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Effect of pruning intensity on leaf tissue micronutrient status in three mango (*Mangifera indica* L.) cultivars under high density planting

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ABSTRACT

An experiment was conducted to study the effect of pruning on leaf micro nutrient (Cu, Zn, Fe and Mn) status in non-floral and floral shoots of three mango cultivars ('Amrapali', 'Mallika' and 'Dashehari') under high density planting during 2005-2007. All the three cultivars differed significantly in Cu, Zn, Fe and Mn content in leaves of non- floral as well as floral shoots. Pruning showed marked influence only on Cu and Zn content in the leaves of non- floral and floral shoots. Leaf nutrient status in terms of Fe and Mn also varied in cultivars irrespective of pruning intensity, and pruning did not have significant impact on Fe and Mn status in leaf tissue. Non-floral shoots had greater concentration of Cu and Zn than floral shoots in both the years of experiment. Highest Cu, Fe and Mn content was recorded in 'Mallika' mango, while, Zn content was highest in 'Dashehari' mango. Severe pruning (90 cm from apex) improved Cu and Zn content in leaves of non-floral shoots as well as floral shoots. The lowest amount of Cu and Mn was noted in 'Dashehari' leaves, while, 'Amrapali' had the lowest Zn and Fe content in both non-floral and floral shoots. Severely pruned 'Mallika' trees registered the highest amount of Cu, while lightly pruned 'Dashehari' trees had highest Zn content in their floral and non-floral leaves. Moderate pruning in' Mallika' enhanced Mn content in leave of non-floral and floral shoots. No-pruning in 'Dashehari' trees led to lower Cu content but Zn content was the least in lightly pruned 'Amrapali' trees. Severe pruning in 'Dashehari' trees drastically reduced Mn content. Thus, severe pruning in old mango trees may be advisable to improve micronutrient status in floral and non floral shoots.

Key words: Mango, *Mangifera indica*, pruning, micronutrients, Cu, Zn, Fe, Mn

INTRODUCTION

Mango (*Mangifera indica* L.), member of the family Anacardiaceae, is the most important fruit crop of both subtropical and tropical regions of the world. There is ample scope for enhancing production and productivity of mango through pruning under high density planting (HDP). Pruning is also practised to avoid overlapping/ intermingling of branches, improve light interception, increase photosynthetic rate, reduce relative humidity within the plant canopy, etc. (Lal *et al*, 2000). Not much work has been reported on determining optimum pruning intensity in close spaced orchards compared to wider spaced (traditional) ones. The practice of mango pruning is followed immediately after harvest (heading back branches) which encourages shoot growth just beneath the site of the first bud break (Sauco, 1996). These shoots [newly emerged] have different physiological responses post-pruning, i.e., changes in biochemical, physiological and nutritional status, which subsequently affect overall performance of the trees in the long run. Pruning decreases yield in the initial years due to simulative growth of shoots, while minerals absorbed by roots are readily available to a few fruits only (Mika, 1986). Root shortening coupled with stem pinching, followed by spray of PBZ or TIBA on shoots is the most effective treatment enhancing root and shoot branching and also for increasing leaf content of N, Ca, Mg, Fe and Zn (Helail and Eissa, 1997). Hence, the present work was carried out to study effect of pruning intensity on micronutrient status in leaf tissues of mango obtained from non-floral (vegetative) and floral (reproductive) shoots, which may reflect futurie performance of trees, especially under high density planting.

MATERIAL AND METHODS

The field experiment was conducted at the Main Orchard of the Division of Fruits and Horticultural Technology, IARI, New Delhi, during 2005-2007. Three mango cultivars, *viz*., 'Amrapali' (23-year-old), 'Mallika' (24-year-old) and 'Dashehari' (26-year-old) were selected

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for the present study. These cultivars were planted under high density with spacings of 2.5m x 2.5m, 3.0m x 4.0m and 3.0m x 2.0m for cvs. Amrapali (V_1), Mallika (V_2) and Dashehari (V_3), respectively. Trees were provided with uniform agronomic and cultural practices during the course of investigation. Pruning was done in mid August, 2005 and pruning intensities were**:** I0 (Control): un-pruned, I1 (Light): 30 cm from the apex, I2 (Moderate): 60 cm from the apex, and I3 (Severe): 90 cm from the apex. Each cultivar had three replications with four levels of pruning intensities. Thus, the total number of treatment combinations was 12, with one tree per replication. Balanced pruning was performed in all directions by removing the inner and a few peripheral branches of the canopy that were dense and overcrowded. The control trees were maintained without pruning. As a result of pruning, trees did show some flowering and fruiting during 2006, i.e. the first year (presumed to be an 'off' year) and the second year (2007, the 'on' year). The leaves (7-8 month old) from non-flowered (vegetative), flowered (reproductive) shoots were collected from all directions and immediately shifted to the laboratory where these were washed quickly and rinsed with distilled water. The samples were air dried, cut into small pieces and oven dried at 70^0C for 48h in paper bags until gaining constant weight and milled to a powder in a stainless steel grinder. The powder was stored in paper bags at room temperature. The powdered plant material (500 mg) was digested in 20 ml di-acid mixture [nitric acid (HNO_3):perchloric acid ($HClO_4$) 3:1] and the volume was made up to 100 ml with distilled water. Micro-nutrient concentration was determined on an atomic absorption spectrophotometer directly from the di-acid digest, using an air-acetylene flame. Content of Cu, Fe, Mn and Zn was measured at 386 nm (Lamp current 7 mA), 22.6 nm (Lamp current 3 mA), 403.1 (Lamp current 5 mA) and 213.9 nm (Lamp current 5 mA) wavelength, respectively. The sensitivity was 0.05, 0.008, 0.02, and 0.025 µg/ ml for Fe, Zn, Mn and Cu, respectively. Final concentration (in ppm) was calculated by multiplying the concentration with a suitable dilution factor. Experimental data were subjected to statistical analysis in factorial Randomized Block Design and two years data from non-floral and floral shoots were analyzed as per methods suggested by Gomez and Gomez, 1984. Interpretation of results was based on 'F' test and critical difference (CD) at P=0.05 was worked out for comparing means.

RESULTS AND DISCUSSION

Role of micronutrients in plant nutrition is vital because several deficiency symptoms occur in plants due to which performance of the entire tree declines markedly. Although micronutrient deficiencies produce characteristic symptoms, the symptoms are very confusing under field conditions, especially, when more than one nutrient is deficient. Mango cultivars, irrespective of pruning intensity, had significantly different concentrations of Cu, Zn, Fe and Mn in the leaves in the 'off' as well as the 'on' year of our experiment. Highest concentration of Cu and Mn was observed in 'Mallika', and lowest in 'Dashehari' (Table 1) which may be due to the biennial nature of 'Dashehari' mango (Thakur *et al*, 1981). It was also noted that in the 'on' year, Cu and Mn content leaves was lower than in the 'off' year (Thakur *et al*, 1973) because fruiting terminals numbered more in the 'on' year than in the 'off' year which acted as a sink for mineral nutrients (Thakur *et al*, 1981). Similarly, pruning intensity showed marked influence on Cu and Zn content in mango leaves. Severely pruned trees (I_3) had the highest Cu content, followed by moderately pruned (I_3) trees and the least Cu content was observed in un-pruned trees (I_0), as, pruning destabilizes the root:shoot ratio. In addition, defoliation along with root pruning and stem pinching invariably increases Cu content in shoots as noted by Helail and Eissa, 1997. In contrast, Mn content in leaves did not differ significantly (Table 1). Content of Zn in mango leaves improved after severe pruning (I_3), followed by light pruning while, moderate pruning reduced Zn level in mango leaves of both non-floral and floral shoots.

The interaction effect of cultivar and pruning intensity also affected Cu (except flowered shoots in the 'off' year), Zn and Mn content in leaves of non-floral and floral shoots. Cu and Mn content were highest in severely (V_2I_3) and moderately pruned 'Mallika' (V_2I_2) trees, respectively, while the lowest Cu concentration was estimated in un-pruned 'Dashehari' mango. In contrast, severely pruned 'Dashehari' had the lowest Mn in leaves (Table 2). Cultivar 'Mallika' encouraged greater vegetative growth (and produced substantial number of non-fruiting terminals in the beginning) /and non-fruiting terminals had higher Cu and Mn content (Thakur *et al*, 1979). Un-pruned trees had slow growth (less number of new shoots), thus resulting in deficiency of Cu.

Among the three cultivars, 'Dashehari' leaves had highest Zn content (Kumar *et al*, 1985), while 'Amrapali' had the lowest concentration of both Zn and Fe due to continuous production of fruiting terminals in both the years of experiment (Thakur *et al*, (1981). On the other hand, severely pruned tree had the lowest Zn content (26.66, 23.25; 25.64, 22.35 ppm) probably due to higher number of new

Table 1. Effect of cultivar and pruning intensity on micronutrient content in leaves of three mango cultivars under high density planting

Treatments†	Cu (ppm)				Zn (ppm)				Fe (ppm)				Mn (ppm)			
	2005-06*		2006-07**		2005-06*		2006-07**		2005-06*		2006-07**		2005-06*		2006-07**	
	NFS	FS	NFS	FS	NFS	FS	NFS	FS	NFS	FS	NFS	FS	NFS	FS	NFS	FS
Amrapali (V_1)	18.78	15.58	16.00	13.07	19.44	16.40	18.59	15.59	201.11	126.50	162.78	146.86	100.50	95.84	88.62	85.10
Mallika (V_2)	22.80	18.92	20.02	16.80	22.12	19.39	21.39	18.62	238.62	218.92	215.05	196.02	113.45	110.27	102.33	101.57
Dashehari (V_3)	14.30	10.72	12.27	8.83	30.90	26.91	29.60	26.01	202.85	181.36	174.75	156.44	76.42	73.75	67.18	63.62
SEm ±	0.41	0.29	0.32	0.97	0.80	0.74	0.82	0.79	11.85	12.02	13.31	13.64	5.09	5.00	5.45	5.12
CD *(P=0.05)*	1.18	0.86	0.93	0.80	2.31	2.14	2.37	2.20	34.05	34.33	38.22	45.24	14.64	14.60	15.60	14.71
Un-pruned (I_0)	17.17	13.56	14.27	11.23	23.67	20.34	22.42	19.71	208.46	183.96	174.96	156.84	92.14	88.83	80.91	81.24
30 cm (I_1)	18.13	14.40	15.20	12.10	25.33	21.97	24.08	20.83	196.25	175.94	172.21	134.20	102.07	99.26	92.14	88.83
60 cm (I_2)	18.52	15.02	16.21	13.00	20.95	18.03	20.62	17.41	237.23	216.13	197.53	182.88	96.07	91.85	83.05	79.20
90 cm (I_3)	20.72	17.32	18.72	15.21	26.66	23.25	25.64	22.35	213.54	192.04	192.00	171.79	96.88	93.21	88.07	84.20
SEm ±	0.47	0.34	0.37	0.32	0.93	0.86	0.95	0.92	13.69	13.88	15.36	15.75	5.88	5.87	6.30	5.91
CD *(P=0.05)*	1.36	0.99	1.07	0.92	2.67	2.47	2.74	2.64	NS	NS	NS	NS	NS	NS	NS	NS

* 'off' year; ** 'on' year
NFS = Non-floral shoots; FS = Floral shoots
†For details of the treatments, please see text

Table 2. Interaction effect of cultivar and pruning intensity on micronutrient content of leaves in three mango cultivars under high density planting

Treatments†	Cu (ppm)				Zn (ppm)				Fe (ppm)				Mn (ppm)			
	2005-06*		2006-07**		2005-06*		2006-07**		2005-06*		2006-07**		2005-06*		2006-07**	
	NFS	FS	NFS	FS	NFS	FS	NFS	FS	NFS	FS	NFS	FS	NFS	FS	NFS	FS
V_1I_0	18.56	15.16	13.66	12.83	23.23	19.53	21.16	18.86	202.90	176.13	159.13	144.60	88.30	84.66	76.76	72.80
V_1I_1	16.80	13.26	13.83	10.56	17.08	14.20	17.06	13.0	200.03	180.66	167.00	149.68	108.90	105.43	98.66	95.33
V_1I_2	19.03	15.90	16.36	13.40	17.56	15.43	17.46	14.76	226.20	202.23	173.90	161.96	86.10	73.66	67.60	64.23
V_1I_3	20.73	18.00	18.16	15.26	19.93	16.43	18.66	15.73	175.33	147.00	151.13	131.26	118.73	114.60	112.06	108.06
V_2I_0	21.60	17.90	18.10	15.33	22.63	20.23	22.56	19.60	218.10	193.60	185.63	167.16	97.00	92.60	82.13	90.20
V_2I_1	23.40	19.46	20.20	17.43	21.43	18.40	19.90	17.33	206.16	182.86	190.33	168.93	117.73	115.56	109.30	106.20
V_2I_2	21.06	16.96	18.40	15.10	21.33	18.56	20.73	17.90	267.60	251.13	244.96	228.13	134.46	181.80	122.66	110.56
V_2I_3	25.16	21.36	23.40	19.36	23.10	20.36	22.36	19.66	262.63	246.16	239.30	219.86	104.63	101.13	95.22	91.33
V_3I_0	11.36	7.63	9.06	5.53	25.16	21.26	23.33	20.66	205.90	183.16	180.16	158.76	91.13	89.23	84.43	80.73
V_3I_1	14.20	10.46	11.56	8.30	37.33	33.33	35.60	32.16	192.56	164.30	159.30	144.16	79.60	76.80	68.46	64.96
V_3I_2	15.46	12.20	13.86	10.50	23.96	20.10	23.66	18.56	217.90	195.03	173.73	158.56	67.66	65.10	58.90	54.80
V_3I_3	16.26	12.60	14.56	11.0	36.96	32.96	35.30	31.66	202.66	182.96	185.83	164.26	67.30	63.90	56.93	53.20
SEm ±	0.82	0.60	0.64	0.55	1.61	1.49	1.65	1.59	23.71	24.04	26.61	27.29	10.19	10.17	10.91	10.24
CD*(P=0.05)*	2.36	NS	1.85	1.59	4.63	4.29	4.74	4.57	NS	NS	NS	NS	29.20	29.21	31.36	29.43

* 'off' year; ** 'on' year
NFS = Non-floral shoots; FS = Floral shoots
† For details of treatments, please see text

leaves and perhaps due to Zn regulating enzymes synthesized after pruning and then rapid translocation due to high activity of cytokinins in leaves. The lowest level of Zn in moderately pruned trees (I2) may be due to existence of old leaves and fruiting leading to exhaustion of nutrients (Table 1). The rest of the treatments were at par. Lightly pruned 'Dashehari' recorded maximum Zn content (37.33, 33.33, 35.60 and 32.16 ppm) due to varietal characters, while lowest was seen in lightly pruned 'Amrapali' (17.08, 14.20, 17.06 and 13.0 ppm) may be due to a higher number of fruiting terminals (Table 2) (Thakur *et al*, 1981). During the 'on' year, Zn and Fe content decreased in mango leaves compared to the'off' year (Mishra and Dhillon ,1978; Thakur *et al*, 1979). Highest Fe content was noted in leaves of 'Mallika', while the minimum in 'Amrapali'. Effect of pruning intensity and its interaction with cultivar on Fe content was non-significant, which could be due to the several factors regulating nutrient composition in plant tissues. It is also clear from the data (Tables 1 and 2) that 'on' year had low levels of all the micronutrients studied in leaves than in the 'off' year. Similarly micronutrient content declined during the reproductive stage compared to the vegetative stage. The result of this study indicates that severe pruning in old mango trees may be preferred to improving micronutrient status, especially Cu and Zn, in flowering and non-flowering shoots.

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