Plant Archives Vol. 15 No. 1, 2015 pp. 61-66 ***ISSN 0972-5210***

DTPA EXTRACTABLE MICRONUTRIENT STATUS OF SOIL FROM MANGO ORCHARDS OF RATNAGIRI DISTRICT AND THEIR RELATIONSHIP WITH SOIL PROPERTIES

N. S. Joshi, K. P. Vaidya and C. D. Pawar

Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dapoli - 415 666, Dist. Ratnagiri (Maharashtra), India.

Abstract

To study the DTPA extractable micronutrient status of soil from mango orchards of Ratnagiri district in all 100 surface and 40 profile samples were collected. The status of DTPA extractable (Fe, Mn, Zn and Cu) micronutrients found to be adequate in most of the mango orchards selected for the present investigation. However, few of the samples were found to be deficient in available Cu and Zn content. The correlation study of soil properties with available micronutrients showed that availability of micronutrients in soil get influenced by mechanical composition, maximum water holding capacity, pH, EC, organic carbon, available nitrogen, available phosphorous, available potassium and exchangeable calcium. It was concluded that balanced fertilizer application through integrated nutrient management can sustain fertility status especially in relation to zinc (Zn) and copper (Cu).

Key words : Ratnagiri district, mango (Alphanso), DTPA extractable micronutrients (Fe, Mn, Zn and Cu) status, correlation.

Introduction

Mango (*Mangifera indica* L.) belonging to family Anacardiaceae is the most important commercially grown fruit crop of Indian subcontinent and particularly in Konkan. It is one of the most popular, nutritionally rich fruit with unique flavour, fragrance, taste often called "The king of the fruits". The world famous and the prime variety of mango, the Alphanso is chiefly produced in the Ratnagiri district. The domain of the present research work is Ratnagiri district is a part of Konkan tract and identified as horticulture district of Maharashtra. The district has humid, sub-tropical climate with high rainfall (Average annual rainfall of 2515 to 3625 mm, latitude of 16.58^0 to 16.98^0 N, longitude 73.18^0 to 73.30 ^{0}E, average altitude is 11 m, lateritic soil). Here, mango is grown on hilly area under rainfed conditions.

The soils of the district suffers from leaching of nutrients due to heavy rainfall and sloppy area and possibly accentuates to the deficiency of some micronutrients in the soil (Pereira *et al*., 1986). Since, micronutrients present in soil play important role in fruit yield, tree development, fruit quality, flowering and fruit size of mango and since deficiency of the micronutrients may cause spongy tissue or delaying maturity of fruits in mango, the study of micronutrient status of mango orchards of Konkan achieves a great consequence.

Materials and Methods

For the present investigation, two mango orchards each from five research stations or agricultural centers of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, encompassing Ratnagiri district were selected from different tahsils namely Dapoli (Dapoli), Dapoli (Wakawali), Khed (Avashi), Ratnagiri (Shirgaon) and Lanja (Lanja). From each of the mentioned mango orchards, ten surface samples (0 to 15 cm) and four profile samples (0 to 15, 15 to 30, 30 to 45 and 45 to 60 cm) were collected by following standard procedure of soil sample collection. Thus, in all 100 surface soil samples and 40 profile samples were collected in the month of April. The collected soil samples were processed and analysed for DTPA extractable micronutrients (Fe, Mn, Zn and Cu) as per standard methods (Lindsay and Norvell, 1978). The data obtained from analysis was processed statistically by SAS 9.3, ICAR- 11601386, for studying correlation of soil properties with available micronutrients.

Results and Discussion

The perusal of data presented in table 1 revealed that the available iron (Fe) status of surface soil samples of all tahsils varied from 30.65 to 51.30 with a mean value of 40.62 mg kg^{-1}. In profile samples the available Fe showed a range of 28.61 to 50.14 with an average value of 37.77 mg kg^{-1}. Available Fe status in similar range was also reported by Sankpal (2008) for lateritic soils of Konkan.

In general, all mango orchards were found adequate with available Fe as per the ratings given by Gajbhiye (1985). The sufficient amount of available Fe in surface and profiles of 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 lateritic soil (Diwan, 1982).

The data presented in table 2 on overall mean for available manganese (Mn) of different tahsils when studied revealed that the available Mn of surface soil samples of all tahsils ranged between 41.34 and 60.89 with a mean value of 52.76 mg kg^{-1}. In case of profile soil samples the available Mn of all tahsils varied from 31.12 to 60.53 with an average value of 48.88 mg kg^{-1}. Similar range for available manganese was also reported by Patil and Meisheri (2004). In general, almost in all the mango orchards available Mn showed a decreasing trend with soil depth. However, all the mango orchards showed sufficient amount of available Mn content on the basis of critical limits given by Gajbhiye (1985).

Data on overall mean for available zinc of different tahsils showed that the available Zn status of surface soil samples of all tahsils had a variation between 0.41 and 3.60 with an average value of 1.50 mg kg^{-1}. For profile soil samples the available zinc ranged from 0.14 to 2.54 with a mean value of 1.22 mg kg^{-1} (table 3). These results are in conformity with Gaidhani (2008). At all the profiles available Zn showed a decreasing trend with soil depth. Further, from data it was observed that most of the soil samples of mango orchards had sufficient amount of available zinc. However, few soil samples at Dapoli and Wakawali mango orchards were found to be deficient in available zinc content as per the critical limits given by Gajbhiye (1985).

As seen from table 4, the data on available copper status of different tahsils revealed that the available Cu of surface soil samples varied from 0.95 to 4.67 with a mean value of 2.21 mg kg^{-1}. For profile soil samples the available copper had a range of 0.70 to 3.89 with an average value of 1.96 mg kg^{-1}. In general, available copper

Table 1 : DTPA-extractable micronutrient (Fe) status of mango orchards (mg kg^{-1}).

Mango orchard soil depth (cm)	DTPA-extractable Fe				
	Dapoli	**Waka-wali**	**Avashi**	**Shirg-aon**	**Lanja**
Mango orchard I (0 to 15)	34.40	30.80	44.44	49.61	35.54
	47.27	34.90	50.06	41.16	38.03
	33.87	37.96	41.99	38.88	41.23
	32.94	41.99	40.76	34.48	30.77
	49.77	40.78	48.77	44.90	36.90
	30.65	39.55	38.71	40.44	43.55
	50.41	41.89	35.50	39.66	46.02
	39.88	46.45	32.49	43.40	37.81
	34.51	48.08	35.66	43.12	32.22
	44.12	35.55	44.66	37.88	36.78
Mean	**39.78**	**39.80**	**41.30**	**41.35**	**37.89**
Mango orchard II (0 to 15)	40.76	40.32	48.73	38.65	41.18
	38.67	36.66	49.34	30.77	43.99
	51.30	41.80	37.66	41.33	39.82
	43.65	38.70	42.22	40.97	34.41
	42.09	47.89	40.06	38.76	40.82
	37.89	30.77	43.35	46.23	32.29
	48.90	49.70	39.07	37.51	39.03
	36.53	38.21	38.60	34.59	34.23
	50.07	47.75	40.54	41.15	47.78
	49.36	38.66	42.66	40.55	45.05
Mean	**43.92**	**41.05**	**42.22**	**39.05**	**39.86**
Location mean	**41.85**	**40.42**	**41.76**	**40.20**	**38.88**
Profile (I)					
A	41.11	49.84	50.14	36.60	37.71
B	37.84	42.21	37.80	42.47	38.15
C	35.70	37.50	30.72	38.76	30.65
D	31.80	30.61	28.61	32.90	28.90
Mean	**36.61**	**40.04**	**36.82**	**37.68**	**33.85**
Profile (II)					
A	46.75	50.01	47.66	46.90	43.30
B	38.88	47.63	41.30	40.74	37.90
C	32.23	36.00	38.72	34.55	32.55
D	35.19	29.55	29.51	32.77	29.84
Mean	**38.26**	**40.80**	**39.30**	**38.74**	**35.90**
Profile mean	**37.27**	**40.42**	**38.06**	**38.21**	**34.88**

A -0 to 15, B-15 to 30, C-30 to 45, D-45 to 60 cm.

Table 2 : DTPA-extractable micronutrient (Mn) status of mango orchards (mg kg^{-1}).

Mango orchard soil depth (cm)	DTPA-extractable Mn				
	Dapoli	Waka-wali	Avashi	Shir-gaon	Lanja
Mango orchard I (0 to 15)	55.78	56.66	56.67	60.46	55.44
	51.87	48.99	55.34	55.77	56.90
	49.98	47.77	49.80	54.09	48.66
	60.00	57.43	43.60	46.71	60.13
	51.12	59.33	41.34	48.62	60.55
	48.77	41.45	52.67	56.00	60.43
	54.77	39.03	49.93	51.43	59.03
	46.98	48.77	43.66	47.00	54.44
	43.90	54.23	58.91	43.93	60.78
	56.88	54.98	49.08	60.56	57.77
Mean	**52.01**	**50.86**	**50.10**	**52.46**	**57.41**
Mango orchard II (0 to 15)	54.81	58.77	60.89	59.61	54.35
	54.23	48.99	49.49	52.00	55.55
	50.09	45.41	50.02	54.26	49.78
	48.93	57.65	53.72	46.77	51.45
	48.60	54.69	54.22	60.23	56.61
	54.27	57.45	48.76	56.31	53.37
	55.66	49.90	49.21	58.72	59.60
	43.89	47.78	44.67	52.33	58.47
	59.88	49.80	55.45	45.56	60.43
	51.23	51.16	48.81	48.76	54.64
Mean	**52.16**	**52.16**	**51.52**	**53.46**	**55.43**
Location mean	**52.08**	**51.51**	**50.81**	**52.96**	**56.42**
Profile (I)					
A	56.00	52.67	51.44	57.71	60.53
B	54.34	44.56	50.32	53.12	55.10
C	50.77	47.90	47.78	47.76	43.66
D	44.21	35.50	42.21	40.25	46.94
Mean	**51.33**	**45.16**	**47.94**	**49.71**	**51.56**
Profile (II)					
A	59.88	54.44	56.77	54.66	59.02
B	50.78	49.70	54.34	49.71	51.23
C	44.70	36.88	50.67	52.30	47.67
D	39.56	31.12	48.90	36.67	41.34
Mean	**48.73**	**43.04**	**52.67**	**48.34**	**49.82**
Profile mean	**50.29**	**44.10**	**50.31**	**49.03**	**50.69**

A- 0 to 15, B-15 to 30, C- 30 to 45, D- 45 to 60 cm.

Table 3 : DTPA-extractable micronutrient (Zn) status of mango orchards (mg kg^{-1}).

Mango orchard soil depth (cm)	DTPA-extractable Zn				
	Dapoli	Waka-wali	Avashi	Shir-gaon	Lanja
Mango orchard I (0 to 15)	1.03	2.11	1.89	2.10	1.75
	2.02	0.48	0.56	2.31	1.61
	1.56	0.89	1.61	3.09	1.03
	2.03	1.99	1.52	3.25	1.77
	0.64	0.82	2.71	1.66	0.82
	2.51	3.06	2.50	2.54	1.08
	1.74	0.96	0.51	1.00	1.66
	3.50	1.70	2.57	1.65	1.20
	2.48	2.69	0.65	1.21	1.41
	1.97	0.97	1.77	1.50	1.26
Mean	**1.95**	**1.57**	**1.63**	**2.03**	**1.36**
Mango orchard II (0 to 15)	3.60	0.69	1.28	1.32	1.26
	0.46	0.42	1.05	2.66	1.50
	1.48	0.41	1.18	2.10	1.71
	0.23	1.98	1.24	2.21	1.33
	1.80	0.63	1.01	1.90	0.88
	0.80	0.69	0.67	1.17	1.43
	1.69	1.07	0.80	1.44	0.97
	1.27	0.61	1.15	1.87	1.88
	2.08	0.50	0.84	2.12	1.36
	0.50	0.98	0.79	1.77	1.79
Mean	**1.39**	**0.80**	**1.00**	**1.86**	**1.41**
Location mean	**1.67**	**1.18**	**1.32**	**1.95**	**1.39**
Profile (I)					
A	1.23	1.87	1.40	2.54	1.90
B	2.27	1.29	1.09	2.05	1.66
C	1.02	0.97	0.67	1.47	1.35
D	0.32	0.45	0.50	1.06	0.54
Mean	**1.21**	**1.15**	**0.92**	**1.78**	**1.36**
Profile (II)					
A	0.72	1.23	2.33	2.14	1.47
B	0.57	0.89	1.45	1.60	1.23
C	0.22	0.60	1.65	1.23	0.81
D	0.14	0.67	0.99	1.32	1.00
Mean	**0.41**	**0.85**	**1.61**	**1.57**	**1.13**
Profile mean	**0.89**	**1.00**	**1.27**	**1.68**	**1.25**

A -0 to 15, B-15 to 30, C-30 to 45, D-45 to 60 cm.

Table 4 : DTPA-extractable micronutrient (Cu) status of mango orchards (mg kg^{-1}).

Mango orchard soil depth (cm)	DTPA-extractable Cu				
	Dapoli (I and II)	Dapoli (III and IV)	Khed (I and II)	Ratnagiri (I and II)	Lanja (I and II)
Mango orchard I (0 to 15)	2.96	1.21	1.77	2.88	2.14
	2.47	0.95	2.11	2.12	3.09
	3.99	1.22	1.87	3.23	2.44
	2.67	1.43	2.33	2.98	4.67
	2.41	1.76	1.32	2.66	3.71
	2.23	1.23	1.89	3.11	3.21
	2.96	1.19	1.55	2.76	2.95
	1.99	1.34	2.02	3.23	2.23
	1.10	1.71	1.07	4.03	2.56
	2.18	1.31	1.33	3.05	3.42
Mean	**2.50**	**1.34**	**1.73**	**3.01**	**3.04**
Mango orchard II (0 to 15)	2.31	1.85	1.44	2.88	2.16
	2.15	1.61	1.65	2.59	2.06
	1.34	1.97	1.29	3.17	2.55
	1.19	2.79	1.17	3.42	2.54
	2.24	1.61	1.64	1.65	2.13
	3.32	1.96	1.33	2.20	2.50
	2.19	2.16	1.21	2.31	2.43
	2.07	1.22	1.56	2.29	2.18
	1.86	1.65	1.28	2.99	2.77
	3.19	1.30	1.43	3.07	2.59
Mean	**2.19**	**1.81**	**1.40**	**2.66**	**2.39**
Location mean	**2.34**	**1.57**	**1.57**	**2.84**	**2.72**
Profile (I)					
A	2.60	1.38	1.66	2.14	2.83
B	3.52	1.06	1.21	2.66	2.76
C	2.56	0.89	0.98	2.31	2.60
D	2.37	0.77	0.70	2.08	1.90
Mean	**2.76**	**1.03**	**1.14**	**2.30**	**2.52**
Profile (II)					
A	2.34	1.98	1.87	1.89	2.70
B	2.06	1.62	1.77	3.03	1.44
C	2.06	1.50	1.54	2.78	2.05
D	0.862	1.01	1.41	2.44	0.82
Mean	**1.83**	**1.53**	**1.65**	**2.54**	**1.75**
Profile mean	**2.39**	**1.28**	**1.40**	**2.42**	**2.14**

A -0 to 15, B-15 to 30, C-30 to 45, D-45 to 60 cm.

content showed a decreasing trend with soil depth in profile samples. Similar findings were also reported by Suryavanshi (2010). Also, the available Cu in most of the soil samples of mango orchards was found to be adequate with exception of only one soil sample at Wakawali according to the critical limit given by Gajbhiye (1985).

The data from table 5 showed that available Fe exhibited positive and significant correlation with sand (r = 0.1909) whereas negative and significant relationship was found with clay content (r = - 0.2609). The maximum water holding capacity was found to be negatively and significantly correlated with available iron content in the soil (r = -0.2975). In case of pH (r = - 0.2072) negative but significant correlation with available Fe was observed. However, organic carbon was positively and significantly correlated with available iron content (r = - 0.267). Negative but significant correlation of available Fe may be due to formation of insoluble higher oxides of Fe at higher pH (Patil & Meisheri, 2004 and Patil *et al.*, 2003). The available Fe content established positive significant relationship with available nitrogen (r = 0.257) and available phosphorus (r = 0.2290) whereas with available K_2O, a negative but significant relationship was observed (r = - 0.2862) with available Fe content.

The sand content had shown positive and significant influence on the availability of Mn in the soil (r = 0.271) while the clay content showed negative and significant correlation with available Mn (r = -0.2665). Increase in maximum water holding capacity (r = -0.2265) and pH (r = -0.3777) were found to have inverse effect on availability of Mn. Further data on correlation also revealed that available Mn. exhibited positive and significant correlation with organic carbon (r = 0.3106), available nitrogen (r = 0.4319), available phosphorus (r = 0.3017) and exchangeable Ca^{2+} (r = 0.3598). A positive correlation of available Mn with organic carbon indicated that availability of Mn increases with increase in organic matter for the lateritic soils of Konkan (Patil *et al.*, 2003).

Zinc was found to be positively and significantly correlated with sand (r = 0.3282) and silt content (r = 0.2372) while it showed negative, but significant relationship with clay

Table 5 : Correlation between available micronutrients and physico-chemical properties of soil.

Soil properties	Available Fe	Available Mn	Available Zn	Available Cu
Sand	0.1909*	0.2715*	0.3282*	0.4557*
Silt	0.1078	0.0134	0.2372*	0.0028
Clay	-0.2609*	-0.2665*	-0.4156*	-0.3899*
BD	0.1220	0.0693	-0.0523	0.0365
PD	0.0732	0.0998	-0.0312	-0.0155
MHWC	-0.2975*	-0.2165*	-0.1837*	-0.1311
pH	-0.2072*	-0.3777*	-0.3006*	-0.1781*
EC	0.0908	-0.0335	0.0905	0.0579
OC	0.3921*	0.3106*	0.1607	0.0553
Available Nitrogen	0.2571*	0.4319*	0.3691*	0.4359*
Available P_2O_5	0.2290*	0.3017*	0.0481	0.0312
Available K_2O	-0.2862*	-0.1452	-0.1110	0.0602
Exchangeable Ca^{2+}	0.1094	0.3598*	0.2282*	0.4204*
Exchangeable Mg^{2+}	-0.0848	0.1003	0.0377	0.0772

*Significant at 5 per cent level.

content (r = -0.4156). Available Zn had a positive, but significant correlation (r = 0.1607) with organic carbon content in soil. Increase in maximum water holding capacity (r = -0.1837) and pH (r = -0.3006) resulted in decrease in available zinc content in soil. Available nitrogen (r = 0.3691) and exchangeable calcium (r = 0.0067) were found to be positively and significantly correlated with available Zn content in soil. Similar findings were noticed by Mahajan (2001).

Available copper was found to increase significantly with sand content in the soil (r = 0.4557), while clay content (r = -0.3899) had negative but significant correlation with available Cu. From table 5, it was also observed available copper content had a negative, but significant correlation with pH (r = -0.1781). Available nitrogen (r = 0.4359) and exchangeable calcium (r = 0.4204) was correlated positively and significantly with available Cu content in soil.

Conclusion

From the data, it could be concluded the status of DTPA extractable (Fe, Mn, Zn and Cu) micronutrients found to be adequate in most of the mango orchards selected for the present investigation. However, 2% and 17% samples from Dapoli (Dapoli) and Dapoli (Wakawali) locations were respectively found to be deficient in available Cu and Zn content. The correlation study indicated that the mechanical composition, maximum water holding capacity, pH, EC, organic carbon, available nitrogen, available phosphorous, available potassium and exchangeable calcium of soil affected the availability of micronutrients. From the results, it is suggested that in future, balanced fertilizer application through integrated nutrient management should be followed to sustain fertility status especially in relation to calcium (Ca^{2+}), magnesium (Mg^{2+}), zinc (Zn) and copper (Cu).

References

Diwan, P. M. (1982). Micronutrient status of the soils from bench terraced area of the Central Farm, Wakawali. *M.Sc.(Agri.) Thesis* submitted to Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (Maharashtra).

Gaidhani, S. M. (2008). Effect of integrated nutrient management on yield, partitioning and uptake by rice and on fertility status of lateritic soils of Konkan. *M.Sc. (Agri.) Thesis* submitted to Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra (Unpublished).

Gajbhiye (1985). Common extractants and critical limits for available Fe, Mn, Zn and Cu in soil. *J. Maharashtra Agril. Univ.*, **10(3)** : 239-241.

Lindsay, W. L. and W. A. Norvell (1978). Development of DTPA soil test for Zn, Fe, Mn and Cu. *Proc. Soil Sci. Soc. Amer.*, **42** : 421-428.

Mahajan, T. S. (2001). Status and distribution of micronutrients in relation to the properties of lateritic soils under mango orchards in South Konkan. *M. Sc. (Agri.) Thesis* submitted to Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra.

Patil, K. D. and M. B. Meisheri (2004). Minerological studies and DTPA-Extractable Zn, Cu, Mn and Fe in representative soils of Konkan region. *J. Maharashtra Agril. Univ.*, **29(1)** : 4-8.

Patil, K. D., M. B. Meisheri, D. J. Dabke and D. S. Bagade (2003). Distribution of DTPA-extractable cinc, copper, iron and manganese contents in rice soils of Konkan. *J. Soils and Crops*, **13(1)** : 85-90.

Pereira, A. J., A. S. Chavan and P. A. Varade (1986). Physico-chemical properties and micronutrients status of the mango orchard hill soils of Konkan. *J. Maharashtra Agric. Univ*., **11(2)** : 134-136.

Sankpal, A. A. (2008). Studies on physico-chemical properties of lateritic soils of Agriculture Research Station, Phondaghat (Sindhudurg). *M.Sc. (Agri.) Thesis* submitted to Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra (unpublished).

Suryavanshi, A. V. (2010). Micronutrient status and it's relationship with soil properties in mound planted mango orchards of Sindhudurg district (Konkan region, M.S.). *M.Sc. (Agri.) Thesis* submitted to Balasaheb sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra.