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Evaluation of Leaf Biochemical Status at different Phenological Stages of Litchi (*Litchi chinensis* Sonn.) cv. Deshi

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ABSTRACT: Leaf nutrient and biochemical properties play important role in flowering and yield parameters of a plant. Thus, a study was undertaken to estimate leaf nutrient and biochemical status at different phenological stages of bearing litchi plants (*Litchi chinensis* Sonn.) in variety Deshi which is one of the commercial varieties of Bihar. Altogether ten phenological and meso stages were selected as per BBCH scale of litchi to measure the level of biochemical parameters in litchi leaves from shoot emergence to harvesting of fruits. Significant variation in leaf nutrient such as content of nitrogen, phosphorus and potassium in leaf and biochemical parameters like carbohydrate, protein, phenol and chlorophyll was observed with changes in phenology. The highest amount of leaf nitrogen, phosphorus, carbohydrates (7.56%), phenol and total chlorophyll was accumulated when shoots were about 90% of final length before flowering and it gradually decreased till stage of fruit maturity. However, the maximum protein content in leaf was noted in initial stage of leaf emergence and it gradually decreased with leaf maturity and least protein content was estimated at fruit maturity stage. Specific leaf weight was increased gradually and it was maximum (0.064%) at the stage when fruit colour fully developed.

Keywords: Litchi, Phenology, Leaf, nutrient, biochemical.

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.) of family Sapindaceae is an evergreen subtropical crop and is popularly known as the queen of fruits due to its attractive colour, taste, and quality. It is the most important commercial fruit plant among species of sapindaceae family. China is the biggest producer of litchi followed by India, Vietnam, and Thailand. In India, 568,200 metric tons of litchis are produced annually from 93,300 hectares (Anonymous, 2018). The state of Bihar in India is leading state and 66% of the total production of the country comes from Bihar, West Bengal and Jharkhand. Various works have demonstrated that the biochemical constituent of plants, their content and their biological activities are influenced by phenological stages (Pirbalouti *et al.*, 2013). It has been reported that young leaves have lower chlorophyll concentrations and photosynthetic rates than mature leaves.

In general, net CO_2 assimilation increases during leaf ontogeny, often reaching maximum level at about full leaf expansion and then decreases during senescence. Litchi trees flower at the apex of terminal shoots and the accumulation of carbohydrates in these shoots is dependent on mature leaves which have photosynthetic capacity. Litchi flowering is considered to be related to the patterns of carbohydrate distribution in trees (Chen *et al.*, 2004). Carbohydrates play an important role in flowering (Chen *et al.*, 2004; Menzal *et al.*, 1995). Changes in different phytoharmones have been reported to influence floral initiation process in litchi. However, information on the biochemical variation related with phenological stages is very limited. Phenolics are the most important secondary metabolites in litchi and it plays various roles in entire metabolic process for instance incorporating attractive substances to accelerate pollination, coloring for camouflage and defence against herbivores, as well as antibacterial and antifungal activities (Ahmad and Tahir 2017). The phenol acts as analogues of hormone which trigger floral development in litchi.

Generally young leaves have lower chlorophyll concentrations and photosynthetic rates than mature leaves. The changes in chlorophyll concentrations reflected changes in the colour of leaves. In a study by Filleal *et al.* (1995) it was observed that the chlorophyll content makes an indirect estimation of the nutritional status possible, since it has great amount of nitrogen. The photosynthetic rate also plays a key role for the energy availability in the plant, which is again control directly or indirectly by chlorophyll contents and its stability Nahakpam (2017). Litchi leaves produce large amounts of carbohydrates that store in the branches and trunks having highest concentration of starch in the small branches (Chen *et al.*, 2004). Changes in the biochemical composition in leaf have been reported also to be associated with differential phenophases of the plants. Hence, the determination of biochemical needs for efficient production of high-quality fruit of litchi is an important aspect of nutrient management for the growers.

MATERIALS AND METHODS

A. Experimental site

The Investigation was carried out in the Department of Horticulture (Fruit and Fruit Technology), Bihar Agricultural College, Sabour (Bhagalpur) during the year 2020 in litchi variety Deshi for estimation of the biochemical content of litchi leaves at different phenophases of litchi. This is an early variety and commercially grown mainly in South Bihar. The leaves for this purpose were sampled from the trees of Deshi situated in horticulture Garden of Bihar Agricultural College, Sabour, Bihar. The place is in the alluvial Gangetic plain south to river Ganga. The research area has a semi-arid sub-tropical climate with extremes of summer and winter.

B. Leaf sampling

For the biochemical estimation, leaves collected at ten different growth stages or phenophases as per BBCH scale given by Heik *et al.* (2013). The various stages at which leaves collected were stage-(i) when vegetative bud started to break (stage -019), (ii) leaves unfolding stage when red petiole was start visible (stage-113), (iii) stage-117 i.e when all leaves unfolded and expanded , (iv) stage-119 i.e when leaves become mature and colour changed to dark green, (v) when shoots were about 90% of final length (stage-319), (vi) stage-509 i.e at end of panicle development having most flowers with petals, (vii) stage-615 i.e when panicle is in full bloom stage ,(viii) when fruit was about 50% of final size (stage-705), (ix) stage of colour break (stage-801) and (x) when fruit in full colour development stage and fruit ripe for consumption (stage-805). Samples were taken for the estimation at the stage-019 simply by scooping the bud.

At the stage of 019, 113 and 117 the leaves were not clearly visible thus the whole bud or leaves were taken for estimation. For remaining stages, 3rd pair of leaflets of fully mature leaf were selected for estimation of biochemical parameters in leaves. Leaves were collected in perforated paper bags and brought to the laboratory on the same day for the estimation.

C. Estimation of biochemical parameters

Leaf nitrogen was determined by micro-kjeldhal methods as described by Jackson (1973). The phosphorus content was determined in the test sample by using ammonium molybdate: ammonium metavanadate-yellow colour method given by Jackson (1973) Potassium was determined with flame photometry technique using coming flame photometer, U.K (Jackson, 1967). Carbohydrate was determined by anthrone method given by Sadasivam and Manickam (1992) and absorbance was taken at 630 nm. Total phenolic content was estimated using Folin-Ciocalteu's method with some modifications. OD was taken at 760 nm in a spectrophotometer. Acetone method was used to determine the chlorophyll content from the leaves of litchi with little modification given by Arnon (1949).

The experimental design was randomized block design with three replication. Critical difference (CD) values at $p = 0.05$ were used to determine the significance of differences between mean values of treatments.

RESULTS AND DISCUSSION

A. Leaf nutrient content

There was gradual increase in nitrogen phosphorus and potassium content from stage when green shoot tips start to visible (stage 019) to stage 509 when panicle development comes to end before flowering and declined afterward till fruit ripening (stage 805). The maximum nitrogen content (1.67%) was found at stage 509 which was at par with stage 319 i.e 90% shoot length when leaves fully mature and stage 509 i.e end of panicle development. Minimum nitrogen content was noted at stage 805 i.e fruit colour fully developed (Fig. 1). Similar trend was noted for phosphorus and potassium content also (Fig. 2 and 3). Increasing trend in N and potassium content with leaf maturity has also been advocated by Yang *et al.* (2014) in litchi. Declined trend of N reported by Menzel *et al*. (1988) in fruiting shoots in litchi. They further reported that leaf N and K content acts as source that rapidly decreased in transition phase from vegetative to reproduction and fruit growth. Similar report has been given various workers in litchi (Saykhul *et al.,* 2014; Yurtseven *et al.,* 2005).

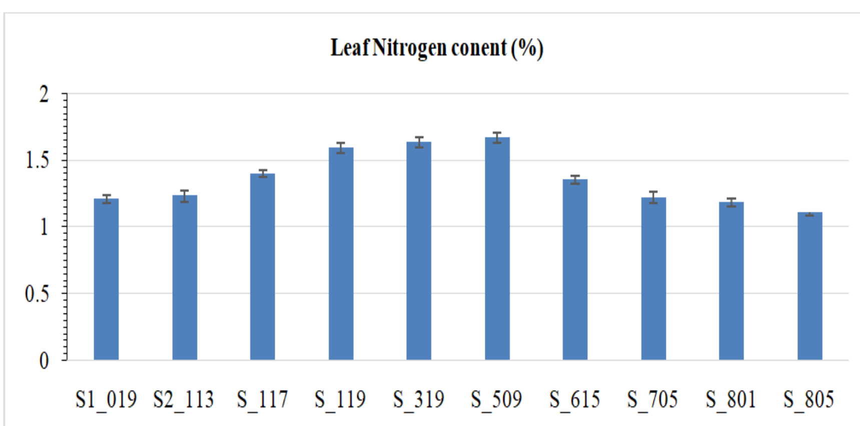

Fig. 1. Changes in leaf Nitrogen content at different phenophases of litchi.

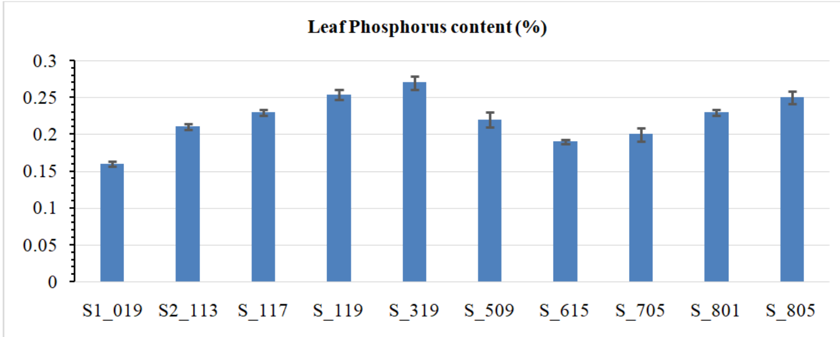

Fig. 2. Changes in leaf phosphorus content at different phenophases of litchi.

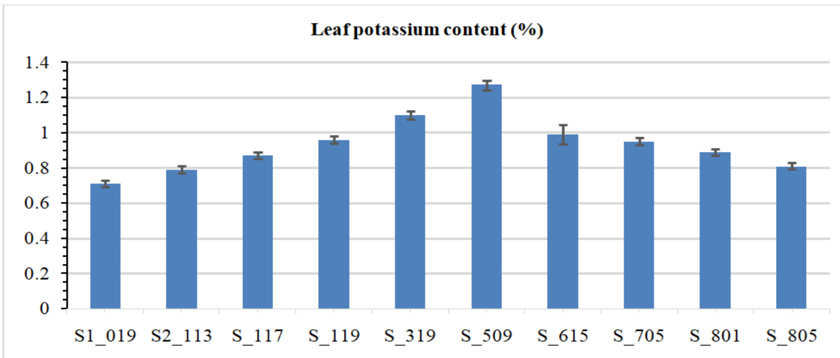

Fig. 3. Changes in leaf potassium content at different phenophases of litchi.

B. Leaf biochemical parameters

Significant change in carbohydrates content of leaves at various stages in litchi variety Deshi at different phenophase was reflected (Fig. 4). It is evident that the leaves carbohydrates content followed a particular trend which ranged from at a higher level (7.87%) at the stage 319 i.e. 90 % shoot length to lowest (3.52 %) at stage 019 i.e green shoot tips start visible later stages. After flowering it decreased continuously till fruit ripening. Increased level of carbohydrates and CO_2 assimilation increases during leaf growth reaches to maximum in fully mature leaf of mature shoot has also been reported by Hieke *et al.* (2002); Das *et al*. (2004). The decrease carbohydrates content during flowering in litchi has also been reported by Menzel *et al*. (1995). Fruits act as major sink in the plant during its developmental stage may induce changes in the leaf biochemical composition. Information about the biochemical status of a plant is a basic prerequisite for its adequate nutrition and crucial to achieve high yield productivity.

The leaf protein content was maximum (0.41%) at stage 019 (when vegetative shoot tips started visible) gradually decreased with leaf maturity, flowering and continued to decreased and minimum leaf protein content (0.17%) was recorded at fruit ripening stage (stage 805).

Variation in phenol content of leaves at various phenophase in litchi variety Deshi was also reflected (Fig. 5). It is evident that the leaves phenol content was increasing gradually as the developmental stages passes and it was at the maximum level (45.04mg/100 g) at the stage 319 i.e. 90 % shoot length followed by stage 509 (end of panicle development: secondary axes fully grown; most flowers with petals form hollow ball) and stage 119 (Leaves mature: colour from light green to dark green) and further it started to decline till stage 805 i.e fruit colour fully developed. The relation of higher content of phenol with flowering in litchi might be due to the mobilization of reserved food materials to shoots which promote floral bud differentiation resulting in good flowering. The findings of Lal *et al.* (2019); Das *et al.* (2004) were also in the same tune who reported increased level of phenol in flowering shoot of litchi as compared to non-flowering shoots. Highest level of phenol content at flower and fruit bud differentiation stage provides supporting evidence on the role of phenol in litchi flowering (Kumar *et al*., 2014).

Noticeable difference in chlorophyll content of leaves at different phenophase in litchi at different phenophase was noted. The leaf chlorophyll content was increasing gradually from emergence of leaf and it was maximum (7.55mg/g) at the stage 319 i.e at 90 % of total shoot length followed by stage at end of panicle development when most flowers with petal form hollow ball, The minimum chlorophyll (1.49 mg/g) was estimated at stage 019 i.e green shoot tips start visible. Leaf Chlorophyll a, b and total chlorophyll contents were higher during flowering stage over floral bud differentiation stage (Singh *et al.,* 2017). It was found that low chlorophyll in young leaf of litchi and maximum content in green fully expanded leaves (Hieke *et al*., 2002) who also reported variation in chlorophyll concentration at different growth stages and it was higher at stage I-2 (fully expanded, leaves dark green, apical bud dormant) than at stages F-1 (bud swelling, leaf initiation, unfolding and initial expansion, leaves red), F-2 (leaf expansion, leaves thin, red and green, apical bud dormant) and I-1 (leaf expansion completed, leaves light green , apical bud dormant).

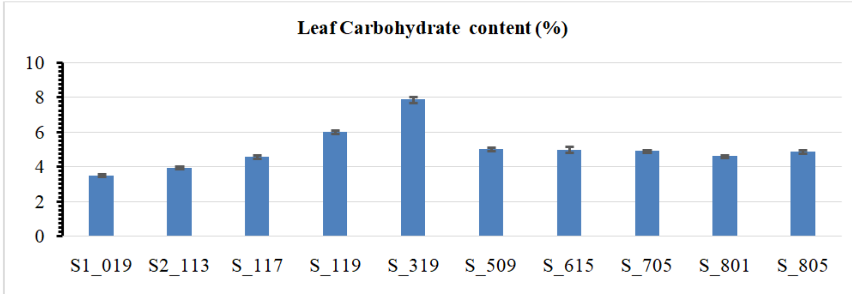

Fig. 4. Changes in leaf carbohydrate content at different phenophases of litchi.

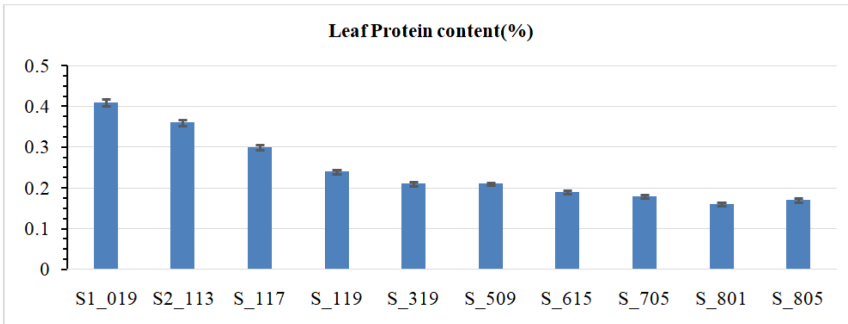

Fig. 5. Changes in leaf protein content at different phenophases of litchi.

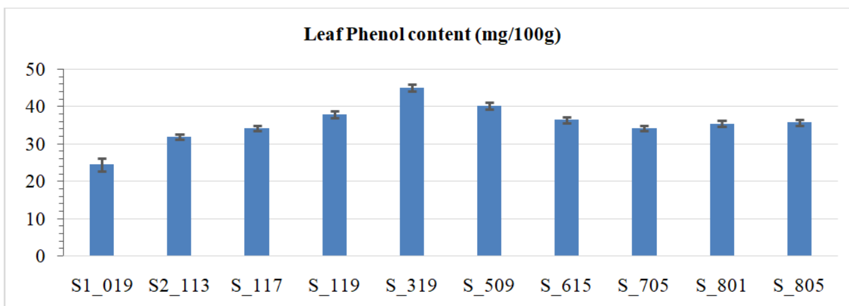

Fig. 6. Changes in leaf phenol content at different phenophases of litchi.

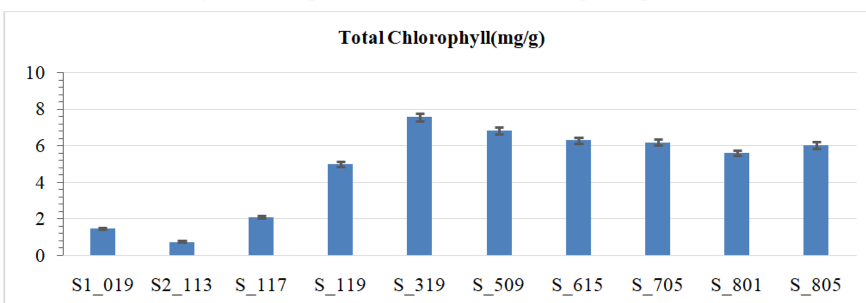

Fig. 7. Changes in total leaf chlorophyll content at different phenophases of litchi.

CONCLUSIONS

On the basis of above finding it can be concluded that it may be concluded that leaf nutrient content and leaf biochemical parameters varies with phenological changes in litchi that play important role in inducing flowering and fruit set in litchi. Role of carbohydrate, nitrogen, phenol and chlorophyll has been well advocated for improving fruit set and yield as well in different crops. Thus, present study is informative pertaining to trends of change in these parameters.

FUTURE SCOPE

By using these findings the level of these parameters may be manipulated in order to get more flowering and other yield parameters. Similarly other leaf parameters like changes in enzyme levels are need to be studied for better understanding the changes in nutrient and biochemical parameters.

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Conflict of Interest. None.

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