-1} with a mean value of 44.35 mg kg^{-1}. The iron bound phosphorus in soils ranged from 20.04 to 107.50 mg kg^{-1} with a mean value of 54.84 mg kg^{-1}. The calcium bound phosphorus in these soils varied from 20.48 to 199.76 mg kg^{-1} with a mean of 59.64 mg kg^{-1}. Compared to mean calcium bound phosphorus, mean alumnium phosphorus and iron bound phosphorus were recorded higher due to acidic to neutral pH. Lower occluded and reductant soluble phosphorus were found in all these soils compared to Al-P, Fe-P and Ca-P. The similar trend was also followed in Kalaivanan and Sudhir (2012) [15].

The fractions of phosphorus were in the order of total P >Ca-P > Fe-P > Al-P > Red-P >Occl-P. Chang and Jackson (1957) [6] observed that highly weathered soils always contained appreciable amount of reductant soluble P and occluded forms of P. This result was in conformity with Kothandaraman and Krishnamoorthy (1979) [18], Sheela (2006) [38] and Doddamani (1982) [10]. They observed high content of Al-P and Fe-P in red and lateritic soils of Tamil Nadu and Karnataka and it was attributed to high content of sesquioxides, low pH and advanced stages of weathering. The Fe-P content was highest in surface soils due.

Table 3: Status of secondary and micro nutrients in soils of Nelamangalataluk, Bangalore rural district.

S. No	Farmer's name	Village name	Ca	Mg	S	Micro nutrient (mg kg^{-1})				
			[c mol (P^+) kg^{-1}]		(mg kg^{-1})	B	Zn	Fe	Cu	Mn
1	Rangaswamiah	Makenahalli	2.00	0.75	24.24	0.15	0.50	12.92	1.22	9.50
2	Venkatagiriyappa	Bugudihalli	2.50	1.50	21.44	0.11	0.75	23.84	2.30	10.53
3	Siddarajappa	Adivasagalli	1.25	0.75	14.69	0.30	0.75	10.17	0.69	14.46
4	Naveen, R.S	Thyamagondlu	3.25	1.50	12.40	0.17	1.50	8.98	1.64	22.84
5	Siddalingappa	Mylayahalli	3.50	1.30	23.97	0.13	1.00	15.54	2.08	6.36
6	Hanumantharayappa	Basavanahalli	5.75	2.50	13.96	3.10	5.50	15.68	2.95	27.00
7	Thimmahanumaiah	Mallumghatteri	3.50	1.75	11.53	0.13	1.75	30.24	1.28	21.25
8	Sriramaih	Kundanahalli	5.25	2.25	28.64	0.12	2.25	17.98	1.65	32.95
9	Narayanaswamy	Thyamagondlu	9.25	4.25	18.00	0.24	6.25	15.33	2.79	22.96
10	Srinivas, V	Enchenahalli	4.25	1.25	23.26	0.13	1.25	14.94	2.79	10.51
Range			1.25-9.25	0.75-4.25	11.53-28.64	0.11-3.10	0.50-6.25	8.98-30.24	0.69-2.95	6.36-32.95
Mean			4.05	1.78	19.21	0.46	2.15	16.56	1.94	17.84
SD			2.29	1.03	5.90	0.93	2.04	6.32	0.77	8.79

to the presence of more organic carbon which provides organic acids which leads to solubilization of iron to ferrous form along with phosphates resulting in precipitation of ferrous phosphates as reported by Chang and Juo (1963) [7], Sacheti and Saxena (1973) [34] and Kalaivanan and Sudhir (2012) [15]. The low content of Ca-P in the soils may be due to low pH and low calcium carbonate content (Negassa and Leinweber, 2009) [26]. Low amount of Ca-P and high content of Al-P and Fe-P in the soils of Karnataka confirmed that the soils were considered to be more weathered Kalaivanan and Sudhir (2012) [15]. The occluded and reductant soluble phosphorus ranged from 12.92 to 45.91 mg kg^{-1} and 13.06 to 46.90 kg ha^{-1} respectively with 26.86 and 29.09 mg kg^{-1} as a overall mean respectively. The total phosphorus ranged from 173.30 to 795.27 mg kg^{-1} with a mean value of 384.72 mg kg^{-1}. The fractions of potassium were in the order of Total K > Non exchangeable K > Exchangeable K > Water soluble K. Low status of these fractions in some soils because of the depletion of K due to crop removal (Divya, 2013) [9] and partly to the leaching of K with the colloidal fraction of the soil to the lower layers. The amount of total K which depended largely upon the clay content and type of clay mineral present in the soils (Mehrotra *et al*., 1973) [25] might be the cause for huge amount of total potassium. Continuous application of FYM and NPK fertilizer enhanced the water soluble potassium to a considerable extent. The results are similar to Pannu *et al*. (2002) [27] and Gurumurthy and Vageesh (2007) [2]. The results pertaining to the status of potassium fractions in soils collected from different villages of Nelamangala taluk, Bangalore rural district are presented in Table 5. According to the results, the water soluble potassium ranged from 5.70 to 22.80 mg kg^{-1} with overall mean value of 11.59 mg kg^{-1}. The exchangeable and non exchangeable potassium in the range of 50.00 to 234.63 mg kg^{-1} and 201.45 to 864.89 mg kg^{-1} respectively with a mean of 107.62 and 423.04 mg kg^{-1} respectively. The total potassium ranged from 519.00 to 2634.35 mg kg^{-1} with 1463.10 mg kg^{-1} as overall mean.

Status of biological properties in soils of Nelamangala taluk, Bangalore rural district

The results presented in Table 6 revealed that the acid and alkaline phosphatase activity in soils belongs to Nelamangala taluk, Bangalore rural district. The results indicated that acid phosphatase activity in soils of Nelamangala in the range of 6.89 to 23.76 µg PNP g^{-1} soil hr^{-1} with a mean of 16.68 µg PNP g^{-1} soil hr^{-1}. The alkaline phosphatase activity ranged from 11.29 to 32.67 µg PNP g^{-1} soil hr^{-1} with a mean of 19.82 µg PNP g^{-1} soil hr^{-1}.The alkaline phosphates activity was found higher than acid phosphatase activity in most of soil sample. Because, most of these soils varied from acidic to alkaline pH. The conversion of organic P in to inorganic P forms is mainly governed by soil phosphatase activity. It is dependent on pH, organic carbon and P compounds of soil (Halstead and Sowden, 1986) [1].

Table 4: Status of fractions of phosphorus in soils of Nelamangala taluk, Bangalore rural district

S. No.	Farmer's name	Village name	Al-P	Fe-P	Ca-P	Occl-P	Red-P	Total-P
			(mg kg^{-1})					
1	Rangaswamaih	Makenahalli	41.53	46.57	32.05	23.61	31.29	340.58
2	Venkatagiriyappa	Bugudihalli	54.91	78.30	24.66	19.65	23.57	646.69
3	Siddarajappa	Adivasagalli	41.33	49.76	51.47	39.76	41.14	302.20
4	Naveen, R.S	Thyamagondlu	59.67	74.98	76.26	45.91	46.00	480.13
5	Siddalingappa	Mylayahalli	89.67	107.56	20.48	17.45	19.33	795.27
6	Hanumantharayappa	Basavanahalli	17.55	20.04	199.76	12.92	13.06	173.30
7	Thimmahanumaiah	Mallumghatteri	30.69	34.65	31.73	23.60	25.70	499.81
8	Sriramaih	Kundanahalli	49.65	70.93	57.07	45.15	46.95	213.97
9	Narayanaswamy	Thyamagondlu	24.56	27.85	77.77	19.12	21.52	195.31
10	Srinivas, V	Enchenahalli	33.97	37.81	25.19	21.47	22.38	199.90
Range			17.55-89.67	20.04-107.50	20.48-199.76	12.92-45.91	13.06-46.90	173.30-795.27
Mean			44.35	54.84	59.64	26.86	29.09	384.72
SD			20.68	27.34	53.54	12.06	11.78	214.00

Table 5: Status of fractions of potassium in soils of Nelamangala taluk, Bangalore rural district

S. No	Farmer's name	Village name	Water soluble K	Exchangeable K	Non-Exchangeable K	Total K
			(mg kg^{-1})			
1	Rangaswamaih	Makenahalli	10.00	82.00	364.63	1502.02
2	Venkatagiriyappa	Bugudihalli	8.00	65.13	243.30	732.65
3	Siddarajappa	Adivasagalli	6.00	59.07	221.05	592.13
4	Naveen, R.S	Thyamagondlu	16.10	145.34	674.00	2138.04
5	Siddalingappa	Mylayahalli	9.00	79.00	321.97	1327.99
6	Hanumantharayappa	Basavanahalli	22.80	234.63	864.89	2634.35
7	Thimmahanumaiah	Mallumghatteri	11.00	93.00	379.01	1629.11
8	Sriramaih	Kundanahalli	14.00	134.04	491.04	1823.64
9	Narayanaswamy	Thyamagondlu	5.70	50.00	201.45	519.00
10	Srinivas, V	Enchenahalli	13.30	134.02	469.06	1732.04
Range			5.70-22.80	50.00-234.63	201.4-864.8	519.00-2634.35
Mean			11.59	107.62	423.04	1463.10

Table 6: Status of phosphatase activity in soils of Nelamangala taluk, Bangalore rural district

S. No.	Farmer's name	Village name	Acid phosphatase	Alkaline phosphatase
			(µg PNP g^{-1} soil hr^{-1})	
1	Rangaswamaih	Makenahalli	20.89	15.2
2	Venkatagiriyappa	Bugudihalli	22.01	11.29
3	Siddarajappa	Adivasagalli	18.93	18.79
4	Naveen R.S	Thyamagondlu	22.67	13.28
5	Siddalingappa	Mylayahalli	23.76	14.35
6	Hanumantharayappa	Basavanahalli	6.89	32.67
7	Thimmahanumaiah	Mallumghatteri	11.78	22.17
8	Sriramaih	Kundanahalli	15.64	20.17
9	Narayanaswamy	Thyamagondlu	9.87	28.67
10	Srinivas, V	Enchenahalli	14.35	21.67
Range			6.89-23.76	11.29-32.67
Mean			16.68	19.82
SD			5.87	6.83

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