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Micronutrient status of soils in different medicinal and aromatic land use systems of Karnataka

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Abstract
Medicinal and aromatic plants, though minor crops but contribute significantly to rural economy and health security of the country. Micronutrients are essential for enzymes involved in many biosynthetic steps of secondary compounds of medicinal and aromatic plants. Recent studies indicated that imbalanced fertilizer application and deficiency of micronutrients in the soils is one of the major factors responsible for stagnation or decline in crop productivity of the land use systems. The deficiencies of micronutrients became a serious limitation in achieving optimum yield and quality of produce. Every micronutrient has certain specific role to play and their presence in optimum concentration is a must for the plant to complete its life cycle. However, excess concentrations of these nutrients can have multiple adverse effects on plant secondary metabolism. Productivity of these soils can be enhanced through balanced nutrient management by knowing the status of micronutrients of soils. Hence, present study was initiated to know the micronutrient status of soils which are used for growing extensively for aromatic and medicinal crops in Karnataka. Surface soil samples (0-15 cm) were collected from different Agro-ecological Zones of Karnataka covering land use systems like *Eucalyptus citriodora*, Davana, Palmrosa, scented geranium, Tulsi, Bajje (*Acorus calamus*), Amla, Vetiver and rosemary.
The preliminary studies indicated that boron and zinc are extensively deficit in all the land use systems studied. In *E. citriodora*, davana and Vetiver land use, maximum number of samples showed deficiency of zinc and boron. Whereas, zinc, iron and boron deficiency was prominent in tulasi and amla land use system, deficiency of iron and boron in scented geranium, Zn in rosemary and Zn, Mn, Fe, B in palmarosa land use system was observed.

Keywords: Micronutrients, Deficiency, Medicinal and aromatic crops, land use system, Karnataka

Introduction
Medicinal and aromatic plants (MAPs), though minor crops contribute significantly to rural economy and health security of the country. In general, medicinal plants are grown for their active principles and aromatic crops are grown for their essential oils. India is the second highest producer of essential oils. And the plant based system of health care is practiced since centuries in India. Synthetic drugs although used extensively, could not completely replace the medicines of traditional system. About 90% of modern drugs have molecules from raw plant sources. In recent years, an increasing interest in the cultivation and production of medicinal and aromatic plants has been noticed worldwide in order to meet the increasing demand by both phyto- medicinal sector and essential oil production.
Mineral nutrients are indispensable for the growth and development of plants as their deficiency limits crop production significantly. Like other plants, medicinal and aromatic plants also require mineral elements for their growth and development. However, their requirement varies with species. Recent studies indicated that imbalanced fertilizer application and deficiency of micronutrients in the soils is one of the major factors responsible for stagnation or decline in crop productivity of the different land use systems (Ramamurthy *et al.* 2009) [9]. Micronutrients are essential for enzymes involved in many biosynthetic steps of secondary compounds of medicinal and aromatic plants. The deficiencies of micronutrients became a serious limitation in achieving optimum yield and quality of produce. Every micronutrient has certain specific role to play and their presence in optimum concentration is a must for the plant to complete its life cycle. Fe is a part of the catalytic group for many redox

enzymes including the heme containing cytochromes and non-heme Iron-sulphur proteins as well as several oxidases (catalase, and peroxidases). It plays an essential role in chlorophyll synthesis, thylakoid synthesis and chloroplast development (Miller *et al*., 1995) [7]. Copper functions as a cofactor for a variety of oxidative enzymes including the photosynthetic electron superoxide dismutase. Similarly, Zinc act as a metal component for various enzymes or as a regulatory cofactor and for protein synthesis, photosynthesis, the synthesis of auxin, cell division, the maintenance of membrane structure and function, and sexual fertilization (Marschner, 1995) [6]. B plays role in pollen development and fertilization. However, excess concentrations of these nutrients can have multiple adverse effects on plant secondary metabolism. Therefore, the information regarding the status of available micronutrients is needed to realize the concept of importance of micronutrients in soils. Hence, present study was initiated to know the micronutrient status of soils which are used for growing extensively for aromatic and medicinal crops like *Eucalyptus citriodora*, Davana, Palmrosa, scented geranium, Tulsi, Baje, Amla, Vetiver and rosemary in different Agro-ecological Zones Karnataka.

Material and methods

Data collection and soil sampling

The secondary data on extent of spread under different MAP's in Karnataka, obtained from State horticulture department and CIMAP resource centre, Bangalore was used as base information for the study. The survey was conducted during 2011-13 in the districts having maximum area under MAP's cultivation. Sixty four surface samples (0-15 cm) from *Eucalyptus citriodora*, twenty five from davana, twenty four from tulsi, twenty from amla and ten samples from each of baje, geranium, palmrosa, vetiver and rosemary land uses were collected to assess the nutrient status.

Laboratory analysis

Before analyses, the collected soil samples were air dried and powdered with wooden pestle and mortar and passed through 2 mm sieve. For organic carbon, the soil samples were finely powdered to pass through a 0.25 mm sieve. Processed soil samples were analyzed in the laboratory. Soil pH was determined in 1:2.5 soil water suspension, potentiometrically using a pH meter (Jackson, 1973) [1]. Organic carbon was estimated by Walkley and Black's wet oxidation method (1934) [11]. Micronutrients *viz*. Fe, Mn, Zn and Cu were extracted by using DTPA extracting solution consist of 0.005 M diethylenetriaminepenta acetic acid + 0.01 M $CaCl_2$ $2H_2O$ + 0.1 N_triethanolamine buffered at pH 7.3 (Lindsay and Norvell, 1978) [5] and their concentration was estimated using atomic absorption spectrophotometer fitted with appropriate hollow cathode lamps under specific measuring conditions. Available B boron was determined by hot water soluble (HWS-B) method developed by Berger and Troug (1939) [2].

Results and Discussion

The soil chemical properties under different MAPs land uses varied considerably (Table 2). Most of the soils of MAP's land uses were acidic to alkaline in reaction excluding baje and rose merry (ranged from neutral to alkaline) with low to high organic carbon. The available Mn and Cu were sufficient in all the MAP's land uses, whereas Fe, Zn and B were deficient.

Available Fe: Table 2 indicated that the soil samples of davana and baje were sufficient for Fe status. Whereas, major proportion of samples (70 %) from tulsi, geranium, amla and palmarosa land uses were deficient in Fe. The low content of Fe may be due to higher soil pH.

Available Zn: Available Zn content in many of the MAP's land uses were fall under deficient category (Fig 2). However, the Zn content in soils of baje land use was found to be sufficient (Table 2). Whereas, higher number of samples for Zn deficiency was noticed in tulsi (80%), amla (60%) and *E. citriodera* (50%). The dominance of Zn deficiency may be attributed to low organic carbon content of major proportion of the MAP's soil samples (Naidu and Vadivelu, 2007; Srikanth *et al*., 2008) [8, 10].

Available B: Major proportion of soil samples under all MAPs were deficient in B (Fig. 3). Gerenium with 90 per cent, palmarosa with 80 per cent, *E. citriodera* with 70 per cent and vetiver with 65 per cent of samples deficient for B, indicating critical need for B replenishment in these soils. The lower available boron content in acid soils might be attributed to boron sorption to iron and aluminum oxide surfaces of soil minerals (Goldberg and Glaubio, 1985) [4]. In general, at low pH values solubility of micronutrient is high while at high pH solubility and availability of micronutrient to plants will decline (Brady and Weill, 2002) [3].

Table 1: Distribution of MAPs cultivation in the State

MAP's	Districts
Medicinal crops	
Amla	Mysore, Chitradurga, Tumkur
Baje	Tumkur
Tulsi	Bellary, Shivamogga, Uttara Kannada, Chikkamangalore
Aromatic Crops	
Davana	Chikkabalapura, Bangalore
Eucalyptus citriodora	Bangalore, Chikkabalapur, Dharwad, Kolar
Geranium	Davanagere, Chikkabalapura
Palmarosa	Bangalore
Rosemary	Chamarajanagar ,Mysore
Vetiver	Uttara Kannada

*MAP's-Medicinal and aromatic plants

Table 2: Soil chemical properties and micronutrient status in different MAP's land use systems

Soil properties	*E. citriodora*	Davana	Tulsi	Geranium	Baje	Vetiver	Amla	Rosemary	Palmarosa
pH									
Range	4.25-7.88	6.06-8.11	5.63-9.75	5.92-9.10	7.80-8.33	4.4-8.83	5.20-9.24	7.00-8.92	5.46-9.43
Mean	5.89	7.19	8.37	8.21	7.96	5.44	7.52	7.96	7.80
OC (%)									
Range	0.02-1.51	0.02-3.52	0.15-2.38	0.07-2.14	1.06-1.49	0.50-1.57	0.04-2.35	0.08-1.10	0.19-0.73
Mean	0.29	0.39	0.57	1.19	1.26	0.99	0.95	0.71	0.39
Cu (mg kg^{-1})									
Range	0.16-7.60	0.84-3.70	0.36-6.24	2.60-4.60	5.94-14.20	0.22-13.60	0.42-4.58	0.96-2.86	0.32-1.12
Mean	1.76	1.74	1.33	3.40	8.85	3.40	1.97	1.69	0.75
Zn (mg kg^{-1})									
Range	0.2-7.0	0.40-8.46	0.08-2.48	0.60-4.00	1.66-9.42	0.16-3.26	0.04-5.94	0.30-7.82	0.34-3.16
Mean	1.32	2.28	0.67	1.24	4.90	0.98	0.98	2.23	0.96
Fe (mg kg^{-1})									
Range	2.30-62.38	6.42-29.90	1.60-105.90	3.62-24.00	50.14-82.94	3.18-63.50	3.90-55.54	2.70-20.70	1.40-20.80
Mean	20.28	17.79	14.61	7.88	64.69	28.53	19.46	11.64	8.63
Mn (mg kg^{-1})									
Range	3.04-78.00	5.74-79.00	2.00-58.20	9.58-22.58	5.26-10.04	3.62-56.06	6.78-51.60	9.60-35.80	1.00-50.00
Mean	26.69	19.67	9.74	14.23	7.92	23.68	20.93	19.51	11.30
B (mg kg^{-1})									
Range	0.01-3.61	0.03-1.71	0.03-2.92	0.09-0.89	0.52-1.36	0.04-0.98	0.03-1.46	0.10-1.69	0.14-1.18
Mean	0.56	0.62	0.74	0.35	1.08	0.39	0.70	1.00	0.69

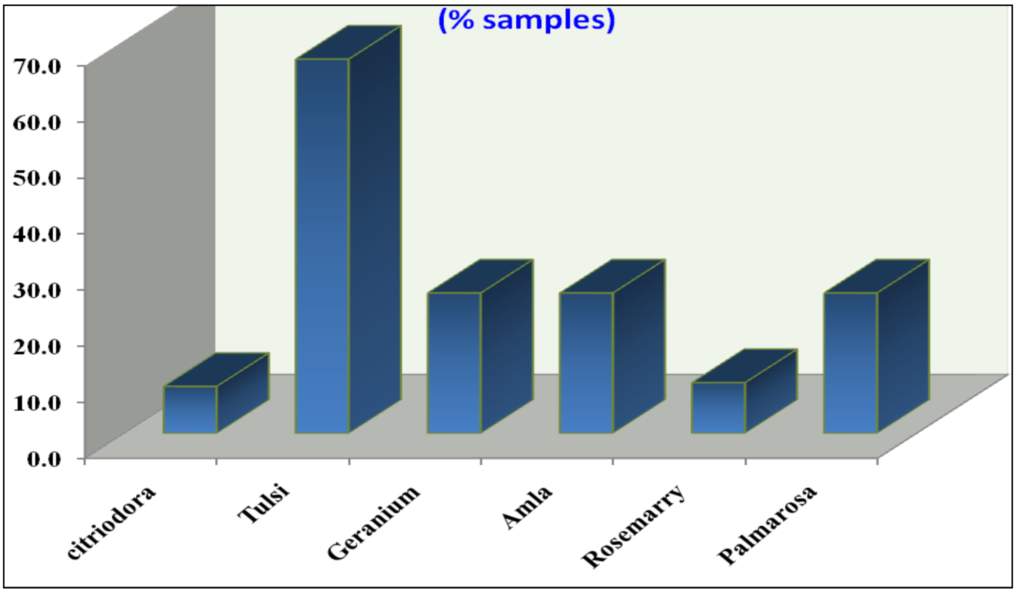

Fig 1: Per cent of samples under Fe deficiency in different MAP's Land Use Systems

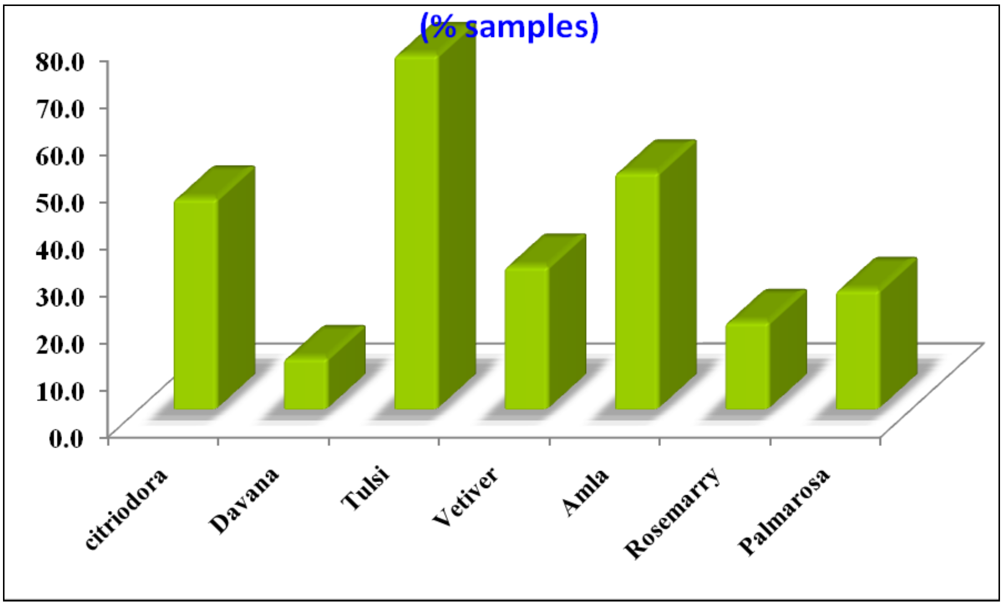

Fig 2: Per cent of samples under Zn deficiency in different MAPs Land Use Systems

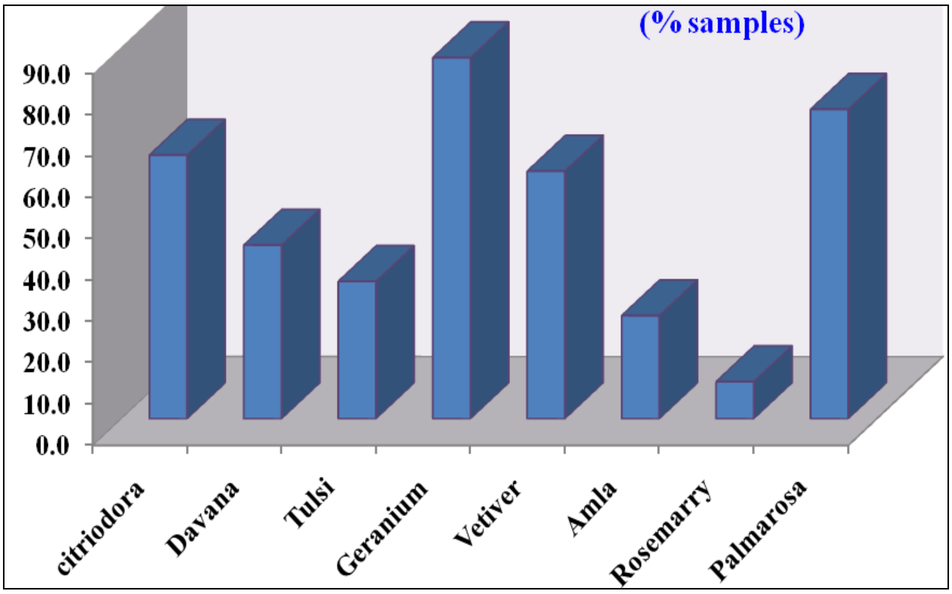

Fig 3: Per cent of samples under B deficiency in different MAPs Land Use Systems

Conclusion

Our study results indicated the remarkable differences in the micronutrient contents in different MAP's land use systems. In all the MAPs growing areas, Cu and Mn contents were sufficient where as Fe, Zn and B deficiency was most prominent except in baje. Hence, to improve the soil fertility and crop productivity, supply of these elements to the studied MAP's areas is essential.

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