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Quantification of mineral nutrient variation at different growth stages of litchi fruit (*Litchi chinensis* Sonn.)

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Abstract: The present study was conducted to quantify nutrient variation at different growth stages of litchi fruit (*Litchi chinensis* Sonn.). Experimental result shows that the highest amount of nitrogen (1.51%) and manganese (31.83ppm) was accumulated in cv. Dehra Rose and while iron content was highest in cv. Ajhauli (159.81ppm) among the cultivar investigated. However, no significant differences were recorded in respect to fruit phosphorus, calcium and magnesium content in all varieties .As far as potassium content is concerned, the highest potassium was registered in cv. Ajhauli and Shahi (0.96%). Micronutrient like zinc content was found maximum in cultivar Purbi (31.88ppm), while copper content was found maximum in cv. Shahi (78.67ppm).In general, mineral nutrient like nitrogen (1.62%) was observed highest at fruit initiation stage and decrease with the fruit growth. However, very least difference in mineral nutrient content among stages was observed in phosphorus, calcium and magnesium. While the maximum concentration of potassium (1.05%), iron (286.92ppm) and manganese content (41.28ppm) was observed during stone hardening stage and decreases in later stages. While, the maximum concentration of zinc (32.48ppm) and copper (95.78ppm) content was observed in harvest stage (based on pulp). However, no significant difference was observed in phosphorus and magnesium.

Keywords: Litchi, mineral nutrients, growth stage, variety and quantification

Introduction

The litchi (*Litchi chinensis* Sonn) is an important commercial fruit crop providing nutritional security to millions of people of South East Asia. It belongs to the Sapindaceae family and is popularly known as the queen of fruits due to its attractive colour, taste, and quality. India and China account for 91 percent of the world litchi production but it is mainly marketed locally. The area under fruit in Bihar during 2010-2011 was 296.4 thousand hectares with a total annual production of 3911.8 thousand tones and registered productivity of 13.2 tone/ha. Litchi is the third major fruit crop in Bihar covering an area of 31.1 thousand hectare with production of 227.0 thousand tone contributing 45.6% of litchi production in the country followed by West Bengal (17.1%) and Jharkhand (7.2%) (NHB, 2011-12). However, the productivity of Bihar is very low (7.3t/ha) as compared to Punjab (14.7t/ha) and West Bengal (9.9t/ha). This indicates that low productivity in Bihar can be increased by adopting good package and practices. There is a need to give special attention which forces to seek and employ more efficient production technique by devising a precise package of practices for this crop with special reference to fertilizer management. In recent past, declining productivity of old senile orchard existing in abundance has become a matter of concern for planners, orchardists, as well as scientists. It is estimated that about 35% orchards of litchi in Bihar are very old which affect litchi production in Bihar. In the perennial fruit crops, the tree witness decline in productivity after certain age making orcharding economically non-viable and non-remunerative. In decline orchards, the productivity status is further affected due to compounding problem of different package and practices and precise fertilizer management is the one of the major component of any production system. Hence, the determination of nutritional needs for efficient production of high quality fruit is an important aspect of nutrient management for the growers. Considering the importance of this fruit crop in the region, efforts are made to provide technological support through research and promoting production and marketing, including export, through development programmes. Litchi has also been identified as an important crop for export.

Nutritional concentration associated with optimal tree growth, fruit yield and quality. The interpretation of leaf analysis must consider many factors that may influence foliar nutrient levels, seasonal differences related to rainfall, fruit load, pruning, variety, rootstock, nutritional interaction and nutrient removal (Heckman, 2001). Information about the nutritional status of a plant is a basic prerequisite for its adequate nutrition and crucial to achieve high yield productivity. Assessing the annual amount of nutrient that tree needs to absorb in order to successfully complete a vegetative and reproductive growth is a fundamental step for developing rational fertilization in orchards. The cumulative amount of nutrients taken up by a tree in one year equals the nutrient content in the yearly net primary production of the tree (Roccuzzo *et al*., 2012). According to literature survey, very meagre information is available on variation in nutrient content among different varieties of litchi. In order to avoid misleading soil fertility program, reference value used for interpreting the results of plant analysis should reliably reflect differences in nutrient content among very closely related plants. This is especially important for establishing and maintaining a proper fertilizer program in an orchard. Hence, the determination of nutritional needs for efficient production of high quality fruit of litchi is an important aspect of nutrient management for the growers. Keeping in view the importance of precise fertilizer management under traditional and fertigation method of fertilizer application, the information on accumulation of nutrient at different growth stages and total removal of nutrient by

the produce is absolutely essential for making a good recommendation through leaf tissue testing. Therefore, the present study is proposed to established proper nutrient management for litchi.

Materials and Methods

The Investigation was carried out in the Department of Horticulture (Fruit and Fruit Technology), Bihar Agricultural College, Sabour (Bhagalpur) during the year 2013-2014 for screening the different genotypes of Litchi (*Litchi chinensis* Sonn) to find the association between morphological parameter and yield attribute on cost benefit ratio as well as suitability under farm condition. The fruits for this purpose were procured from the trees of various age groups from the horticulture garden of Bihar Agricultural College, Sabour. The place is about 10km east of Bhagalpur town in Bihar state of India. It is situated between 25.15°North latitude and 87.24° East longitude and at an altitude of 45.72 m above the mean sea level in the vast alluvial Gangetic plain south to river Ganga in zone IIIA. The research area has a sub-tropical climate with extremes of summer and winter. During the summer season, the temperature reaches upto 46-48^{0}C, while during winter season, especially in the month of Nov. and Jan. temperature drops down to as low as 10-20^{0}C. During winter, frost and during summer, hot scorching wind are common features. The average rainfall in this area is around 882 mm, during the monsoon i.e. June to Sept, with a few occasional light showers and drizzles are seen in the winter also. Fruits were collected in perforated paper bags and brought to the laboratory on the sameday. The fruit samples were thoroughly washed first with tap water, then dipped in 0.1NHCl, distilled water and finally in double distilled water. After air drying, the samples were cut in small pieces and dried in an oven at 68^{o}C till the constant weight is obtained. The dried sample has been ground in grinder and then kept in butter paper bags for chemical analysis. Nitrogen was estimated by Kjeldahl method and phosphorus content was determined by using ammonium molybdate: ammonium metavanedete. (Champman and Pratt,1961). The colour intensity was measured at 440nm in a spectrophotometer. Fruit potassium and calcium were determined with flame photometry technique using corning flame photometer, U.K.(Jackon,1973). The magnesium was estimated by using atomic absorption Spectrophotometer. The elements will analysed by using the di acid digested material using Atomic Absorption Spectrophotometer for the estimation of Zn, Cu, Fe and Mn. Available nitrogen was estimated by using alkaline KMnO4 method as suggested by Subbaiah and Asija(1956). Available phosphorus content of the soil was extracted with sodium bicarbonate (Olsen *et al*.,1954) and the blue colour intensity was measured calorimetrically using 660nm wave length (Dickman and Bray,1940). It was determined in the neutral normal ammonium acetic extract of soil through a flame photometer. Available micro nutrients in the soil sample were extracted with DTPA (Lindsay and Norvell, 1978) and were estimated using Atomic Absorption spectrophotometer

The statistical methods described by Gomez and Gomez (1984) were followed to analyse and interpret the data. The experimental design was randomized block design (factorial). Total six treatments (varieties) comprised of a single plant of each and was replicated thrice. Critical difference (CD) values at p = 0.05 were used to determine the significance of differences between mean values of treatments. The standard level of significance used to justify a claim of a statistically significant effect is 0.05 (Draper and smith 1998).

Results and Discussion

Main effect of varieties on micronutrient content in different varieties of litchi-

Nitrogen content (%): Data pertaining to nitrogen content in fruit of various cultivar of litchi has been presented in Table-1. There was a significant difference in Nitrogen content was recorded in different cultivars. It is clearly shows that the maximum concentration of nitrogen content was found in Dehra Rose (1.51%) followed by Ajhauli (1.39%) and Deshi (1.30%). However, no significant difference were recorded in cv. China and Purbi (1.23%) while the minimum nitrogen concentration was observed in the cultivar Shahi i.e.(1.21%)on dry basis. This might be due to varying range of accumulation in different cultivars which is greatly influenced by physiology.

Phosphorus content (%): Data on phosphorus content in different litchi cultivar have been presented in Table-1 shows minute level of differences. Close perusal of data indicates that maximum phosphorus content was observed (0.02%). No significant difference has been observed among China, Deshi, Dehra Rose and Shahi while as minimum phosphorus content (0.01%) was observed in cv. Ajhauli.

Potassium content (%): A perusal of Table-1 indicates that the highest accumulation of potash was found in the variety Ajhauli and Shahi i.e. (0.96%) followed by cultivar Dehra Rose (0.93%) and Purbi (0.90%) however, the lowest accumulation of potash content was observed in cultivar Deshi and China (0.86%).

Calcium content (%): The observation on Calcium content accumulation in various litchi cultivars has been presented in Table-1. It would be evident from the aforesaid table that marked difference were observed with regards to calcium content accumulation in litchi cultivars. The highest calcium content accumulated (0.15%) in cultivar Deshi, DehraRose, and Shahi which was statistically at par with Ajhauli and Purbi (0.14%) while as the lowest calcium was found in variety China(0.13%).

Magnesium content (%): The data on magnesium content accumulation in different cultivar of litchi has been depicted in Table-1. It was observed that maximum concentration of magnesium was found in the cultivar Purbi (0.08%) which was statistically at par with the cultivar Ajhauli (0.08%) and Shahi (0.06%) while the minimum concentration (0.05%) of calcium accumulation was found in the cultivar China, Deshi and DehraRose.

Iron content (ppm): The mean iron content accumulation in litchi fruits has been also presented inTable-1.Data revealed that the highest accumulation of iron was found in the cultivar Ajhauli (159.81ppm) which was statistically at par with the cultivar Deshi (158.71ppm) followed by cultivar Purbi (151.71ppm) and China (150.78ppm) whereas, the minimum iron content was found in the cultivar Shahi (131.81ppm).

Manganese content (ppm): The data pertaining to manganese content accumulation in litchi cultivars have been presented in table-1. There was a significant difference in manganese content was recorded in different cultivars. The maximum manganese content was accumulated in cultivar DehraRose (31.83ppm) which is at par with the cultivar Deshi (31.08ppm) followed by cultivar China

Table-1: Effect of varieties on mineral nutrient content indifferent variety of litchi fruit

varieties	Macronutrients (%)					Micronutrients (ppm)			
	Primary					Secondary			
	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
Ajhauli	1.39	0.01	0.96	0.14	0.08	159.81	29.25	31.03	73.58
China	1.23	0.02	0.86	0.13	0.05	150.78	30.08	27.31	69.58
Desi	1.30	0.02	0.86	0.15	0.05	158.71	31.08	25.61	69.33
DehraRose	1.51	0.02	0.93	0.15	0.05	143.58	31.83	29.88	71.75
Purbi	1.23	0.02	0.90	0.14	0.06	151.71	27.08	31.88	77.67
Shahi	1.21	0.02	0.96	0.15	0.06	131.81	29.75	31.16	78.67
SE m ±	0.059	-	0.0 9	-	0.01	9.91	0.45	2.48	2.02
CD@5%	0.120	N S	0.019	N S	0.02	19.94	0.91	5.00	4.08

Table-2: Interaction effect of varieties and stages on Nitrogen content (%)

Cultivars	Fruit initiation stage	Marble stage	Stone hardening stage	Harvest stage
Ajhauli	1.69	1.71	1.15	0.98
China	1.64	1.51	0.97	0.80
Deshi	1.49	1.32	1.34	1.04
Dehra Rose	1.68	1.64	1.76	0.97
Purbi	1.82	1.32	0.97	0.82
Shahi	1.38	1.46	1.02	0.98
SE m ±	0.11	0.11	0.11	0.11
CD @ 5%	0.24	0.24	0.24	0.24

Table-3: Interaction effect of varieties and stages on Phosphorus content (%)

Cultivars	Fruit initiation stage	Marble stage	Stone hardening stage	Harvest stage
Ajhauli	0.01	0.02	0.01	0.01
China	0.01	0.02	0.02	0.02
Deshi	0.01	0.02	0.02	0.02
Dehra Rose	0.02	0.02	0.02	0.02
Purbi	0.02	0.02	0.02	0.02
Shahi	0.01	0.02	0.02	0.02
SE m ±	-	-	-	-
CD @ 5%	N S	N S	N S	N S

Table-: 4 Interaction effect of varieties and stages on Potassium content (%)

Cultivars	Fruit initiation stage	Marble stage	Stone hardening stage	Harvest stage
Ajhauli	0.91	1.03	1.15	0.76
China	0.57	0.97	1.07	0.82
Deshi	0.85	0.86	0.96	0.76
Dehra Rose	0.84	0.90	1.10	0.87
Purbi	0.83	0.84	0.98	0.93
Shahi	0.96	0.94	1.06	0.88
SE m ±	0.01	0.01	0.01	0.01
CD @ 5%	0.03	0.03	0.03	0.03

(30.08ppm), Shahi (29.75ppm) and Ajhauli (29.25ppm). However, the minimum content of manganese was found in cultivar Purbi (27.08ppm).

Zinc content (ppm): Data related to zinc content accumulation in litchi cultivars have been presented in table-1 which revealed that maximum concentration of zinc was observed in cultivar Purbi (31.88ppm) which was statistically at par with the cv. Shahi (31.16ppm), Ajhauli (31.03ppm) followed by cv. Dhera Rose (29.88ppm) and China (27.31ppm). While as the minimum concentration of zinc was observed in the cultivar Deshi (25.61ppm) copper content (ppm).

Interaction effect of varieties and stages of litchi fruit on Macronutrients accumulations-

Nitrogen content (%): The interaction effect of varieties and stages on nitrogen content accumulation has been depicted in table2. A perusal of table indicates that the nitrogen content accumulation are more during the initial fruit growth stage than that of marble stage, stone hardening stage and harvest stage. However, the cv. Ajhuli and cv. Shahi registered more nitrogen accumulation during marble stage. The decreasing trend of nitrogen accumulation was recorded from fruit initiation stage to harvest stages. The highest concentration of nitrogen (1.82%) was observed in fruit initiation stage of cv. Purbi while as no conspicuous trend of nitrogen accumulation were found in cv. Dehra Rose. The nitrogen accumulation reached to the lowest level during the harvest stage sowing to the fact that only pulp was taken for analysis. A critical review of table indicates that the highest nitrogen accumulation in the pulp were recorded in cv.Deshi (1.04%) followed by cv. Ajhauli (0.98%) and cv. Shahi (0.98%).

Phosphorus content (%): The interaction effect of different varieties and stages has been presented in table3. The highest accumulation of phosphorus content was observed (0.02%), no significant difference was found in marble stage of cultivar Ajhauli, China, Deshi, Dherarose,Purbi and Shahi followed by stone hardening and harvest stage of cv.China, Deshi, DheraRose, Purbi and Shahi. However,in fruit initiation stage of Ajhauli, China, Deshi, Dherarose, Purbi and Shahi have lowest and similar phosphorus content i.e.(0.01%) except DheraRose and Purbin(0.02%).

Potassium content (%): It would be evident from the table-4 that the potassium accumulation in litchi fruit increased gradually from fruit initiation stage to stone hardening stage.During fruit initiation stage,the maximum potassium accumulation were recorded in cv.Shahi followed by cv.Ajhauli and minimum accumulation has been found in cv.China. A critical review of table5 indicate that the potassium accumulation from fruit initiation stage to marble stages is very less how ever,the cv.China registered more accumulation during the period from fruit initiation stage to marble stage then that of other cultivars. As far as the potassium accumulation in pulp is concerned (harvest stage), the maximum content of potassium was recorded in cv. Purbi (0.93%) followed by cv. Shahi (0.88%) and minimum potassium in pulp has been registered in cv.Ajhauli (0.76%) and cv. Deshi (0.76%). The variation in potassium accumulation was wide among the varieties / cultivars.

The present study concludes that the highest amount of nitrogen (1.51%) and manganese (31.83ppm) was accumulated in cv. Dehra Rose while iron content was highest in cv. Ajhauli (159.81 ppm) among the cultivar investigated. However, no significant differences were recorded with respect to fruit phosphorus, calcium and magnesium content in all varieties. As far as potassium content is concerned, the highest potassium was registered in cv. Ajhauli and Shahi (0.96%). Micro nutrient like zinc content was found maximum in cultivar Purbi (31.88ppm) while copper content was found maximum in cv .Shahi

(78.67ppm). In general, mineral nutrient like nitrogen (1.62%) was observed highest at fruit initiation stage and decreases with the fruit growth. However, least difference in mineral nutrient content among stages was observed in phosphorus, calcium and magnesium. While the maximum concentration of potassium (1.05%), was observed during stone hardening stage and decreases in later stages.

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