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RESEARCH PAPER

Variation in foliar macronutrient levels of carambola (*Averrhoa carambola* L.) as influenced by type of tree, position of leaf on shoot and months

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Abstract **:** The experiment was carried out in a farmers' orchard situated at Birbhum district of West Bengal during the period of April 2006 to March 2007 to compare the foliar composition of nutrients between sour and sweet types of carambola and to standardize leaf sampling technique on the basis of type of plant, season and position of leaf on shoot. The results revealed that no significant variations in foliar P level could be found between sour and sweet type trees and position of leaf on shoot. However, the accumulation of P in leaf tissue showed strong seasonal fluctuation and it was relatively stable during September to November. The leaves of sour type of tree had significantly higher concentration of foliar K content. The position of leaves on shoot did not have any marked influence on foliar K level. However, the variation in leaf K content did not show any distinct pattern. No significant variations in foliar Ca level could be visualized due to type of tree and position of leaf on shoot. The seasonal changes in foliar Ca content were significantly different with stable period during July-October. Conspicuous variation in Mg level in leaf tissue was noted due to type of tree. However, position of leaf on shoot did not have any significant influence on leaf Mg content. The foliar Mg status remained stable during November-February.

Key Words **:** Foliar composition, Leaf sampling technique, Carambola

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INTRODUCTION

Carambola (*Averrhoa carambola* L.), also known as the five corner fruit or star fruit or *kamrakh*, is an important fruit crop of tropical and subtropical areas of the world. It belongs to the family Oxalidaceae and native to Malaysia or Indonesia. The available types are divided into two groups *i.e.* sour and sweet types. Fruits of carambola are rich source of reducing sugar, ascorbic acid and minerals like calcium, magnesium, and phosphorus. The mineral concentrations varied with the process of development of fruits. Nutritional status of perennial tree is one of the important factors that govern the growth and bearing habit of trees. Leaf analysis is more useful than soil analysis in perennial trees, mainly because of the difficulty of determining with sufficient accuracy the root zones in which deep rooting plants take up most of the nutrients (Marschner, 1986).The influence of age of leaf and/or season on foliar nutrient composition has been evaluated by some workers. Recently matured leaves are considered ideal for diagnostic and predictive purposes as the meristematic tissues are generally very rich in mobile elements (Bhargava and Chadha, 1993). Chandeler (1970) noted that leaves of same age, regardless of flush or sampling date were similar in chemical composition. On the contrary, a strong influence of month and growth flushes on the nutrient element composition of Khasi mandarin leaves has been reported (Sanyal *et al.*, 1994).The sixth leaf collected during the flowering peak period from August to October appeared ready to allow a nutritional diagnosis of carambola trees (Prado and Natale, 2004). In carambola cv. Arkin, George *et al*. (2002) observed that leaf

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Ca, Mg, Fe, and Zn were greater for trees at 5° C than trees at other root temperatures (10, 20, 25, and 38° C). However, there is lack of information in literature regarding the most adequate sampling time and the index leaf for the assessment of the nutritional status of carambola trees. In the present experiment, an attempt has been made to closely follow the seasonal fluctuations of nutrient element composition of leaf tissues and to comprehend the period of maximum uptake and stable period of nutrient; to compare the foliar composition of nutrients between sour and sweet types of carambola and to standardize a leaf sampling technique for carambola on the basis of type of plant, season and position of leaf on shoot.

MATERIALS AND METHODS

The experiment was carried out in farmer's orchard situated at Birbhum district of West Bengal during the period of April 2006 to March 2007. The maximum and minimum temperature during the period of experimentation ranged from 24.7^0 C to 37.5^0 C and 10.0^0C to 27.5^0C, respectively with a mean temperature variation from 15^0 C to 37^0 C (Table A). The relative humidity ranged from 60 per cent to 96 per cent with an average annual rain fall of 174.7 cm. The months July to September received the maximum rain fall. The soil of the experimental site was sandy loam in texture, having pH 6.4, organic carbon 0.57 per cent, total nitrogen 0.06 per cent, available phosphorus and potassium 31.5 and 281.4 kg ha^{-1}, respectively (Table B). Two different types of plants (sour and sweet types) were considered for this investigation. Leaves from the top, middle and basal portion of shoot were collected in every month. No fertilizer or manures was given and uniform cultural practices and plant protection measures were adopted. The experiment was conducted in a split-split-plot design with 3 number of replications having 3 number of plants per replication with main factor as type of tree (Sour and Sweet), sub factor as leaves on portion of shoot (top, middle and base) and sub-sub factor as months (12 months). Twenty leaves with petiole from the top, middle and basal portions of the shoot representing all the direction from both types (sour and sweet) were collected on 20^{th} of every month, starting from April, 2006 to March, 2007. Leaves collected were brought to the laboratory shortly after collection and processed further. The leaf samples were washed first by running water followed by 0.1N HCl, detergent water and finally by distilled water to decontaminate from dust and any other foreign materials. The leaves were then oven dried at 68 ± 2° C and ground to pass through a 40 mesh screen. The ground leaf samples were hermetically sealed in polyethylene bags for further analysis. The samples were digested with 4:1 ratio of nitric: perchloric acid and as suggested by Piper (1966).Total P contents of leaves were determined by Vando Molybadate yellow colour method (Jones, 1984), potassium content of leaf tissue was determined by Flame photometry (Chapman and Pratt, 1961) and calcium and magnesium contents in leaf tissues were analysed by "Versenate" method (Black, 1965) and the results were presented as percentage on dry weight basis. The data recorded during the period of experimentation were analyzed by the analysis of variance method (Panse and Sukhatme,1978) and significance of different sources of variations were tested by error mean square using Fisher

Table A : Meteorological data during the period of investigation

Year	Month	Temperature (^{0}C)		Mean (^{0}C)	Relative humidity (%)	Rainfall (cm)
		Maximum	Minimum			
2006	April	36.0	23.0	29.5	75.6	8.4
	May	36.3	25.0	30.6	73.2	8.0
	June	34.3	25.8	30.0	82.0	29.6
	July	32.2	26.0	29.0	87.4	57.0
	Aug.	31.8	25.7	28.7	87.0	20.0
	Sept.	32.4	25.0	28.7	86.7	34.6
	Oct.	32.0	22.6	27.3	82.8	3.0
	Nov.	29.0	17.8	23.4	77.7	1.3
	Dec.	26.6	13.2	20.0	75.8	----
2007	Jan.	25.3	10.6	18.0	70.2	----
	Feb.	26.6	15.4	21.0	81.6	7.5
	Mar.	31.0	17.7	24.3	66.7	5.3

Source: Meteorological observatory, Sriniketan, Birbhum, West Bengal.

Table B : Chemical characteristics of soil of experimental site

Depth of soil (cm)	pH	Organic carbon (%)	Total nitrogen (%)	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
0-20	6.4	0.57	0.06	31.5	281.4

Snedecor "F" test of probability at 0.05 per cent level of significance.

RESULTS AND DISCUSSION

In the present investigation no significant variations in foliar P level could be found between sour and sweet type trees and position of leaf on shoot (Table 1). However, the accumulation of P in leaf tissue showed strong seasonal fluctuation. It was maximum in the month of April, which gradually declined up to July followed by a short rise in August and thereafter tended to decline. The foliar P content was relatively stable during September to November. The decreasing trend of phosphorus might be partly due to losses prior to abscission of leaves (Cameron *et al.*, 1952) and partly due to low uptake of this element (Singh and Randhawa, 1961).

The leaf of sour type of tree in the present investigation had significantly higher concentration of foliar potassium content. The position of leaves on shoot did not have any marked influence on foliar K level. It remained high in the beginning (April) and gradually declined thereafter, however, the variation in leaf K content did not show any distinct pattern. As carambola bears thrice a year in this region, the fluctuations of K content in leaves might be due to mobilization from leaves to fruit. The outward migration of K from leaves in the fall and winter would suggest that it was either being mobilized into fruit or accumulated in woody tissue or both (Smith and Reuther, 1950). In the present investigation, the potassium levels in leaf tissue were relatively stable during September to October, which might be attributed due to variation of soil nutrient status, agro-climatic conditions and management practices. The variation in K content in leaves due to season in carambola might be ascribed to its bearing habit. A negative relationship between the level of K and

Table 1 : The macro- nutrient status of carambola leaves as influenced by type of trees, position of leaves on shoots and months

Factors	Phosphorous contents (% dry matter)	Potassium contents (% dry matter)	Calcium content (% dry matter)	Magnesium content (% dry matter)
Type of tree				
Sour type	0.13	1.93	0.61	0.24
Sweet type	0.12	1.69	0.58	0.20
C.D. (P=0.05)	NS	0.06	NS	0.03
Position of leaves on shoots				
Top	0.12	0.12	0.61	0.22
Middle	0.13	0.13	0.59	0.23
Base	0.12	0.12	0.59	0.21
C.D. (P=0.05)	NS	NS	NS	NS
Months				
April	0.20	2.29	0.42	0.21
May	0.16	1.91	0.78	0.24
June	0.11	2.05	0.77	0.28
July	0.11	1.70	0.57	0.16
August	0.16	1.99	0.53	0.21
September	0.14	1.83	0.59	0.31
October	0.13	1.65	0.55	0.18
November	0.13	1.95	0.74	0.22
December	0.06	1.74	0.81	0.21
January	0.07	1.16	0.83	0.20
February	0.11	1.69	0.70	0.25
March	0.10	1.74	0.89	0.18
C.D. (P=0.05)	0.04	0.19	0.10	0.6
Interactions: C.D. (P=0.05)				
Type of tree × Position of leaves on shoots	0.05	0.12	0.06	0.03
Type of tree × Months	0.06	0.28	0.14	0.08
Position of leaves on shoots × Months	0.07	0.34	0.18	0.09
Type of tree × Position of leaves on shoots × Months	0.10	0.48	0.25	0.38

NS=Non-significant

increasing age of leaf was also reported by several workers (Singh *et al.*, 1990). Patange and Patil (1981) reported substantial decrease in K level in lemon from November to April, which coincided with second flowering, fruit set, fruit development and fruit maturity.

It is apparent from the results that similar to foliar P content the accumulation of Ca in carambola leaf tissue was not influenced by the type of tree and position of leaves on shoot. In general, the leaves of sour type trees and apical portion of shoot had higher value of Ca. Significant variations in foliar Ca concentration could be recorded due to months. It was initially low but shot up during May to June and tended to decline thereafter up to October. The foliar Ca concentration again started rising from November onwards attaining the peak value in March. The Ca content in leaf tissue remained more or less stable from July to October. Crescimanno *et al.* (1975) compared the leaf composition of calcium in olive and found a continuous fluctuation of Ca level between full bloom throughout the autumn, late winter and early spring. The calcium content of leaf in litchi cv. Bombai and cashew cv. Red Hazari showed no consistent pattern of changes in different months of the year (Sanyal and Mitra, 1990b and 1991). Calcium observation in satsuma was lowest in winter and highest in August and September (Hirobe *et al.*, 1977). Calcium content increased with the increase in age of leaf (Singh *et al.*, 1990) in acid lime and mandarin till October and thereafter declined from November to April (Patange and Patil, 1981). This period corresponded to the period of fruit maturity, second flowering, fruit set and development and fruit maturity.

Conspicuous variation in Mg level in leaf tissue during the present investigation was noted due to type of tree. Leaves of sour type tree had higher concentration of foliar Mg level in comparison to sweet type tree. However, position of leaf on shoot did not have any significant influence on leaf Mg content. In general, the foliar Mg level tended to decrease from top to basal direction. The Mg content in leaves exhibited a variation due to season; the foliar Mg status remained stable during November-February. Magnesium was classified as immobile although it may not be completely so when Mg deficiency develops and may be transported from old leaves to new leaves, woody tissues, roots and fruits (Menzel *et al.*, 1992). Magnesium is known to have negative correlation with K content and it was found that Mg level decreased with rising K content in leaves (Bakr *et al.*, 1980). The proportions of K, Ca and Mg in the leaves were strongly influenced by soil cation status when the soil was well supplied with Ca and K/Mg antagonism was less acute (Smith, 1966).

In general, the interactions between type of tree x position of leaves on shoot, type of tree x months, position of leaves on shoot x months and type of tree x position of leaves on shoot x months had profound influences on the foliar phosphorus, potassium, calcium and magnesium content of carambola trees.

Conclusion:

From the present study it may be concluded that for determination of nutritional status of carambola tree grown in red - lateritic belt, leaf samples should be collected in the month of October-November from all directions and irrespective of portion of the shoot. However, for estimation of potassium and magnesium leaves from different types of tree should be collected separately.

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