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Distribution of secondary nutrients under different land use in Hebburu micro-watershed of Chikkamagaluru district, Karnataka

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Abstract
The investigation was conducted at UAHS, Shivamogga to know the distribution of secondary nutrients under different land use in Hebburu micro-watershed. 158 soil samples were collected grid-wise under different land use *viz.*, coconut, arecanut, onion, chili, ragi, oilseed/pulse, uncultivable land and other horticultural land use were analysed for their fertility status. The texture of soils varied from sandy loam to sandy clay loam in texture. Results revealed that bulk density and particle density ranged from 1.09 to 1.88 and 1.80 to 2.87 Mg m^{-3}, respectively. The values of pH, electrical conductivity, organic carbon, cation exchange capacity, calcium carbonate equivalent and per cent base saturation ranged from 4.15 to 9.37, 0.01 to 3.07 dS m^{-1}, 0.60 to 9.60 g kg^{-1}, 0.20 to 128.60 g kg^{-1}, 6.31 to 135.80 c mol (p^+) kg^{-1} and 31.57 to 99.35 per cent, respectively. The distribution of secondary nutrients *viz.*, exchangeable Ca, exchangeable Mg and available S values in soils ranged from 1.70 to 52.25and 0.30 to 26.80 c mol (p^+) kg^{-1} and 0.26 to 9.51 mg kg^{-1}, respectively. Secondary nutrients showed positive and significant correlation with pH, clay, CEC and negative and significant correlation with BD.

Keywords: Secondary nutrients, land, Hebburu micro-watershed

Introduction
The introduction of high yielding varieties, use of high analysis secondary nutrient free fertilizers, scarce use of organic manures and adoption of intensive cropping due to increase in irrigation facilities, the deficiency of secondary nutrients in soils has been widespread in many states of India. Calcium (Ca), magnesium (Mg) and sulphur (S) occur in soils in different forms. Knowledge of distribution of different forms of secondary nutrient throughout the zone of root penetration is essential in improving Ca, Mg and S nutrition of crops.

In the discipline of soil fertility, Ca, Mg and S are put into the category of secondary nutrient, rather than primary or macronutrients as they are essential to crop development. Seasonal crop uptake is usually lower than the primary nutrients N, P, and K but considerably higher than the micronutrients. Ca, Mg and S deficiency are seen in the coarse textured soils with low organic matter status or in highly weathered soils. Keeping these points in view, the present investigation entitled, "Distribution of secondary nutrients under different land use in Hebburu micro-watershed of Ajjampura sub-watershed, Tarikere taluk, Chikkamagaluru district" was undertaken.

Material and Methods
The study area is Hebburu micro-watershed covering 95 percent of area under Ajjampura sub-watershed of Tarikere taluk, Chikkamagaluru district representing Southern Transition Zone of Karnataka, covering an area of 1037.59 ha. The climate of the study area is tropical climate with an average rainfall and elevation of the study area is 547 mm and 800.58 m above the Mean Sea Level (MSL), respectively. The relief is normally having nearly level (0-1%) to very gently sloping (3-5 %) in the dominant black soils. The basalt, granite and schist rocks majorly cover the Hebburu micro-watershed area. The predominant mineral noticed in the area is chlorite schist.

In order to study the distribution of secondary nutrients in Hebburu micro-watershed under different land use such as coconut, arecanut, onion, ragi, chilli, oilseeds/pulses (horse gram, castor and groundnut), uncultivated land and other horticultural land use Mango, marigold, banana and potato) were identified. The soil samples were collected grid-wise under different land use using village cadastral map. The soil samples were air dried, sieved through 2 mm sieve and analyzed for important physical and chemical properties *viz.*, particle size analysis (Piper, 1966) [15], bulk density, particle density, pH, electrical conductivity, organic carbon, calcium carbonate equivalent, cation exchange capacity, per cent base saturation, exchangeable Ca and Mg and available sulphur using standard procedures (Jackson, 1973) [8].

Results and Discussion

The results on physical, chemical properties, distribution of secondary nutrients of soils is given in the table 1, 2 and 3, respectively.

Physical properties of soils under different land use

The present study indicated that the results on sand, silt and clay content of soils under different land use varied from 8.91 to 80.87, 1.96 to 19.00 and 12.80 to 78.59 per cent, respectively. The texture of the soil in different land use system was between sandy loam to sandy clay loam. This may be due to the fact that those soils are derived from coarse grained and grano-diorite parent materials are normally exhibit coarse texture with higher sand particles. The soils were dominant in sand content but accumulation of clay and silt was observed in the subsurface layer with decrease in sand content. Similar results have been reported by Sahu and Mishra (1997).

The results on BD and PD of soils under different land use varied from 1.09 to 1.88 and 1.80 to 2.87Mg m^{-3}, respectively. The rate of change in bulk density, porosity, and soil strength was varied among soil textural classes as reported by Gomez *et al.* (2002) [6]. and also the land use changes from forest to agriculture resulted in significant decreases in organic matter and with this change, bulk density was increased significantly were obtained by the results of Javad *et al.* (2014) [10]. The lowest PD was found under different land use due to consequent of organic matter content of the soil. Low soil organic matter was responsible for decreased bulk density in cultivated soils similar results have been conducted by Ahukaemere and Akpan (2012) [1].

Chemical properties of soils under different land use

The data on pH of soils under different land use ranged from 4.15 to 9.37 indicating acidic to alkaline in nature. The data of pH values resulted in the calcareous soils may be due to fine sized smectitic group clay minerals translocation and the presence of $CaCO_3$ caused flocculation (Srinivasa Rao *et al.*, 2008) [17]. and higher pH values in soils attributed to the calcareous nature of parent material and $CaCO_3$ also reported by Balpande *et al.* (2007) [5]. The acidic nature of the soils under ragi land use might be attributed to the acid igneous and metamorphic rocks parent material and high rainfall which could leach out basic cations from the soil solum the similar results have been reported by Amara and Momoh (2014) [2].

The EC of soils results under different land use ranged from 0.01 to 3.07 dS m^{-1} indicating normal to very critical in range. The normal range of EC may be ascribed to presence of soluble salt to lower horizons due to its light textured nature (Kunal *et al.*, 2013) [13]. The resultson organic carbon of soils under different land use ranged from 0.60 to 10.5 g kg^{-1} indicating medium to high status in soil. The organic carbon content of soils results revealed that medium to high status in soils may be due to repeated application doses of FYM or due to decomposition of plant parts or due to high temperature leads to rapid oxidation of organic carbon as reported by Bali *et al.* (2010) [4].

Table 1: Physical properties of soils under different land use

Land use	No. of samples	Particle size distribution (%)						Bulk density		Particle density	
		Sand		Silt		Clay		(Mg m^{-3})			
		Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Coconut	37	33.56-77.20	56.09	1.96-16.60	7.87	14.20-54.33	35.32	1.12-1.88	1.40	2.19-2.87	2.36
Arecanut	12	30.25-73.80	58.00	1.98-16.40	7.55	12.80-54.75	34.68	1.11-1.63	1.35	2.32-2.62	2.47
Onion	74	27.20-77.18	46.19	2.40-18.80	10.23	30.01-59.50	41.69	1.09-1.76	1.35	1.80-2.80	2.33
Chilli	7	08.91-55.29	39.45	3.99-19.00	10.24	39.91-78.59	50.29	1.12-1.56	1.31	2.10-2.45	2.30
Ragi	8	67.40-80.87	71.73	3.98-17.20	8.16	14.20-24.16	20.11	1.35-1.76	1.53	2.36-2.75	2.59
Oilseed/ pulses	5	30.80-71.43	57.08	4.97-15.50	9.83	13.30-55.00	30.97	1.28-1.73	1.51	2.31-2.75	2.49
Uncultivable land	7	67.80-73.20	69.67	4.48-17.40	11.52	14.10-25.16	18.78	1.38-1.77	1.53	2.45-2.79	2.57
Other Horticultural land use	8	35.00-72.18	62.08	5.46-17.00	9.21	13.40-48.00	28.67	1.21-1.80	1.48	2.23-2.66	2.43

Table 2: Chemical properties of soils under different land use

Land use	No. of samples	pH		EC (dS m-1)		Organic carbon		CCE		CEC [cmol (p+) kg-1]		% BS	
						(g kg-1)							
		Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Coconut	37	4.15-9.37	7.82	0.04-2.82	0.46	0.60-9.00	6.00	4.00-99.00	67.90	15.32-114.1	47.05	31.94-98.81	68.67
Arecanut	12	6.24-8.70	7.82	0.07-2.77	1.04	3.10-9.60	5.70	3.20-94.00	46.40	8.58-69.11	38.38	49.26-92.74	72.36
Onion	74	4.65-8.86	7.79	0.01-3.07	0.41	0.60-10.5	4.80	17.20-128.6	78.90	18.50-135.8	78.29	30.26-98.74	59.24
Chilli	7	7.19-8.86	8.03	0.11-0.32	0.21	0.60-5.40	3.80	67.20-95.00	86.80	56.05-81.82	66.67	43.95-96.37	69.97
Ragi	8	4.47-5.91	5.17	0.19-2.47	1.57	0.90-6.60	3.80	0.20-32.20	10.50	6.50-30.85	16.65	25.13-49.63	37.33
Oilseed/ pulses	5	4.64-8.46	6.32	0.05-1.88	0.52	2.20-7.50	4.20	5.00-91.00	43.50	13.10-84.76	41.74	40.61-64.61	49.86
Uncultivable land	7	4.35-7.06	6.10	0.03-2.89	1.05	2.50-5.50	4.30	8.20-66.20	29.80	8.81-98.10	32.82	36.38-99.33	69.69
Other Horticultural land use	8	4.88-8.48	6.50	0.05-1.94	0.44	0.60-6.30	4.00	1.20-100.2	41.00	6.31-54.13	23.92	69.14-97.87	82

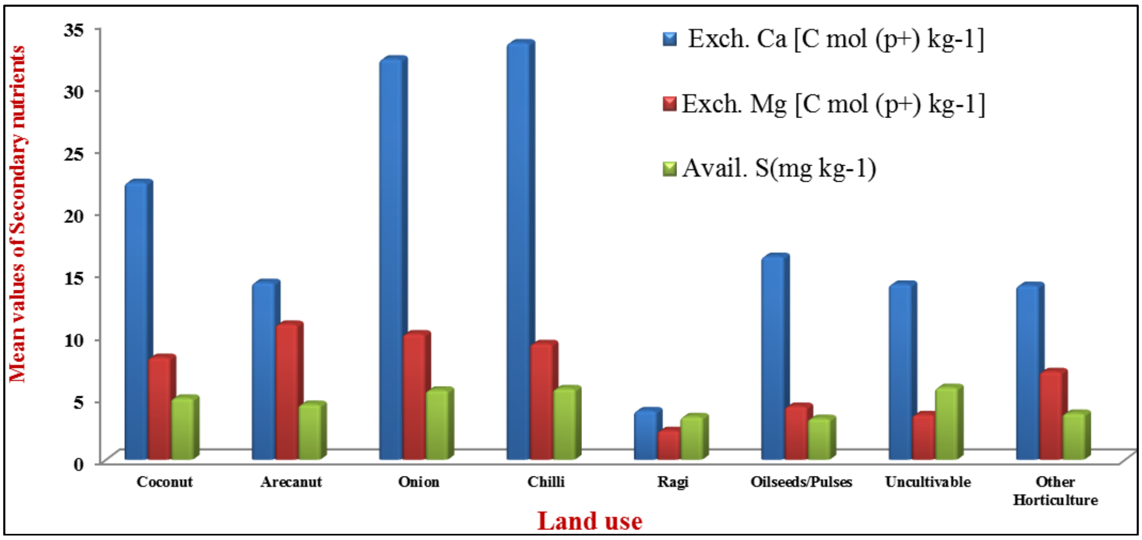

Fig 1: Secondary nutrient status of soils under different land use

Table 3: Correlation co-efficient (r) between secondary nutrient and soil properties under different land use

Parameters	Ph	Clay	BD	PD	OC	CCE	CEC	BS	Ca	Mg
Clay	0.526**	1.000								
BD	-O.428**	-0.562	1.000							
PD	-0.239**	-0.404**	0.258	1.000						
OC	0.223**	0.033	-0.041	-0.022	1.000					
CCE	0.612**	0.530	-0.252**	-0.358**	0.110	1.000				
CEC	0.428	0.553**	-0.348**	-0.374**	0.011	0.68**	1.000			
BS	0.112	0.008	-0.049	-0.050	0.124	0.110	-0.343**	1.000		
Ca	0.418**	0.570**	-0.331**	-0.410**	-0.011	0.728**	0.786**	0.064	1.000	
Mg	0.348**	0.323**	-0.257**	0.257**	0.094	0.214**	0.326**	0.292**	0.192*	1.000
S	0.199*	0.202*	-0.171*	0.024	0.029	0.122	0.294**	-0.167*	0.134*	0.161*

The results of present study found that the calcium carbonate of soils under different land use ranged from 0.20 to 128.60 g kg-1 indicating slightly calcareous to very high calcareous in nature. The precipitation of calcium carbonate from the solution rich in carbonate resulted in the high pH values (Paramasivan and Jawahar, 2014) [14]. The CEC of soils under different land use ranged from 6.31 to 135.80 cmol (p+) kg-1. Fine-textured soils (clay) usually have a greater CEC than coarse soils because of a higher proportion of colloids and reported that when humus is combined with clay, it increased soil CEC, while low pH reduces CEC. The same results were obtained by Habtamu *et al.* (2014) [7] and higher CEC values also attributed to the dominant smectitic clay mineralogy of the shrink-swell soils as reported by Kale *et al.* (2015) [11].
The results on per cent BS of soils under different land use ranged from 25.13 to 99.33 per cent indicating the BS depends mainly on the pH and basic cations present in the soil. The results of the per cent BS of these soils were more than 90 per cent and it increased with pH due to high amount of bases in the soil parent materials. The exchangeable cations and extractable bases were considerably highin soils. Among the exchangeable cations, Ca was predominant followed by Mg, Na and K. Similar observations were made by Paramasivan and Jawahar (2014) [14].

Distribution of secondary nutrients in soils under different land use

The exchangeable Ca of soils under different land use varied from 1.70 to 52.25 c mol (p+) kg-1. Exchangeable Ca showed a larger variation in Vertisols is due to the presence of free Ca carbonate in these soils as reported by Jagdish Prasad *et al.* (2007) [5]. Exchangeable Ca showed positive and significant correlation with pH, Clay, CCE, CEC and negatively significant correlation with BD and PD.The data on exchangeable Mg of soils under different land use ranged from 0.30 to 26.80 c mol (p+) kg-1. Magnesium was present in low amount than calcium. This could be attributed to higher mobility of Mg which is not strongly adsorbed on the clay and organic matter surfaces (Kavitha and Sujatha, 2015) [12]. Exchangeable Mg showed positive and significant correlation with pH, Clay, PD, CCE, CEC, BSand negatively significant correlation with BD.
The lower values of available sulphur status were found under different land use. The results of available sulphur varied from 0.26 to 9.51mg kg^{-1} indicating low rate of available S in status may be due to intensive agricultural practices including growing of crops and application of S free high analysis fertilizers besides ignoring application of organic manures to fields are causing quick depletion of soil S leading to widespread soil and crop deficiencies as reported by Anjali Basumatary and Das (2012) [3]. and Srinivasa Raju (2003). Available S showed positive and significant correlation with pH, Clay, CEC and negatively significant correlation with BD and per cent BS.

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