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Effect of girdling and defoliation on physical properties of litchi fruit

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ABSTRACT

A field experiment was conducted during 2011-12 to delineate the role of current and stored assimilates on fruit growth of litchi. The experiment included of twelve treatments. The level of days was 3 viz. 30 days after fruit set(DAFS), 40 DAFS and 50 DAFS, level of girdling were 2 viz. girdling and no girdling and the level of leaf removal were 2 viz. leaf removal and no leaf removal. The results revealed that with regard to physical fruit properties, the maximum fruit weight (25.03g), bunch weight (351.02g) was observed in the treatment of girdling with no leaf removal of 40 DAFS. The seed-pulp ratio found least (0.14) at the stage of girdling with no leaf removal at 40 DAFS. The size of the fruit was also good (3.18cm) with treatment of girdling and no leaf removal of Litchi plant. The maximum juice percentage of about 71.04% was found in the treatment of girdling. There is positive effect of girdling in fruit drop. The minimum fruit drop was recorded in the treatment girdling with no leaf removal condition.

***Keywords*:** Defoliation, girdling, leaf removal, litchi

Litchi (*Litchi chinensis* Sonn.) is a non-climacteric fruit of South East Asian origin (Nakasone and Paull, 1998). It is most popular member of family Sapindaceae and sub-family Napheleae (Groff, 1921). The crop with high potential of area expansion in India is grown in about 60,000 hectares in Bihar (Land of Litchi), Jharkhand, West Bengal, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Haryana and Punjab. In litchi, a number of efforts have been made by different workers to develop an understanding of the assimilate partitioning behaviour with respect to fruit growth and yield. For these kinds of investigations, girdling has been used as an effective method for isolating a part of the plant from the rest of the plant and, hence, for investigating source-sink relationships in perennial woody plants. Being a terminal growing crop, girdling helps in limiting the carbohydrate source of the growing fruits within the region between the girdled portion and the panicle. Furthermore, after leaf removal, plants may compensate for loss of tissue by a number of mechanisms which include morphological and physiological components, such as increased photosynthetic rates and mobilization of storage reserves (Rosenthal and Kotanen, 1994). In view of this, the present investigation was carried out to find out the best combination of girdling, leaf removal and days after fruit set on physical properties of litchi fruit.

Field experiments were conducted during summer 2012-13 in the Experimental Field, Department of Horticulture, Birsa Agricultural University, Ranchi on cultivar *'Shahi'*. The experiment was planned in Randomised block Design with three replications. The experiment consists of twelve treatment combinations depicted in the following table:

Serial No.	Methods of source limitation	Stages of growth
T_1	Girdling with no leaf removal	30 days after fruit set
T_2	Girdling with no leaf removal	40 days after fruit set
T_3	Girdling with no leaf removal	50 days after fruit set
T_4	Girdling with leaf removal	30 days after fruit set
T_5	Girdling with leaf removal	40 days after fruit set
T_6	Girdling with leaf removal	50 days after fruit set
T_7	No girdling with leaf removal	30 days after fruit set
T_8	No girdling with leaf removal	40 days after fruit set
T_9	No girdling with leaf removal	50 days after fruit set
T_{10}	Control (No source limitation)	30 days after fruit set
T_{11}	Control (No source limitation)	40 days after fruit set
T_{12}	Control (No source limitation)	50 days after fruit set

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Data was recorded on physical and chemical characteristics of the litchi fruits and the methods were followed as suggested by Panse and Sukhatme (1985). Five fruits of each replication were weighed with the help of electronic balance and average weight of one fruit was calculated in gram. The diameter of fruits was measured with the help of slide callipers. The average diameter was calculated in centimeter. The volume was measured by Archimedes principle *i.e.,* water displacement method. Specific gravity of litchi fruits was determined by measuring their weight (g) in air and in water and then applying the following formula as obtained by water displacement method (Gustafson, 1926). By dividing the weight of stone by the weight of pulp, the seed-pulp ratio of the fruit was determined. The percentage of juice was calculated with the formula:

$$\text{Juice percentage} = \frac{\text{Total weight of juice (g)} - \text{Weight of beaker (g)}}{\text{Total weight of fruits (g)}} \times 100$$

The treatment comparisons were made using t-test at 5% level of significance.

Effect on fruit weight

The maximum average fruit weight (25.03 g) was obtained in the treatment T_2 (girdling x no leaf removal x 40 DAFS) and the minimum (11.43 g) was recorded in treatment T_4 (girdling x leaf removal x 30 DAFS). Source limitation at 30 DAFS resulted in a maximum reduction of average fruit weight (17.34 g). There was rapid increase in the average fruit weight after 35 days of fruit set which indicated an increased demand for photosynthate by the sink at that stage. Hence, source limitation at the stage of peak photosynthate demand might have contributed towards reduced fruit weight. According to Bustan *et al*. (1995), this is due to an increase in specific mass transfer (SMT) through the existing vascular routes, but long-term enhancement of fruit growth was largely due to the rapid development of new vascular tissues, suggesting that limitation in transport capacity does occur. It was interesting to note that girdling x leaf removal did not result in significant reduction in fruit weight than that of control although the treatment indicated source limitation of current as well as translocated photosynthates. This can be attributed to less number of fruits per bunch due to high rate of fruit drop recorded under this treatment. Partitioning of available assimilates to total number of fruits might have resulted in increased fruit weight even under the condition of source limitation.

Table 1: Effect of girdling and defoliation on physical properties of litchi

Treatment	Fruit weight (g)	Bunch weight (g)	Seed-pulp ratio	Diameter (cm)	Juice content (%)	Fruit drop (%)
T_1	20.06	212.42	0.18	2.86	71.04	59.63
T_2	25.03	351.02	0.14	2.91	57.46	37.71
T_3	20.26	228.45	0.18	2.97	63.26	44.84
T_4	11.43	90.03	0.47	1.81	19.06	91.29
T_5	11.63	133.12	0.51	2.06	27.83	84.39
T_6	11.86	101.65	0.46	1.92	24.75	80.65
T_7	18.33	185.03	0.24	2.31	40.58	71.14
T_8	18.73	206.54	0.23	2.49	41.33	47.42
T_9	19.13	196.41	0.28	2.49	36.51	68.38
T_{10}	19.53	219.36	0.2	3.01	51.43	56.09
T_{11}	19.86	216.54	0.21	3.13	54.05	57.15
T_{12}	20.33	236.34	0.22	3.18	54.18	52.39
SEm(±)	**0.76**	**13.59**	**0.004**	**0.13**	**1.86**	**5.76**
LSD(0.05)	**2.26**	**39.88**	**0.012**	**0.38**	**5.46**	**16.91**

Effect on bunch weight

Girdling x no leaf removal x 40 DAFS treatment recorded highest bunch weight (351.02 g) while minimum (90.03 g) was observed with treatment girdling x leaf removal x 30 DAFS. The total bunch weight in litchi is a function of percent fruit retention and average fruit weight in the photosynthates to other plant parts and partitioning of the current photosynthates to the growing fruits. Source limitation through girdling resulted in 17.8% increase in bunch weight over that of control whereas source limitation through leaf removal resulted in 12.53% reduction in bunch weight which indicates significant contribution of current photosynthates to growing fruits. These results are in agreement with the findings of Roe *et al.* (1995). However, source limitation through girdling as well as leaf removal in the present investigation resulted in 51.68 % reduction in bunch weight. This indicates existence of a mechanism for partial contribution of translocated stored-assimilates towards fulfilling assimilate demand of growing fruits in the absence of current photosynthate supply to the fruits due to leaf removal. Das *et al.* (2006) have also reported a significant role of translocated assimilates in growing litchi fruits.

Effect on seed-pulp ratio and juice percentage

Lowest seed-pulp ratio (0.14) and highest juice percentage of litchi fruits (71.04%) were observed in the interaction girdling x no leaf removal x 40 DAFS during the present study. Similar type of result is reported by Lechaudel *et al*. (2004). However, maximum seed-pulp ratio was recorded in case of girdling x leaf removal x 40 DAFS which is in agreement with Singh *et al*. (2006) and Abd *et al*. (2003). Increase in proportion of aril by girdling can be attributed to increased contribution of assimilate from current photosynthesis which might have resulted due to prohibition of downward translocation of current photosynthate to other plant parts. Again, this higher accumulation of pulp can also be attributed to increased accumulation of plant hormones like auxins, gibberellins in the fruit due to the restriction of their movement which also play an important role on water import in to the fruit. Abd *et al*. (2003) also reported that increased water movement in to the fruit can also be attributed to increased juice content in the fruit.

Effect on diameter of fruits

As shown in table 1, that the fruits with girdling treatments exhibited different growth patterns with respect to fruit diameter as compared to that in case of control. The treatments with girdling and no leaf removal thereafter exhibited a higher growth rate of the fruits from the sixth week till harvest compared to the control. This growth trend was observed until the harvesting period. Similar results were reported by Bustan *et al*. (1995).

Effect on fruit drop

Fruit drop was observed to be minimum (37.71%) with treatment girdling × no. leaf removal × 40 DAFS while treatment girdling × leaf removal × 30 DAFS resulted in maximum fruit drop (91.29%). The fruit retention capacity in a panicle is a function of the strength of source tissue to support the carbohydrate demand of the growing sink (fruits). Previous studies in litchi cv. 'Bombai' indicated that the intensity of the fruit drop was positively correlated with the net CO_2 assimilation rate suggesting an increased carbon demand of growing fruits from source leaves (Debnath *et al*., 2006). Alteration in balance between auxins and abscisic acid also regulate the fruit drop in a bunch. Moreover, photosynthesis is largely dependent on stomatal regulation and plant productivity/ yield is directly related to the photosynthetic efficiency (Hsiao, 1973). In the present investigation, the data of effect of different source limitation treatments on percent of fruit drop are presented in table 1. Irrespective of method of source limitation, the maximum percent of fruit drop was observed when the source limitation treatments were imposed 30 DAFS. Source limitation after 40 or 50 days did not result in a significant increase in percent of fruit drop over that in the case of no source limitation until harvest. This indicated the criticality of the stage of fruit growth (30 DAFS) with respect to dependency on the source. Girdling with leaf removal resulted in the maximum fruit drop while the percent of fruit drop in the case of girdling with no leaf removal and no girdling with leaf removal were at par. The result is in conformity with Das *et al.* (2006) and Ruan (1993). As discussed in case of bunch weight, reduction in fruit drop due to girdling can be attributed to restriction of translocation of current photosynthates to other plant parts and partitioning of the current photosynthates to the growing fruits. However, no reduction in fruit drop due to leaf removal is an indication of a higher role of balance between auxins and abscisic acid in regulating fruit drop. Significantly higher values of fruit drop recorded with girdling + leaf removal supports the hypothesis of hormonal regulation of fruit drop, because higher accumulation of inhibitors synthesized in shoot tip in the portion above girdling might have contributed towards the fruit drop. Hence, fruit drop in litchi was found to be a function of hormonal balance in the tissue with contribution of current photosynthates playing a significant role.

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