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Influence of pruning intensities on leaf nutrient composition in some mango cultivars planted under high density

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ABSTRACT

A field experiment was conducted on mango cultivars (Amrapali, Mallika and Dashehari) planted under high density to study the changes in the nutrient composition in leaves after pruning. The maximum nitrogen percentage was found in Amrapali in 'on' year while Dashehari recorded the lowest. Similarly, the highest phosphorus, calcium and sulphur was estimated in leaves of Mallika, whereas Amrapali had the lowest phosphorus, calcium and magnesium content. The significant difference was also observed for N, P ('on' year), Ca, Mg and S due to different pruning levels. The highest N and Ca content were observed in control (un-pruned) trees, which had the lowest levels of Mg and S. The light pruning improved the level of phosphorus but reduced the nitrogen concentration. Severe pruning led to lowest P and Mg content with better S content. The interaction effect due to cultivar and pruning intensity was found to be significant for nutrient like N, C and M. The pruning intensity did not have any significant effect on potassium content. Consequently, major nutrients (primary and secondary) reduced during flowering, while during 'on' year the N, P and Ca levels increased. In contrast, Mg and S were observed to be higher during vegetative phase.

Key words: Mango, pruning, leaf nutrients, high density planting.

INTRODUCTION

The mango (*Mangifera indica* L.) is an evergreen fruit tree grown in tropical regions but is also well adapted to sub-tropical regions of the world. Due to strong apical dominance in shoot, mango has continuous vegetative growth. As long as apical bud of shoot remains intact, there is little axillary's growth either vegetative or reproductive (Shivagami *et al*., 14). There are several reasons for pruning perennial fruit trees and if done drastically may influences several physiological processes directly or indirectly. These effects result from alteration in communication system within the tree. It also helps to restore the balance between root system and the above ground parts, followed for maintaining height, canopy spread and density required for effective spraying with better fruit quality. Low yield is generally associated with high concentration of mineral nutrients in the fruits because minerals absorbed by roots are readily available to the few fruits produced. Therefore, it is expected that any type of pruning that reduce yield should increase the mineral content of fruits (Mika, 7). The nitrogen, potassium, and phosphorus contents are increased by dormant pruning while calcium and magnesium are usually decreased (Olszewski and Slowik, 8; Ibrahem-Ahmed *et al*., 5, 6). Sometimes, decapitation (a pruning method) in fruited shoots of 'Dashehari' mango (after harvest) causes no significant differences for K, Mg, Fe and Zn contents. However, level of N, P, Ca and Mn are higher in the leaves during 'on' year than 'off' year shoots but higher concentration of N and lower P, K and Ca may also be attributed to mango malformation (Singh *et al.,* 17) The decrease in number of fruits caused by pruning is associated with an increase in leaf N, P, K and a reduced concentration of Mg and Ca in fruit (Ferree and Schupp, 2). They also found that more severe the pruning, greater the reduction of Ca concentration and presumed flowering involves several internal and external factors. Pruned plants distribute about 118% more total P to branches and had a higher physiological P use efficiency (PPUE) than un-pruned trees (Sangingal *et al*.,13). Therefore, nutritional status of shoots may play an important role in such context. Keeping in view of above mentioned facts, the present investigation was conducted to study how nutrient levels of leaves got changed after pruning.

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MATERIALS AND METHODS

The field experiments were conducted at the Main Orchard, Division of Fruits and Horticultural Technology, IARI, New Delhi, during 2005 to 2007. Three mango cultivars, *viz*. Amrapali (V_1) (23-year-old), Mallika (V_2) (24-year old) and Dashehari (V_3) (26-year-old) were planted under high density at 2.5 m × 2.5 m, 3.0 m × 4.0 m and 3.0 m × 2.0 m, respectively. The trees were maintained under uniform cultural practices during the entire course of investigation. The pruning was done in mid August 2005 and pruning intensities

were I_0 (Control): un-pruned, I_1 (Light): 30 cm from the apex, I_2 (Moderate): 60 cm from the apex and I_3 (severe): 90 cm from the apex. Each variety had three replications with three trees/ treatment. The experiment was conducted under factorial randomized block design. The balanced pruning was performed in all directions of the canopy, which were dense and over-crowded. The control trees were left as such without pruning. As a result of pruning, the trees did show mild-flowering/ fruiting in 2005-06 and was referred as 'off' year and following year (2006-07) as 'on' year. The leaf samples were collected from all cultivars at the vegetative and reproductive stages during both years. The leaf nitrogen was determined by Kjeldahl method and phosphorus by vanado-molebdate colour reaction method. Potassium content was estimated by a microprocessor based flame photometer (Systronic flame photometer, Ahmedabad, India) using specific filter (K filter) and LPG flame. Calcium and magnesium were determined by atomic absorption spectrophotometer (GBC Avanta PM) using nitrous oxide-acetylene and air-acetylene flame (oxidizing), respectively, while sulphur was determined by turbidometric method using spectrophotometer. The data of two years on both (vegetative and reproductive) stages were analyzed as per method suggested by Gomez and Gomez (3).

RESULTS AND DISCUSSION

Nitrogen is the main growth manipulating nutrient. Thus the period of vegetative dormancy before flowering should be considered as a period of low nitrogen requirement, as simulative vegetative growth at this time would reduce flowering and productivity. In this investigation (Table 1), the highest nitrogen content was recorded in Amrapali (V_1) while minimum in Dashehari (V_3). This difference may be due to more number of flowered shoots in Amrapali than Dashehari. Devi and Tyagi (1) also found similar results that total nitrogen in shoots significantly higher in flowered shoots than in non-flowered shoots but at FBD stage, they found reverse trend due to utilization of nitrogen during FBD. Un-pruned trees (I_0) did show higher nitrogen percentage and the lowest value in light pruned tree (I_1), owing to only vegetative growth and very old leaves in un-pruned trees than in pruned one, while rest of the treatments was more or less statistically on par. In contrast, Singh (15) reported higher level of total nitrogen in the defoliated shoots of Dashehari as against the fruited shoots. During reproductive phase, the concentration of N was higher than during vegetative phase. Earlier, Pathak and Pandey (9) recorded reduced nitrogen concentrations after FBD and later stages. As far as combination of cultivar and pruning intensity are concerned, the highest percentage of nitrogen was noted in un-pruned Mallika and Amrapali trees, while lowest was recorded in severely pruned Dashehari owing to new shoots, which need nitrogen to form protein bodies, resulting in the maximum depletion of it from the leaves. The data also showed that the nitrogen content decreased with increase in pruning intensities especially in Dashehari.

Mallika (V_2) had the highest P content, whereas lowest was in Amrapali (Table 1) because of non-flowered shoot were more in number in former variety than in later variety which ultimately despite the phosphorus content in Amrapali due to heavy flowering than Mallika. The 'on' year had higher P percentage than 'off' year. This finding is corroborated by Rawash *et al*. (11). In contrary to above, 'off' year pruning did not show any significant changes for phosphorus content in shoots but in 'on' year, the light pruned trees had higher P (0.144, 0.133 %) than the severely pruned trees (0.119, 0.108 %). This may be because the flowered shoots were rather higher in severely pruned than light pruned trees, which acted as an active sink for the nutrient in the leaves. Likewise, cultivars did not show significant differences in P content in combination with pruning intensity may be due to some other factors, *viz.* number of shoots, regularity in bearing and malformation incidence etc, which acted simultaneously. However, Ram (10) also found higher P contents in the leaves in 'on' year/ during FBD than in 'off' year/vegetative stage, which is similar to above findings. The maximum K level was recorded during vegetative phase than during reproductive phase without any significant difference among the cultivars, pruning intensities and their interaction (Table 1). The K which is not directly involved in the metabolism of the plant might be one of the important reasons that render K as a luxury nutrient element. Singh and Rathore (16) also found non-significant changes in P concentration and K in malformed panicle in 25-year-old Chausa mango but there was a slight decline in the concentration of these two nutrients in the leaves of malformed shoots (Table 1).

As per data given in Table 2, the Mallika leaves had the highest content of Ca and lowest in leaves of Amrapali because latter had higher number of malformed shoots, which might have resulted in reduced Ca leaf content than the variety having less number of malformed shoots (Singh *et al*., 17). The above findings are with the conformity with the results obtained by Singh and Rathore (16), who reported that the highest calcium content was also recorded in un-pruned trees (control), which decreased with pruning severity. It may be attributed to the fact that un-pruned trees had developed lesser number of new shoots primarily due to poor growth and cell division. As a result, higher calcium might have accumulated in the

Table 1. Effect of pruning intensities on nitrogen, phosphorus and potassium contents in leaves of different mango cultivars planted under high density.

Treatments†	Nitrogen (%)				Phosphorus (%)				Potassium (%)			
	2005-06*		2006-07**		2005-06*		2006-07**		2005-06*		2006-07**	
	VP	RP	VP	RP	VP	RP	VP	RP	VP	RP	VP	RP
V_1	1.48	1.40	1.55	1.48	0.125	0.092	0.115	0.102	1.12	0.93	0.96	0.78
V_2	1.45	1.30	1.44	1.35	0.151	0.146	0.154	0.142	0.13	0.96	1.00	0.72
V_3	1.44	1.35	1.36	1.28	0.119	0.097	0.128	0.118	1.14	0.94	1.06	0.85
$CD_{0.05}$	NS	NS	0.051	0.50	0.014	0.027	0.016	0.016	NS	NS	NS	NS
I_0	1.51	1.43	1.60	1.53	0.131	0.107	0.140	0.126	1.04	0.81	0.93	0.74
I_1	1.44	1.34	1.38	1.30	0.143	0.124	0.144	0.133	1.13	0.96	1.01	0.79
I_2	1.43	1.36	1.41	1.33	0.129	0.111	0.126	0.116	1.26	0.11	1.13	0.83
I_3	1.45	1.37	1.40	1.32	0.122	0.104	0.119	0.108	1.09	0.91	0.95	0.77
$CD_{0.05}$	0.060	0.058	0.059	0.058	NS	NS	0.019	0.018	NS	NS	NS	NS
V_1I_0	1.48	1.35	1.84	1.81	0.115	0.082	0.107	0.092	1.05	0.76	0.87	0.61
V_1I_1	1.47	1.33	1.40	1.35	0.135	0.099	0.126	0.112	1.10	0.93	0.91	0.75
V_1I_2	1.52	1.44	1.50	1.42	0.124	0.089	0.112	0.099	1.27	1.15	1.13	1.02
V_1I_3	1.47	1.42	1.46	1.37	0.125	0.097	0.115	0.104	1.07	0.87	0.95	0.75
V_2I_0	1.55	1.48	1.53	1.43	0.146	0.150	0.167	0.150	1.18	1.07	1.08	1.02
V_2I_1	1.41	1.31	1.39	1.29	0.168	0.162	0.171	0.158	1.11	0.98	1.01	0.76
V_2I_2	1.40	1.30	1.36	1.28	0.154	0.144	0.148	0.138	1.18	0.99	1.00	0.42
V_2I_3	1.49	1.42	1.46	1.39	0.135	0.128	0.130	0.121	1.05	0.88	0.91	0.70
V_3I_0	1.52	1.47	1.43	1.35	0.131	0.090	0.146	0.137	0.90	0.66	0.86	0.59
V_3I_1	1.45	1.32	1.37	1.28	0.126	0.111	0.136	0.127	1.17	0.97	1.11	0.88
V_3I_2	1.41	1.33	1.36	1.30	0.111	0.099	0.119	0.111	1.34	1.18	1.28	1.07
V_3I_3	1.39	1.28	1.29	1.20	0.106	0.087	0.112	0.098	1.15	0.96	0.99	0.88
$CD_{0.05}$	0.05	0.101	0.102	0.101	NS	NS	NS	NS	NS	NS	NS	NS

*'off' year, †the details of treatment are given in the text.
**'on' year.

shoots. On the other hand, pruning led to vigorous growth, and new shoots acted as sink for calcium. Shoots developed after pruning might have lowered the calcium content. Furthermore, un-pruned trees had higher number of malformed shoots and age-old leaves than pruned trees; as a result, calcium concentration might have increased in un-pruned shoots, which is similar to the finding of Young and Koo (19). Similarly, pruning intensities in combination with cultivars significantly altered the concentration of Ca (Table 2). The mango leaves had the highest amount of Ca in un-pruned trees in all three cultivars whereas lowest was in severely pruned trees. These finding were similar to the earlier results of Young and Koo (19) where they observed that Ca increased significantly with leaf age and the un-pruned trees had the highest number of mature leaves. In un-pruned trees, the non-fruiting terminals were higher in number, which had higher concentration of Ca than the pruned tree, which had maximum fruiting terminals, this finding is similar to the earlier result of Thakur *et al*. (18).

The magnesium content in leaves was significantly affected due to cultivars (Table 2) may be because of differential rate of photosynthesis, variable proportion of chlorophylls and intensities of malformation in them. However, the highest Mg content was recorded in Dashehari, while lowest was in Amrapali, due to fact that former is biennial in nature, having higher total chlorophyll content and less susceptible to floral malformation (Singh *et al*., 17) than the Amrapali (regular bearer). The severely pruned trees had higher Mg content, whereas un-pruned tree had the lowest level. This may be because the pruning helped to increase chlorophyll and higher photosynthesis rate. Similar to above findings, Helail and Eissa (4) also found increased level of Mg in one-year-old 'Hindi Bisinara' mango due to root shortening and stem

Table 2. Effect of pruning intensities on calcium, magnesium and sulphur contents in leaves of different mango cultivars planted under high density.

Treatment	Calcium (%)				Magnesium (%)				Sulphur (%)			
	2005-06*		2006-07**		2005-06*		2006-07**		2005-06*		2006-07**	
	VP	RP	VP	RP	VP	RP	VP	RP	VP	RP	VP	RP
V_1	2.48	2.50	2.61	2.51	0.204	0.200	0.185	0.181	0.134	0.125	0.120	0.115
V_2	3.18	3.07	3.19	3.07	0.223	0.218	0.209	0.206	0.135	0.126	0.126	0.119
V_3	3.07	2.89	3.14	2.97	0.280	0.278	0.268	0.264	0.109	0.107	0.106	0.102
$CD_{0.05}$	0.205	0.205	0.197	0.221	0.009	0.009	0.008	0.009	0.004	0.004	0.003	0.003
I_0	3.56	3.41	3.52	3.47	0.193	0.189	0.178	0.174	0.120	0.113	0.115	0.110
I_1	3.01	2.89	3.03	3.02	0.250	0.246	0.232	0.228	0.125	0.120	0.116	0.111
I_2	2.60	2.63	2.72	2.66	0.224	0.219	0.211	0.208	0.128	0.121	0.117	0.112
I_3	2.47	2.36	2.48	2.38	0.275	0.272	0.262	0.258	0.130	0.123	0.121	0.116
$CD_{0.05}$	0.294	0.232	0.228	0.255	0.011	0.011	0.009	0.010	0.005	0.005	0.004	0.004
V_1I_0	2.98	2.86	3.10	3.01	0.192	0.188	0.168	0.162	0.124	0.118	0.118	0.113
V_1I_1	2.76	2.82	2.88	2.81	0.246	0.242	0.222	0.218	0.137	0.129	0.123	0.118
V_1I_2	2.31	2.13	2.29	2.16	0.138	0.134	0.126	0.123	0.130	0.127	0.118	0.114
V_1I_3	2.09	2.06	2.17	2.08	0.239	0.235	0.224	0.221	1.136	0.127	0.122	0.116
V_2I_0	3.73	3.57	.367	3.43	0.123	0.119	0.112	0.107	0.127	0.119	0.122	0.115
V_2I_1	3.08	2.87	2.96	3.13	0.304	0.299	0.235	0.283	0.134	0.126	0.123	0.116
V_2I_2	3.16	3.13	3.44	3.24	0.217	0.209	0.200	0.198	0.138	0.128	0.128	0.121
V_2I_3	2.77	2.55	2.67	2.47	0.250	0.247	0.239	0.234	0.139	0.131	0.132	0.125
V_3I_0	3.99	3.80	4.04	3.87	0.265	0.261	0.255	0.252	0.110	0.106	0.106	0.102
V_3I_1	3.19	2.99	3.29	3.07	0.201	0.196	0.188	0.184	0.104	0.104	0.101	0.098
V_3I_2	2.52	2.35	2.57	2.43	0.317	0.314	0.306	0.303	0.109	0.107	0.106	0.103
V_3I_3	2.59	2.43	2.63	2.59	0.337	0.334	0.322	0.318	0.113	0.111	0.109	0.106
$CD_{0.05}$	NS	0.410	0.395	0.442	0.019	0.019	0.016	0.018	NS	NS	NS	NS

VP: Vegetative growth phase; RP: Reproductive phase, * = on year; ** = off year

pinching than the un-pruned (control).Existence of old leaves in un-pruned trees are also an important reason of low concentration of Mg, which is in conformity with the results obtained by Young and Koo (19). When we considered the interaction effect of cultivars and pruning intensities (Table 2), the severely pruned Dashehari registered the highest Mg content due to fast cell division, chlorophyll synthesis, gradual increase in photosynthetic rate and low in yield in first year of experiment, while lowest Mg recorded in moderately pruned Amrapali may be due to regular bearing habit which have exhausted the plant in terms of nutrients. However, 'on' year/flowering phase had less percentage of Mg than in 'off' year/vegetative phase. This trend is similar to the findings of Pathak and Pandey (9) who got higher Mg during vegetative phase and lower during flowering stage but the maximum amount was estimated during vegetative phase.

Sulphur is the important constituent of some important amino acids, which are needed for building up of proteins. In this investigation (Table 2), the Mallika had the highest S content, while Dashehari registered the lowest, with higher percentage during 'off' year. This result is in conformity with the earlier findings of Samra *et al*. (12) who had also significantly higher estimated calcium, and sulphur content in 'off' year in Dashehari. Severe pruning intensity *viz*., caused higher amount of S accumulation in leaves while un-pruned tree had the least. This may be due to the effect of severe pruning encouraging vigorous growth which were non-fruiting terminals having highest percentage of sulphur than the fruiting terminals. This finding is confirmed by Thakur *et al*. (18) who found significantly higher S in non-fruiting terminals than the fruiting terminals of 'Lucknow Safeda' mango. In 'on' year, the sulphur content decreased due to increase in number of fruiting terminals. In contrary, the sulfur status was not significantly affected by interaction of cultivar and pruning intensity (Table 2) due to differential growth responses in cultivars as well pruning intensity.

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