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TEMPORAL AND AXIAL VARIATIONS FOR PRIMARY NUTRIENT CONCENTRATIONS IN LEAVES OF LITCHI

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ABSTRACT

An experiment was conducted in an established orchard (since, 1979) planted with cultivars Shahi and China at ICAR Research Complex for Eastern Region, Ranchi Centre (ICAR) to study temporal and axial variations for primary nutrient concentrations in leaves of Litchi as well as their interrelationship with crop productivity with the main objective to find out time of sampling and pair of leaves suitable for leaf tissue analysis in litchi for predicting nutrient deficiency in litchi and recommending most suitable time of sampling. Periodic collection of leaf samples from established orchard was done during the 2006-07; analysis of leaf samples for primary nutrients (N, P and K) in plant (leaf) part was carried out. Leaf concentration of N, P and K varied from 1.08 to 1.20, 0.081 to 0.109 and 0.690 to 0.786 percent, respectively. However, mean leaf nutrient concentration was 1.14, 0.095 and 0.738 percent for N, P and K, respectively. Highest concentration of N was observed for the 2nd pair of leaves where as for P and K was 1st pair of leaves. Significant relationship between yield and concentration were observed in 2nd and 4th pair of leaves. Sampling of 2nd and 4th pair of leaves of litchi during February to April or September to November was most suitable time in predicting.

INTRODUCTION

Leaf analysis is the only technique according to which sensible fertilisation can be applied to orchard crops (Bhargav, 2002). A greatest reserve of nutrients occurs in the leaves, twigs and small branches which accounts for about 75 per cent of the total reserves of the tree. The amount of nutrients in the other plant parts is usually less than 5 per cent. The high reserves in the leaves, twigs and small branches are mainly because these tissues account for a large proportion of the plant's weight. The concentration of nutrients in the leaves reflects the reserves in the rest of the plant indicating that they are a reliable index of the tree's nutrient status. Jharkhand state (India) is emerging as a potential region for litchi cultivation because of its suitable climatic condition. The rolling uplands of Jharkhand have been found to be highly suitable for the good crop of litchi (Rai *et al.*, 2002). Bhargava (2002) suggested that leaf analysis was the best method to ensure high economic productivity, to identify the need for application of nutrients, to sustain the available soil nutrient status at a desirable level, correct doses of manures, bio-fertilizers and chemical fertilizers that must be applied in perennial fruit crops. Influence of mulching with paddy straw enhance the nutrient concentration in Aonla leaf as reported by Bakshi *et al.*, 2015. Leaf analysis seems to be the best method for identifying the need for application of nutrients or diagnosing nutritional problems and a basis for fertilizer recommendation for fruit trees in many countries (Shear and Faust, 1980). Therefore, the present investigation was planned to study to establish the status of primary nutrients (N, P and K) with time and axial effects in leaves of litchi orchard in a year for the purpose of application of appropriate fertilizer to improve quality and productivity. By comparing the results of the analysis of leaf samples, suspected nutrient deficiencies can be confirmed or rejected.

MATERIALS AND METHODS

ICAR Research Complex for Eastern Region (ICARRCER), Ranchi centre, Plandu, Ranchi, formerly known as Horticulture and Agro Forestry Research Programme (HARP), was the site of experimentation. It was situated at Plandu in the district of Ranchi, capital of Jharkhand state. Geographically, HARP is located at the latitude 23°15' and 23°18' North and longitude of 85°25' East and at an elevation of 625 meters above mean sea level. The climate of the station is humid to subtropical type. The temperature ranges from a maximum of 30 to 34°C in April to June and a minimum of about 9 to 10°C in December and January. The mean annual precipitation was about 1473 mm, out of which roughly 3/4th was received during June to September from south west monsoon.

Twenty plants of litchi (10 plants each of Shahi and China) were selected randomly for leaf nutrient analysis from the experimental farm of HARP. Leaf samples were collected from 6th March 2006 to 6th February 2007 and sample were taken on 6th day of every month from the same randomly selected plants.

The leaves were collected from the mid-section of terminal shoots located on different sides of the tree. Leaves were collected from the interior portion of the tree at shoulder height or higher, no more than two leaves from any one shoot. Thirty leaves were collected from a single tree and the different pairs of leaves were separated. Total no of leaf samples were nine hundred sixty.

Fertilizers used during 2006-2007 were 80-100 kg FYM, 3-4 kg karanj cake, 1.7 kg urea, 2.5 kg ssp and 0.66 kg mop per tree. Applications of FYM, potassic, phosphatic and 2/3rd dose of N were done during June-July; just after harvesting the fruit and remaining 1/3rd were applied after fruit set in the month of March-April. After applications of fertilizer, trees were irrigated to maintain proper soil moisture. Fertilizers were applied through in a ring between 150 and 200 cm distance from the trunk. Data were statistically analyzed. The experiment was laid out in Randomized Block Design.

The leaf samples were washed with acidified detergent solution (Bhargava, 2002), rinsed in doubled distilled water, dried in hot air circulation oven at 65ºC till constant weight was obtained and ground in stainless steel blade Waring blender. The powdered samples were stored in polythene bags.

Total Phosphorus (P) and Potassium (K) were estimated after digestion in di-acid mixture (HNO_3:$HClO_4$ 10:4 ratio) Phosphorus in digested part was estimated using spectrophotometer by yellow color method developed by vanadomolybdate as described in Tandon, 2005. Potassium in digested part was estimated using flamephotomete as described in Tandon, 2005. Total nitrogen (N) was analyzed by micro-Kjeldahl method as described in Tandon (2005).

RESULTS AND DISCUSSION

The mean nutrient concentrations of leaf samples collected in 2006-2007 from Litchi orchards and were summarized according to time period. Some of the differences in the nutrient concentrations over the year in this data were also associated with the variability among the trees and different cultivars. These variations in nutrient concentration of the leaf samples indicate the physiological need of litchi at different stages of growth and development. The results were based on the following factors mainly which were associated with the litchi plants and environments.

Temporal variability in leaf nitrogen concentration

From Table 1, it was observed that N concentration in leaf during different months ranged from 1.08 to 1.20 %. The higher concentration (1.20 %) was recorded in February while lowest concentration (1.08 %) was recorded in the month of August.

Menzel *et al.* (1992 a) suggested that Nitrogen leaf concentration for litchi in Australia was 1.50 - 1.80 %. Koen and du Plessis (1993) also observed that N range was 1.26 - 1.46 % in the litchi leaf in South Africa. Similar trend was also made by Huang *et al.* (1998) and Chen *et al.* (1998) for the litchi plants in Taiwan and Guangdong respectively.

It is very clear that N concentration of leaf decreased from March to August which after wards increased during September-October and a further decreased during November-December while increased concentration was recorded during January-February. These observations were in agreement with Poulsen and Hansen (1965); Pant and Singh (1976) who showed a sharp declined in nutrient concentration of leaves of apple at the time of rapid leaf development and there after a slight increase in September. Leaf N concentration was quite stable during July in Golden Delicious Apple as reported by Verma and Singh (1990). Similar trend was also observed by Patel and Chadha (2002) in Grape.

Axial variability in leaf nitrogen concentration

Perusal of data on Table 1 indicated higher mean concentration of N in second pair of leaf which was statistically higher than 1st, 3rd and 4th pair of leaves. In 1st and 3rd pair of leaf remained at par and recorded higher concentration than the 4th pair of leaves. Result of present studies were in conformity with those of Sanyal and Mitra (1990), who also found that 2nd pair of leaves showed maximum N concentration from vertical shoots representing all the four directions in the month of August-September, might be used for estimating the nutritional status of litchi (Bombai) and similar observations were also recorded by Sanyal and Mitra (1990) in Guava cv. Lucknow - 49.

Correlation coefficient between leaf nitrogen concentration and crop productivity

Table 1: Mean N concentration (%) in leaves of litchi

Month	1st pair	2nd pair	3rd pair	4th pair	Mean
Jan	1.19	1.21	1.18	1.16	1.18
Feb	1.20	1.23	1.20	1.18	1.20
Mar	1.17	1.19	1.13	1.10	1.15
Apr	1.15	1.18	1.12	1.10	1.14
May	1.13	1.17	1.12	1.09	1.13
Jun	1.11	1.15	1.11	1.08	1.11
Jul	1.09	1.14	1.09	1.07	1.10
Aug	1.07	1.12	1.07	1.05	1.08
Sep	1.14	1.19	1.15	1.13	1.15
Oct	1.18	1.21	1.17	1.16	1.18
Nov	1.16	1.18	1.15	1.13	1.16
Dec	1.13	1.15	1.12	1.10	1.13
Mean	1.14	1.18	1.14	1.11	
CD (Month, p = 0.05)					0.011
CD (Pair, p = 0.05)					0.006
CV (%)					0.791

Table 2: Correlation coefficient of yield along with leaf N concentration

Month	1st pair	2nd pair	3rd pair	4th pair
Jan	0.086	0.016	0.327	-0.077
Feb	0.073	-0.189	0.267	-0.091
Mar	0.629**	0.638**	0.441	0.296
Apr	0.473*	0.529*	0.340	0.338
May	0.188	0.128	0.091	-0.095
Jun	0.014	0.011	-0.042	-0.068
Jul	-0.073	-0.066	-0.183	-0.290
Aug	0.089	0.106	-0.061	-0.127
Sep	0.311	0.098	0.299	-0.086
Oct	0.097	-0.052	0.170	-0.150
Nov	0.056	-0.328	0.107	-0.125
Dec	0.091	-0.403	-0.155	-0.143

*significant at 5% level**significant at 1% level

Table 3: Mean P concentration (%) in leaves of litchi

Month	1st pair	2nd pair	3rd pair	4th pair	Mean
Jan	0.092	0.088	0.089	0.089	0.090
Feb	0.103	0.099	0.099	0.099	0.100
Mar	0.120	0.098	0.112	0.105	0.109
Apr	0.103	0.092	0.099	0.096	0.098
May	0.097	0.088	0.093	0.090	0.092
Jun	0.094	0.086	0.089	0.087	0.089
Jul	0.090	0.083	0.086	0.084	0.086
Aug	0.086	0.081	0.083	0.081	0.083
Sep	0.090	0.084	0.086	0.085	0.086
Oct	0.094	0.088	0.091	0.089	0.091
Nov	0.089	0.084	0.085	0.085	0.086
Dec	0.084	0.080	0.080	0.080	0.081
Mean	0.095	0.088	0.091	0.089	
CD (Month, p = 0.05)					0.003
CD (Pair, p = 0.05)					0.002
CV (%)					2.468

Table 4: Correlation coefficient of yield along with leaf P concentration

Month	1st pair	2nd pair	3rd pair	4th pair
Jan	-0.255	-0.406	-0.197	-0.181
Feb	-0.249	-0.338	-0.214	-0.245
Mar	0.102	0.303	0.202	-0.012
Apr	-0.229	-0.340	-0.267	0.286
May	-0.209	-0.346	-0.219	0.117
Jun	-0.194	-0.336	-0.233	0.118
Jul	-0.213	-0.339	-0.197	0.105
Aug	-0.203	-0.339	-0.205	0.080
Sep	-0.205	-0.331	-0.166	0.092
Oct	-0.194	-0.326	-0.179	0.003
Nov	-0.184	-0.360	-0.178	-0.053
Dec	-0.225	-0.351	-0.207	-0.093

*significant at 5% level**significant at 1% level

Table 5: Mean K concentration (%) in leaves of litchi

Month	1st pair	2nd pair	3rd pair	4th pair	Mean
Jan	0.776	0.763	0.751	0.739	0.757
Feb	0.806	0.791	0.779	0.766	0.786
Mar	0.781	0.764	0.758	0.759	0.766
Apr	0.771	0.754	0.747	0.746	0.755
May	0.749	0.734	0.719	0.720	0.731
Jun	0.726	0.709	0.704	0.694	0.708
Jul	0.720	0.703	0.697	0.685	0.701
Aug	0.714	0.691	0.684	0.671	0.690
Sep	0.742	0.728	0.716	0.706	0.723
Oct	0.754	0.744	0.733	0.724	0.739
Nov	0.766	0.756	0.746	0.737	0.751
Dec	0.749	0.736	0.726	0.715	0.732
Mean	0.755	0.739	0.730	0.722	
CD (Month, p = 0.05)					0.004
CD (Pair, p = 0.05)					0.002
CV (%)					0.456

From Table 2, the leaf N concentrations were found to be significant and positively correlated with the yield in the month of March and April. Higher correlation values (0.638**) was observed in the second pair of leaf in the month of March. These findings were in agreement with results obtained by Marathe and Bharambe (2007) in sweet orange.

Temporal variability in leaf phosphorus concentration

Perusal of data on mean leaf P concentration (Table 3) indicates that phosphorus concentration in leaf varied from 0.081-0.109%. The highest concentration (0.109 %) was recorded in the month of March which was statistically superior to concentration observed during the whole year. Menzel et al. (1992 a) suggested that leaf P concentration for litchi in Australia were 0.14 - 0.22 %. Koen and du Plessis (1993) also observed that P range were 0.15 - 0.20 % in the litchi leaf in South Africa. Similar trend was also made by Huang *et al.* (1998) and Chen *et al.* (1998) for the litchi plants in Taiwan and Guangdong respectively.

It is seen from Table 3 that P concentration of leaf decreased from April to August which after wards increased during September-October and further decreased and increased during November-December and January to March respectively. However, there was no consistent trend of increase or decrease in P concentration with the month. Pant and Singh (1976) also observed such seasonal fluctuation in P concentration and increased after fruit harvest. Bollard et al. (1962) also founded change in P concentration throughout the season. From this experiment, stable P concentration observed during June, July and August was in agreement with Verma and Singh (1990) who found that Leaf P concentration was quite stable during August in Golden Delicious Apple. Similar trend was also observed by Patel and Chadha (2002) in Grape.

Axial variability in leaf phosphorus concentration

It was seen from Table 3 that 1st pair of leaves showed maximum mean P concentration (0.095 %) which was statistically significant and higher than 2nd, 3rd and 4th pair of leaves. The 3rd and 4th pair of leaves remained at par. These findings were in agreement with the results obtained by Sanyal and Mitra (1990), who also found that 1st pair of leaves showed maximum P concentration from vertical shoots representing all the four directions in the month of August-September, might be used for estimating the nutritional status of litchi (Bombai).

Correlation coefficient between leaf phosphorus concentration and crop productivity

From Table 4, it was clearly seen that no correlation value was found significant in case of phosphorus. The positive correlation was obtained from April to October in 4th pair of leaves and higher r-value (-0.406) was observed in month of January in the 2nd pair of leaves. Negative correlation was found from 1st to 3rd pair of leaves in whole month except March. However, these r-values were non-significant.

Temporal variability in leaf potassium concentration

An appraisal of mean data (Table 5) indicates that K concentration in leaf during different months ranged from 0.690 to 0.786 %. The higher concentration (0.786 %) was recorded in February while lowest concentration (0.690 %) was recorded in the month of August. Menzel *et al.* (1992 a) suggested that leaf K nutrient concentration for litchi in Australia were 0.70 - 1.10 %. Koen and du Plessis (1993) also observed that K range were 0.90 - 1.06 % in the litchi leaf in South Africa. Similar trend was also made by Huang *et al.* (1998) and Chen *et al.* (1998) for the litchi plants in Taiwan and Guangdong respectively.

Table 6: Correlation coefficient of yield along with leaf K concentration

Month	1st pair	2nd pair	3rd pair	4th pair
Jan	-0.691**	-0.711**	-0.687**	-0.701**
Feb	-0.674**	-0.694**	-0.685**	-0.695**
Mar	-0.636**	-0.593**	-0.648**	-0.606**
Apr	-0.609**	-0.607**	-0.625**	-0.578**
May	-0.671**	-0.637**	-0.643**	-0.637**
Jun	-0.662**	-0.624**	-0.635**	-0.631**
Jul	-0.687**	-0.617**	-0.666**	-0.665**
Aug	-0.656**	-0.619**	-0.678**	-0.681**
Sep	-0.670**	-0.705**	-0.673**	-0.681**
Oct	-0.692**	-0.691**	-0.674**	-0.679**
Nov	-0.681**	-0.678**	-0.666**	-0.659**
Dec	-0.675**	-0.682**	-0.658**	-0.680**

*significant at 5% level**significant at 1% level

The concentration recorded in the month of February was statistically superior to concentration observed during the whole year. Significant increase and decrease in concentration were observed during the whole year but concentration during January - April and May - December were remained at par. The pattern of present variation in K was accepted with the results of Menzel *et al.* (1987) reported in litchi cv Bengal.

Axial variability in leaf potassium concentration

Perusal of data (Table 5) revealed that there was significant difference in K concentration between the 1st, 2nd, 3rd and 4th pair of leaves. In 1st pair of leaf was statistically superior to 2nd, 3rd and 4th pair of leaves. Lowest concentration (0.722%) was obtained in 4th pair of leaves. Result of present studies were in conformity with the results of Sanyal and Mitra (1990), who showed that K concentration was maximum (1.56%) in 1st pair of leaves in litchi (Bombai).

Correlation coefficient between leaf potassium concentration and crop productivity

In Table 6, it was seen that potassium concentration with yield were significantly and negatively correlated with all pair of leaves but r-value was maximum (0.711**) in the 2nd pair of leaves in month of January. Similar trend was observed in Apple orchard by Awasthi *et al.* (1998).

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