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Foliar nutrient status of mango orchards in Dapoli Tahsil of Ratnagiri District (M.S.)

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Abstract
The present investigation was consisted collection of 500 leaf samples from five different mango orchards located in Dapoli Tahsil, of Ratnagiri district, during June 2023. All leaf samples were processed and analysed for the macro as well as micronutrient status, to study the variability of nutritional status of leaves of the selected mango. The variability observed in all orchards undertaken in this investigation was from 0.37 to 0.60 per cent in nitrogen. On an average, all selected five locations recorded 0.05 per cent P in leaves, which was found to be deficient. The average total potassium content ranged from 0.63 to 0.46. The potassium content in mango leaf sample were found to be low. The variation within the trees varied from 1.27 to 1.38 per cent of calcium in mango leaves. Optimum content of total Ca was found. The Magnesium content in leaves ranged from 0.39 to 0.58 per cent; which was noticed ‘low to optimum’. The Sulphur content in mango leaves recorded large variation within trees in all orchards. Average mean content of total sulphur varied from 0.06 to 0.14 per cent. The average iron content varied from 220.81 to 323.95 µg g^{-1} in all orchards, which was found to be deficient. The large variation of average total manganese content was observed i.e. 273.98 to 658.44 µg g^{-1} within orchards. The mango orchards showed ‘optimum to excessive’ content of total manganese in mango leaves. On an average, the high zinc content was varied from 21.24 to 16.86µg $g^{-1,}$ and showed ‘optimum to high’ content of total zinc in mango leaves. The average copper content varied from 6.09 to 30.50 µg g^{-1} within orchards. Status of total Cu was found to be ‘excessive’. The total Boron average range ranged from 21.99 to 35.67 in all the selected five orchard. It was observed that boron content in mango leaves showed large variation in all orchards.

Keywords: *Mangifera indica* L. nutrient, mango, orchards

Introduction

Mango (*Mangifera indica* L.) is popularly known as the ‘King of Fruits’ and considered as the ‘National fruit of India’. It is the most cultivated fruit in tropical regions categorized in the plant family named “*Anacardiaceae*”. Mango is originated in South East Asia, Indo Burma region (Mukherjee 1951) [2]. India has the richest collection of mango cultivars and is the most important and commercially grown fruit crop of the country. India is bestowed with mango germplasm, thus more than 1000 varieties are able to produce I mn the country. However, only a few *viz.*, Alphonso, Banganpally, Chausa, Dashehri, Langra, Totapuri and Kesar are commercially cultivated in India (Yadav, 1997) [1]. Mango is cultivated commercially in 111 countries. Mango is grown in tropical and subtropical areas of India. With an annual yield of over 20772.30 thousand tonnes and a productivity of 8.8 MT ha^{-1}, they are grown across an area of 2350.30 thousand hectares and account for more than 55 percent of global production (INDIASTAT, 2023) [3]. Major mango producing states in India are Uttar Pradesh, Andhra Pradesh, Karnataka, Bihar and Telangana However, Maharashtra in production with 459.15 thousand tons from an area of 164.40 thousand hectares and a productivity of 2.79 MT ha^{-1} (NHB, 2022a) [4]. The Konkan, Ratnagiri and Sindhudurg, is popularly known as the basket of Alphonso mango. It produces 0.32 million tons of mango from an area of 0.12 million hectares with a productivity of 2.56 MT ha^{-1} which is meagre to the national productivity (DAC&FW, 2022b) [5].

Alphonso is known as the king of mangoes, and Konkan-grown mangoes are renowned both domestically and internationally for their deliciousness. The scent is the most important warning indicator. The Ratnegiri and Sindhudurga having approximately 10.73 lakh hectares is covered by laterite and lateritic soils formed from basalt during the laterization process (Kadrekar *et al*., 1981) [6]. These soils have low native fertility and nitrogen retention capacity, and some macro-and micronutrients are also lost as a result of the undulating terrain and heavy rainfall. Mango fruit is very popular with the masses due to its wide range of adaptability, high nutritive value and richness in variety, delicious taste and excellent flavour. It is a rich source of vitamin A and C. Macro and micro nutrients in soil plays an important role on production and quality of Mango.

In Konkan region of Maharashtra mango trees suffer from a deficiency of macro and micronutrients due to heavy rainfall and leaching effect of soil. These nutrients if supplied in the right amounts and time can boost the economic yield of the tree. Timely identification of nutrient stress could help avoid deficiencies and yield loss in plants. (Thenkabail *et al.*, 2004; Jongschaap and Booji, 2004) [7, 8]. Thus, monitoring the variability of nutrients is an important component of precision agriculture.

Materials and Methods

In present study, five orchards from Dapoli tehsil of Ratnagiri district were selected and 500 leaf samples (100 from each orchard) were collected from mango. Leaf samples were collected from mature plants yielding fruits with an approximate age of 8–10 years. The 4–7-month-old leaf with petiole from the middle of the shoot was collected during the post-fruiting season, i.e., June of 2023. The sampling was undertaken for 5 days. The post fruiting season was selected in the view that the plant is exhausted of nutrients due to the fruiting in the previous season and gives the actual idea of the nutritional status. The fertilizer application is normally recommended in the second fortnight of June or the end of the monsoon season (second fortnight of September). The post-fruiting stage was ideal for the study to get actual nutritional status and to make the fertilizer prescription for the subsequent season. The samples were collected on dry sunny days.

The detached mango leaf samples, were oven-dried at 60 ± 2 °C to attain a constant weight. These were then powdered and stored polythene bags under dark conditions and ambient temperature for further chemical analysis. Pre-digestion of powdered leaf samples was carried out using a digestion mixture (nitric acid and perchloric acid in a ratio of 9:4 v/v proportion) and digested samples were subjected to analysis of P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, and B (Singh *et al.*, 1999) [10]. The leaf samples were digested in H_2SO_4 and made colourless by adding 30% H_2O_2 and cooled. The digested material was transferred to 25 ml volumetric flask and final volume was made 25 ml with distilled water with repeated washing of digestion flasks and the total nitrogen content was determined by Kjeldhal plus apparatus (Tandon, 1993) [9]. The leaf P concentration was determined by measuring the intensity of the yellow colour developed by the vanado-molybdate reagent with a spectrophotometer (Chopra and Kanwar, 1978) [11]. The Potassium content was estimated using flame photometrically by feeding diluted di-acid digested solution (Piper, 1950) [12]. Total Ca^{++} and Mg^{++} were determined titrimetrically by using known quantity of di-acid digested leaf extract by using Versenate method given by Chopra and Kanwar (1978) [11]. Total sulphur was determined by turbimetrically and turbidity developed by barium chloride was measured spectrophotometrically at 420 nm wavelength**.**

Micronutrients i.e. Cu, Zn, Fe and Mn in the digested sample were estimated by using atomic absorption spectrophotometer (Mclaren and Crawford, 1950) [14]. The B concentration of the digested samples was estimated by measuring the pink colour intensity developed in the digest by Azomethine-H indicator by spectrophotometer.

Results and Discussion

The data related to nutrient content (total N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B)in mango leaves from five different orchards viz., Agronomy Organic Farm, Center of Excellence for Mango, Nursery no. 14, Pangari block and Wakawali block Dr. B. S. K. K. V., Dapoli Dist, Ratnagiri, Maharashtra, are presented in Table 1

The variability observed in all orchards undertaken in this investigation was from 0.37 to 0.60 per cent nitrogen in mango leaves. This might be due to the topographic elevation of all orchards. The minimum average nitrogen (0.37) concentration recorded in nursery No. 14 orchard in which all commercial production of mango was undertaken, which was near to Pangari block orchard i.e. 0.60 per cent N in mango leaves. Similar results on variability of total nitrogen content was observed by Raghupathi and Bhargava (1999) [15] and Ganeshmurthy *et al*. (2013) [16] for Alphonso mango of Ratnagiri district. On an average, all selected five locations recorded 0.05 per cent P in mango Leaves, which found to be deficient. All the selected orchards are located under lateritic soil in which mostly the phosphorous is used to fixed in Al-P or Fe-P in the complexes, because of which the availability is very low, indirectly reflected in mango leaves. The variability of P content in the current study was as per the leaf nutrient norms suggested by Ganeshmurthy *et al*. (2013) [16]. Similarly, more or less similar values of total phosphorus were reported by Dabke *et al*. (2013) [17], More (2013) [19], Joshi *et al*. (2015) [18] and Puranik *et al*. (2015) [20]. The total potassium average range ranged from 0.63 to 0.46 in all the selected five orchard. The potassium content in mango leaf sample were found to be low as per the leaf nutrient norms Excessive leaching of basic cations due to heavy rainfall results in the deficiency of K in this region which is very well reflected in the plant nutrient status. Also, the plants are exhausted potassium during the fruiting stage and thus deficiency might have been observed in the post-fruiting stage. The potassium also get depleted during month of summer because of high atmospheric as well as soil temperature. These figures are in conformity with Dabke *et al*. (2013) [17], More (2013) [19], Joshi *et al*. (2015) [18] and Puranik *et al*. (2015) [20].

Even though the lateritic soil of Konkan are in general deficient in calcium, the variation within the trees in orchards undertaken varied from regarding calcium in mango leaves. Optimum content of total Ca was found in mango leaves as per the norms given by Raghupathi and Bhargava (1999) [15]. Similar values of total Ca were also denoted by Puranik (2015) [20]. The magnesium content of mango leaves ranged from 0.39 to 0.58 per cent in the mango orchards showed ‘low to optimum’ content of total magnesium in mango leaves. As per the ratings given by Raghupathi and Bhrgava (1999) [15], the mango orchards showed ‘low to optimum’ content of total magnesium in mango leaves. Similar trend was observed by Puranik (2015) [20]. The value of S content in mango leaves recorded large variation within trees in all orchards. The trees also located at different elevation because of which sulphur content was very low. But average mean content of total sulphur varied from 0.06 to 0.14 per cent in all orchards. Similar results for total sulphur were observed by Thakre (2016) [21].

The average iron content in mango leaves varied from 220.81 to 323.95 µg g^{-1} in all orchards, which was found to be deficient. The above results are more or less similar to Joshi (2015) [18]. Thakare (2016) [21] and More (2013) [19] quoted similar Fe content in mango leaves. The variation of average total manganese content was observed from 273.98 to 658.44 µg g^{-1} within orchards. The mango orchards showed 'optimum to excessive' content of total manganese in mango leaves. Which might due to varying amount of fertilizer applied through foliar as well as soil application. The centre of excellence of mango orchard recorded highest mean value of 658.44 µg g^{-1}regarding manganese content in mango leaves. Similar magenese content at different growth stages was reported by Joshi (2015) [18], More (2013) [19] and Thakare (2016) [21]. On an average, the high zinc content was found in orchard under lateritic soils of Konkan, which was varied from 21.24 to 16.86µg g^{-1} the mango orchards showed 'optimum to high'content of total zinc in mango leaves. More or less similar results has been observed by Ganeshmurthy *et al*. (2013) [16] for Alphonso mango of Ratnagiri district. In lateritic soils of Konkan, More (2013) [19] and Joshi (2015) [18] also reported excessive status of total Zn. The average copper content varied from 6.09 to 30.50 µg g^{-1} within orchards. The status of total Copper was found to be 'excessive'. Similar result like zinc content in mango leaves were recorded with respect to copper content. Status of total Cu was found to be 'excessive' as per the ratings given by Raghupathi and Bhargava (1999) [15] and Ganeshmurthy *et al*. (2013) [16] for Alphonso mangos of Ratnagiri district. The average total Boron content ranged from 21.99 to 35.67 µg g^{-1} in all the selected five orchard. It is observed that boron content in mango leaves showed large variation in all orchards. This variation might be due to the variation in the topography. The tree located at hill/terrace might be low in boron content which reflects in leaves. The accumulation of boron at low land in general of high amount, in result it reflects in leaves. Joshi (2015) [18] observed more or less similar values in the following experiment followed by him.

Table 1: Variability of nutritional status of mango leaves from five different orchards

Sr. No.	Orchard Locations	Nutrients											
			N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Fe (µg g^{-1})	Mn (µg g^{-1})	Zn (µg g^{-1})	Cu (µg g^{-1})	B (µg g^{-1})
1	Agronomy organic farm	Minimum	0.56	0.08	0.78	1.96	1.24	0.20	2046.25	680.36	59.54	13.44	70.50
		Maximum	0.25	0.01	0.28	0.76	0.12	0.01	143.84	78.35	12.85	1.35	5.50
		Average	0.37	0.05	0.54	1.27	0.45	0.11	250.72	273.98	22.90	6.09	26.51
2	Center of excellence for Mango, Department of Horticulture	Minimum	1.54	0.09	1.06	2.36	1.48	1.23	736.71	1386.92	282.00	66.08	112.00
		Maximum	0.20	0.01	0.23	0.68	0.12	0.01	89.50	227.77	10.71	7.17	9.00
		Average	0.49	0.05	0.52	1.35	0.58	0.14	220.81	658.44	27.63	21.24	35.67
3	Nursery no. 14, Department of Horticulture	Minimum	0.78	0.10	1.00	2.84	1.24	0.27	785.81	1075.96	35.50	65.94	81.00
		Maximum	0.39	0.01	0.39	0.88	0.20	0.04	155.38	225.57	9.94	1.95	3.50
		Average	0.61	0.05	0.63	1.38	0.48	0.14	323.95	487.46	16.86	10.62	21.99
4	Pangari block	Minimum	0.98	0.09	0.68	1.88	1.92	0.21	817.31	827.19	66.25	52.61	78.50
		Maximum	0.42	0.02	0.18	0.64	0.24	0.02	103.86	80.70	9.37	4.26	7.00
		Average	0.60	0.05	0.46	1.32	0.55	0.13	268.16	389.56	18.47	20.58	24.98
5	Wakawali block	Minimum	1.23	0.10	1.02	2.08	0.76	0.15	754.12	848.54	42.84	53.34	315.00
		Maximum	0.22	0.01	0.25	0.44	0.12	0.00	63.25	55.94	7.80	3.53	0.01
		Average	0.48	0.05	0.63	1.31	0.39	0.06	257.91	349.57	18.31	30.50	29.27

The correlation matrix of the mango leaf nutrient content revealed interesting relationships with each other (Table 2) The total N correlated significantly with Fe (r = 0.099, p<0.05) and Cu (r = 0.118, p<0.05) with each other. The Zn had significant and negative (r = -0.138, p<0.01) correlation with total N whereas it was significant and positive with Mn (r = 0.187, p<0.01). The total P strongly and positively correlated with K (r = 0.134, p<0.01), Fe (r = 0.266, p<0.01), Zn (r = 0.160, p<0.01) and Cu (r = 0.195, p<0.01). The total K strongly and positively correlated with Ca (r = 0. 180, p<0.01), Fe (r = 0. 217, p<0. 01), and Cu (r = 0. 111, p<0.05). Whereas S had significant and negative (r = -0.127, p<0.01) correlation with total K. The total Ca and Mg, S, Fe, Cu correlated significantly (r = 0.161, p<0.01), (r = 0.100, p<0.0.05), (r = 0.142, p<0.0.01) and (r = 0.267, p<0.01) respectively with each other. Further, the total Mg positively correlated with S (r = 0.185, p<0.01), Fe (r = 0.109, p<0.01), Mn (r = 0.291, p<0.01) and Zn (r = 0.161, p<0.01). The total S and Mn correlated (r = 0.120, p<0.01) with each other whereas Cu had significant and negative (r = -0.179, p<0.01) correlation with total S. The total Fe and Mn correlated significantly with Zn (r = 0.156, p<0.01) and (r = 0.166, p<0.01) respectively. In general, correlation was significant among the nutrients but it was weak and very poor, which is indicated by a very low value of the correlation coefficient. Presence of weaker correlation among the nutrients makes the dataset a little more suitable to employ for the spectroscopy or remote sensing studies.

Table 2: Correlation matrix of the mango leaf nutrient contents (n = 500).

	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B
N	1.000										
P	-0.004	1.000									
K	0.072	0.134**	1.000								
Ca	0.084	0.003	0.180**	1.000							
Mg	0.072	0.003	-0.093	0.161*	1.000						
S	0.091	0.021	-0.127*	0.100*	0.185**	1.000					
Fe	0.099*	0.266**	0.217**	0.142**	0.109*	0.023	1.000				
Mn	0.187**	-0.088	0.014	0.267**	0.291**	0.120*	-0.030	1.000			
Zn	-0.138**	0.160**	0.007	0.044	0.161**	0.081	0.156**	0.166**	1.000		
Cu	0.118*	0.195**	0.111**	0.068	0.079	-0.179**	0.041	0.060	0.059	1.000	
B	-0.027	-0.007	0.011	-0.004	0.004	-0.062	-0.017	-0.040	0.006	-0.045	1.000

Significant at 5%-*

Significant at 1%-**

Conclusion

It is observed that the total P (average, 0.05 per cent P in mango Leaves), Ca (1.27 to 1.38 per cent) and Fe (220.81 to 323.95 µg g^{-1}) found to be deficient; N (0.37 to 0.60 per cent), K (0.63 to 0.46), S (0.06 to 0.14 per cent) and B (21.99 to 35.67 µg g^{-1})were low; Mg (0.39 to 0.58 per cent), Mn (273.98 to 658.44 µg g^{-1}) and Zn (21.24 to 16.86µg g^{-1}) were optimum and Cu (6.09 to 30.50 µg g^{-1}) was excess in the mango leaves of selected orchards.

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