

Original Research Article

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## Periodical Changes in Soil and Leaf Micronutrients and their Relation to Yield from Alphonso Mango Orchards of Ratnagiri and Devgad, Maharashtra, India

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### ABSTRACT

Mango (*Mangifera indica* L.) belongs to family Anacardaceae is known as “King of fruits” and nectar of God being most palatable and rich in sugar, organic acids and minerals and thus captures great demand for all walks of life. To study Periodical soil and leaf nutrient status of Alphonso mango orchards from Ratnagiri and Devgad and their relationship with yield, two orchards from Ratnagiri talahsil viz. Warwade-1 and Warwade-2 and two from Devgad talahsil viz. Padel and Rameshwar were selected. The analysis of available soil nutrients showed to be sufficient in micronutrients (Fe, Mn, Zn and Cu). While the concentration of nutrients in leaf to be deficient in Fe, high in Mn, high to excess in zinc and excess in Cu. The DTPA extractable micronutrients in soil and total micronutrient contents in leaves showed various trends at all locations. In case of yield, the highest yield was observed at Warwade-2 while, lowest at Rameshwar amongst all locations. The available micronutrients viz. Fe, Mn, Zn and Cu while, micronutrient contents in leaf viz. Fe and Mn were significantly correlated with yield.

#### Keywords

Periodical nutrients, Micronutrients, Ratnagiri, Devgad, Alphonso mango, Yield.

#### Article Info

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### Introduction

Mango (*Mangifera indica* L.) belongs to family Anacardiaceae and originating in South East Asia. It is important fruit crop of India grown in area of 4.95 million ha producing 37.12 million tons showing a productivity of 7.51 tons/ha (Anonymous, 2015). Besides taste and good qualities, it is called “The King of Fruits”. The Konkan region of Maharashtra is famous and well known for mango production. Particularly, the two districts of the region viz. Ratnagiri and Sindhudurg are known as ‘Mango baskets’.

However, the production efficiency of mango orchards can be partially attributed to variations in soil and leaf nutrients (Ray and Mukherjee, 1982). In addition to this, under nutrition and negligence of orchards due to improper management practices are thus been the important reasons affecting the yield in the region (Reddy *et al.*, 2003).

Micronutrients play a vital role in various enzymatic activities and synthesis of assimilates and hormones. As such, much

work has been done in soils of mango orchards in the Konkan region but very little work has been done in respect of stages. Hence, in light of the available information, sparse related research and to overcome the nutritional problems, the present investigation was undertaken.

## **Materials and Methods**

Survey of four mango orchards comprising of Alphonso mango variety was done in present study. Two orchards from Ratnagiri tahasil especially at Warwade-1 and Warwade-2 and two from Devgad tahasil viz. Rameshwar and Padel were selected. Fifteen trees from each orchard were included in the study.

From each mango orchard, the surface soil samples (0-15 cm) were collected from fertilizer ring periphery of each tree while, leaf samples of three to four months old and situated at fourth and fifth position from terminal bud were collected at pre-flowering, flowering, egg stage and at harvest stage by following standard method of collection of soil and leaf samples (Tandon, 1993).

The micronutrients in soil were obtained by DTPA method (Lindsay and Norvell, 1978) while, micronutrients in leaf were estimated by using atomic absorption spectrophotometer (Mclaren and Crawford, 1950).

## **Results and Discussion**

The results obtained are presented in appropriate tables and discussed under suitable headings with abbreviations as follows. The values given in table 2 and 3 are the mean of 15 samples.

### **Abbreviations**

W-1= Warwade-1; W-2; Warwade-2; R= Rameshwar; P= Padel; PF=Pre-flowering;

FF= Full Flowering; E= Egg stage; AH= At Harvest

### **Soil micronutrients**

#### **Available iron (Fe)**

The data prescribed in table 2 observed no any definite trend at all locations from pre-flowering up to harvest. Considering the threshold values for available Fe given by Lindsay and Norvell (1978) all the soil samples had sufficient available iron content. Similar ranges of available Fe was also reported by Patil and Meisheri (2004). The increase in the content may be due to addition of manures and which may be responsible for creating more availability of nutrient. However, its decrease might be attributed to its absorption from soil by tree for flowering and fruit development (Yawalkar *et al.*, 2011). Organic amendment especially FYM increases the concentration of many nutrients. Organic acids such as citric, malic, oxalic and phenolic that form Fe complexes are released when organic matter decomposes. These Fe complexes enhance the mobility and bioavailability of Fe (Lindsay, 1991). The high content of available Fe was found in the surface soils and it may be due to accumulation of sesquioxides and also high organic matter content which keeps iron in complexes and available form (Katyal *et al.*, 1982). Diwan, (1982) also explained that the sufficient amount of available Fe in lateritic soil may be due to laterization processes in which sesquioxides accumulate to increase the Fe content and also it may be attributed to low pH and higher organic matter content of soil.

#### **Available manganese (Mn)**

The available manganese gradually decreased from pre-flowering to flowering stage. At egg stage, it found to be increased and again

decreased at harvest of fruits at all locations except Warwade-2. At Warwade-2, the available Mn content in soil increased up to flowering stage and further decreased at harvest (Table 2). The increase in manganese content may be due to addition of organic manures and enhancement of microbial activity and its decrease might be attributed to its use by tree for flowering and production (Pathmanabhan *et al.*, 2008). In general, all the mango orchards showed adequate amount of available Mn content on the basis of critical limits given by Lindsay and Norvell (1978). The high concentration of available Mn may be due to decomposition and mineralization of organic matter due to warm and humid climate of the region (Mehta and Patil, 1967) and might be due to chelating action of organic compounds released during the decomposition of manures (Chinchmalatpure *et al.*, 2000).

#### **Available zinc (Zn)**

In case of available zinc, the decreasing trend was observed from pre-flowering stage up to egg stage. At harvest of the fruits, the available zinc got decreased at all locations except Warwade-1. At warwade-1, decreasing trend was observed from pre-flowering stage up to harvest. As per the critical limits given by Lindsay and Norvell (1978) all the soil samples were sufficiently supplied with available Zn at all locations. In this context, Patil *et al.*, (2010) and Pawar (2012) observed the similar ranges of available zinc in mango orchards. In general, adequate level of available Zn in lateritic soils might be associated with presence of large amounts of organic matter and hydrous oxides of Fe, Al or Mn (Tandon, 1993). The decrease in content may be due to its consumption through absorption by tree for its vegetative and reproductive growth (Emanuel and bloom, 2004). In this connection Tisdale *et al.*, (1993) explained that the increasing soil temperature increases the availability of zinc

to crops by increasing solubility and diffusion of  $Zn^{++}$ . The availability of zinc might be decreased due to decrease in temperature during flowering and egg stage of fruit.

#### **Available copper (Cu)**

As per the data given in table 2, decreasing trend was noticed at all locations except Rameshwar from pre-flowering stage up to harvest in case of available copper. At Rameshwar, decreasing trend was noticed from flowering stage up to harvest. According to the critical limit suggested by Lindsay and Norvell (1978), the available Cu content of soil showed sufficient range at all growth stages. The study of Mehta and Patil, (1967) also revealed that due to decomposition and mineralization of organic matter because of warm and humid climate of the Konkan region the concentration of available copper content in soil is higher. The similar values of available copper were also noticed by Salvi (1988). The decrease from flowering stage to harvesting stage at Padel location may be due to its consumption through absorption by tree for its vegetative and reproductive growth. At soil organic matter levels up to 8%, both organic and mineral surfaces are involved in Cu adsorption, while at higher concentration of organic matter, binding of copper takes place mostly on organic surfaces. For soils having similar clay and organic matter content, the contribution of organic matter to the complexing of Cu will be highest when the predominant clay mineral is kaolinite and lowest with montmorillonite (Tisdale *et al.*, 1993).

#### **Leaf nutrients**

##### **Total iron (Fe)**

At Warwade-1 and Rameshwar, the total iron content in leaf seen to have increased from pre-flowering to egg stage and found to have decreased at harvest. While, at Warwade-2

and Padel, no definite trend was noticed. At all growth stages, the range of available iron was deficient as per the nutrient norms given by Raghupathi and Bhargava (1999). Medeiros *et al.*, (2004) also observed increase in iron content of leaves at flowering stage over to pre-flowering stage and they have also noticed decrease in iron content at fruit ripening stage at Brazil.

The increase in content due to foliar application of micronutrients prior to flowering and up to egg stage and the iron content found to have decreased at fruit ripening stage because of its absorption by fruit for the development of fruit and its colour.

### Total manganese (Mn)

The periodic determination of total manganese of mango orchard of different

locations is presented in table 3. At Warwade-1 and Padel, the total manganese gradually increased from pre-flowering to flowering stage and then decreased up harvest.

While, at Warwade-2 and Rameshwar it increased up to egg stage and at harvest, it found to have decreased. As per the ratings given by Raghupathi and Bhargava (1999), the total manganese comes under high category at all growth stages. The increase in manganese content of leaves from pre-flowering stage to flowering stage at mango orchards of Brazil is studied by Medeiros *et al.*, (2004).

The increase in manganese content due to foliar application of micronutrients prior to flowering and found to have decreased up to fruit ripening stage due to absorption by fruit for the growth and development.

**Table.1** Schedule of manure and fertilizer application and foliar spray at different locations

Sl. No.	Particulars	Locations			
		Warwade-1	Warwade-2	Rameshwar	Padel
1	Manures	Ankur Plus (0.5:0.5:0.5 N:P:K) @ 15 kg tree <sup>-1</sup> in the II <sup>nd</sup> week of June	Green Gold (0.8:0.4:0.4 N:P:K) @ 20 kg tree <sup>-1</sup> in the II <sup>nd</sup> week of June	5 kg tree <sup>-1</sup> sugarcane pressmud in the III <sup>rd</sup> week of June	Soil application of 50 kg tree <sup>-1</sup> FYM in the III <sup>rd</sup> week of June.
2	Fertilizers	FeSO <sub>4</sub> and MnSO <sub>4</sub> @ 10 g tree <sup>-1</sup> each prior to flowering.	FeSO <sub>4</sub> and MnSO <sub>4</sub> @ 10 g tree <sup>-1</sup> each prior to flowering.	18:18:10 (N: P: K) @ 5 kg tree <sup>-1</sup> in III <sup>rd</sup> week of June.	10:26:26 (N: P: K) @ 5 kg tree <sup>-1</sup> in III <sup>rd</sup> week of June.
3	Foliar spray	00:52:34 (100g) + Ca, FeSO <sub>4</sub> , MnSO <sub>4</sub> , ZnSO <sub>4</sub> and CuSO <sub>4</sub> @ 10 g tree <sup>-1</sup> each prior to flowering 13:00:45 (100g) + CaSO <sub>4</sub> , FeSO <sub>4</sub> , MnSO <sub>4</sub> , ZnSO <sub>4</sub> and CuSO <sub>4</sub> @ 10 g tree <sup>-1</sup> each at pea stage of the fruit	00:52:34 (100g) + Ca, FeSO <sub>4</sub> , MnSO <sub>4</sub> , ZnSO <sub>4</sub> and CuSO <sub>4</sub> @ 10 g tree <sup>-1</sup> each prior to flowering 13:00:45 (100g) + CaSO <sub>4</sub> , FeSO <sub>4</sub> , MnSO <sub>4</sub> , ZnSO <sub>4</sub> and CuSO <sub>4</sub> @ 10 g tree <sup>-1</sup> each at marble stage of the fruit	11.4 g N, 1.75 g P, 10 g K, 13.5 g S, 5.25 g Zn, 6.25 g Cu, 5 g B, 3.25 g Mo, (Amrashakti) + 10 g KNO <sub>3</sub> and 10 g Ca, tree <sup>-1</sup> at flowering and marble stage of the fruit	11.4 g N, 1.75 g P, 10 g K, 13.5 g S, 5.25 g Zn, 6.25 g Cu, 5 g B, 3.25 g Mo, 10 g CaSO <sub>4</sub> , 10 g FeSO <sub>4</sub> and 5 g MnSO <sub>4</sub> tree <sup>-1</sup> at flowering and marble stage of the fruit

**Table.2** Average soil nutrient status at different stages of Alphonso mango orchards from different locations

Loc.	Available Fe ( $\mu\text{g g}^{-1}$ )				Available Mn ( $\mu\text{g g}^{-1}$ )				Available Zn ( $\mu\text{g g}^{-1}$ )				Available Cu ( $\mu\text{g g}^{-1}$ )			
	PF	F	E	AH	PF	F	E	H	PF	F	E	AH	PF	F	E	AH
W-1	41.61	42.23	42.43	38.37	109.57	78.00	136.25	33.00	1.13	0.92	0.62	0.60	5.42	4.74	4.62	3.90
W-2	75.91	74.13	62.02	53.89	138.86	174.75	175.29	84.02	2.86	2.70	1.07	1.64	7.65	7.53	6.99	5.77
R	29.09	34.73	34.81	37.07	78.75	45.20	79.58	68.10	1.22	1.12	0.64	1.35	5.85	5.98	5.78	5.41
P	116.74	112.31	102.17	162.42	102.53	31.75	79.66	64.63	4.31	4.20	2.43	5.26	6.79	6.21	6.19	6.10

**Table.3** Average leaf nutrient contents at different stages of Alphonso mango orchards from different locations

Loc.	Total Fe ( $\mu\text{g g}^{-1}$ )				Total Mn ( $\mu\text{g g}^{-1}$ )				Total Zn ( $\mu\text{g g}^{-1}$ )				Total Cu ( $\mu\text{g g}^{-1}$ )			
	PF	F	E	AH	PF	F	E	H	PF	F	E	AH	PF	F	E	AH
W-1	246.47	297.35	392.64	235.83	452.58	480.98	464.37	437.37	23.93	17.99	24.38	15.83	16.65	19.07	28.72	37.50
W-2	202.57	306.34	294.69	312.40	392.51	433.46	450.69	429.43	24.04	30.41	21.43	15.19	20.31	24.01	9.64	26.83
R	210.13	268.35	311.97	237.63	471.82	536.15	560.86	484.05	23.10	24.04	22.19	14.60	20.98	19.80	11.00	95.00
P	286.84	284.33	485.22	295.85	315.34	391.17	379.23	328.04	39.10	30.71	26.33	19.05	27.95	23.67	16.07	91.65

**Table.4** Yield of mango orchard of different locations

Contents	Locations			
	Warwade-1	Warwade-2	Rameshwar	Padel
Average Yield(kg tree <sup>-1</sup> )	49.73	155.20	25.82	57.60

**Table.5** Correlation between available soil nutrients and yield of mango orchard of Different locations at different growth stages

Parameters	W-1 & W-2 (Ratnagiri tahasil)				R & P (Devgad tahasil)			
	PF	FF	E	AH	PF	FF	E	H
Fe	0.58*	0.67*	0.51	0.60*	0.68*	0.70	0.62*	0.76*
Mn	0.18	0.55*	0.18	0.58*	0.28	-0.35	-0.18	-0.08
Zn	0.61*	0.68*	0.27	0.59*	0.45	0.63*	0.49*	0.64*
Cu	0.59*	0.62*	0.58*	0.55*	0.04	0.10	-0.19	0.51*

**Table.6** Correlation between leaf nutrients and yield of mango orchard of Different locations at different growth stages

Parameters	W-1 & W-2 (Ratnagiri tahasil)				R & P (Devgad tahasil)			
	PF	FF	E	AH	PF	FF	E	H
Fe	-0.04	-0.02	-0.40	0.30	0.59	-0.02	0.48*	0.55*
Mn	-0.40	-0.28	-0.005	-0.08	-0.72	-0.28	-0.70	-0.75
Zn	-0.01	0.50*	-0.28	-0.25	0.22	0.50*	0.40*	0.45
Cu	0.41*	0.66*	-0.59	-0.20	0.46*	0.66*	0.55*	-0.06

### Total zinc (Zn)

At Warwade-1, the total zinc content in leaf decreased from pre-flowering stage up to flowering. At egg stage, it increased and again decreased at harvest stage. In case of Warwade-2 and Rameshwar it increased at flowering and further declining trend was observed up to harvest. While, at Padel decreasing trend was noticed from pre-flowering stage up to harvest of the fruits (Table 3). As per the nutrient norms given by Raghupathi and Bhargava (1999), the total zinc was excess at pre-flowering and egg stage, while it was optimum at flowering and harvest of the fruits. At Brazil, the increase or decrease in total zinc content in leaves of ‘Tommy Atkins’ mangoes at phenological stages was noticed by Medeiros *et al.*, (2004). The increase in total zinc might be due to foliar application on leaves and decrease may be due to its translocation from leaves to fruits as per requirement of fruit for its growth and development.

### Total copper (Cu)

The continuously increasing trend was observed from pre-flowering stage up to at harvest stage in case of total copper at Warwade-1 location. At Warwade-2, it decreased from pre-flowering stage up to flowering while, at egg stage, it increased and again decreased at harvest stage.

In case of Rameshwar and Padel, decreasing trend was observed up to egg stage and at harvest stage, it increased gradually. As per the nutrient norms of Raghupathi and Bhargava (1999), the total copper content was sufficient at all stages except harvesting stage.

At harvest, the total Mn content was excess. Similar values of copper up to egg stage were noticed by Sukthumrong *et al.*, (2000) and values of copper at maturity and the increasing trend of copper are in conformity with Medeiros *et al.*, (2004). The increase in nutrient content reflected due to application of foliar products containing nutrients and decrease in content at egg stage might be due to its translocation from leaves to fruit.

As seen from table 4 the average yield of Warwade-1, Warwade-2, Rameshwar and Padel locations were 49.73, 155.20, 25.82 and 57.60 kg tree<sup>-1</sup>. The average yield of Warwade-2 location was higher, while the average yield of Rameshwar was low amongst all locations.

### Correlation

In the present investigation, among the selected four mango orchards, Warwade-1 and Warwade-2 are in close vicinity in Ratnagiri tahasil while, Rameshwar and Padel are in close vicinity in Devgad tahasil. So for correlation purpose, correlation of nutrients was found out within Ratnagiri (including



both Warwade-1 and Warwade-2) and Devgad tahasil (including both Rameshwar and Padel). The data showed that available micronutrient content in the soil and total micronutrients in the leaf of Alphonso mango orchards were found to be positively and negatively correlated, which suggested the existence of dynamic equilibrium between them.

### **Correlation between available soil nutrients and yield of mango orchards**

A perusal of the data presented in table 5 revealed that available iron, available zinc and available copper exhibited positive and significant correlation with yield at pre-flowering stage; available iron, available manganese, available zinc and available copper at flowering stage; available copper at egg stage and available iron, available manganese, available copper and available zinc at harvest at Warwade-1 and Warwade-2 (Ratnagiri) locations.

Whereas positive and significant relationship was found between yield and available iron at pre-flowering stage; available zinc at flowering stage; available iron and available zinc at egg stage and available iron, available zinc and available copper at harvest of the fruits at Rameshwar and Padel (Devgad) locations. The positive and significant correlation indicates available soil micronutrients (Fe, Mn, Zn and Cu) proved beneficial in increasing fruit yield.

### **Correlation between available leaf nutrients and yield of mango orchards**

The data presented in table 6 when studied revealed that total copper exhibited positive and significant correlation with yield at pre-flowering stage and total zinc and copper at flowering stage at Warwade-1 and Warwade-2 (Ratnagiri) locations. Whereas positive and

significant relationship was found between yield and total copper at pre-flowering stage; total zinc and copper at flowering stage; total iron, zinc and copper at egg stage and total iron at harvest of the fruits at Rameshwar and Padel (Devgad) locations. The total Fe, Zn and Cu contents in the leaves proved that they were beneficial in increasing the yield of mango.

In conclusion, the study revealed that there is positive significant correlation between available nutrients in soil and corresponding nutrient in plant which indicates that soil application of nutrients is beneficial. The location wise yield levels showed that the mango yield is dependent on fertilizer management of the orchard.

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