International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 2010-2013

Received: 27-11-2020
Accepted: 30-12-2020

Hitesh Agarwal
Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

Satish Chand
Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

Ranjan Srivastava
Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

Rajat Sharma
Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

Corresponding Author:
Hitesh Agarwal
Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

Influence of girdling on growth, flowering and fruiting in Litchi cv. Late Bedana

Hitesh Agarwal, Satish Chand, Ranjan Srivastava and Rajat Sharma

DOI: https://doi.org/10.22271/chemi.2021.v9.i1ab.11521

Abstract
The present investigation was carried out at farmer's field, Sainik Farm, Patharchatta, Pantnagar, District Udham Singh Nagar, Uttarakhand. The experiment was conducted to study the effect of girdling on growth, flowering and fruiting attributes in Litchi cv. Late Bedana. Twenty-year-old litchi trees consisted of seven treatments with two level of girdling severity of 25% and 50% primary branches in combination of girdling width of 2 mm, 4 mm and 6 mm, along with ungirdled control which were tested with randomized block design with three replications. The results indicated that all the litchi trees which were subjected to different severity and width of girdling had more flowering intensity (%) fruit set (%) and fruit retention (%) and girdling also reduced fruit drop as compared to control. However, the treatment girdling of 50% of primary branches + 4 mm wide had significant effect on improving fruit set (38.44%) and fruit retention (14.07%). Girdling blocks the downward flow of carbohydrate from leaves to roots thus the carbohydrate may accumulate above the girdled portion which resulted in additional supply of carbohydrates from leaves to fruits, therefore, the fruit yield and fruit quality of litchi may increase.

Keywords: Litchi, girdling, growth and flowering, yield

Introduction
Litchi (*Litchi chinensis* Sonn.) is an evergreen subtropical fruit tree bearing delicious juicy fruits. It is also called Queen of Sub tropical fruits (Nakasone and Paull, 1998) [10]. The origin of litchi lies in Southern China and is cultivated in few sub tropical countries of the world. Litchi belongs to family Sapindaceae and subfamily Nepheleae which has about 125 genera and 1,000 species. The genus Litchi has one species and three subspecies i.e. *Litchi chinensis* subsp. *chinensis*, *Litchi chinensis* subsp. *javenensis* and *Litchichinensis* subsp. *Phillippinensis* (Menzel and Simpson, 1998) [9].

In India, it was introduced by the end of 17thcentury and spread to the other parts of the country. India is the second largest producer of litchi after China. India holds a prominent position in litchi cultivation. The litchi is cultivated on 90 thousand hectare area with 559 thousand metric ton production and 6 metric ton per hectareproductivity (Anonymous, 2016) [1]. Its contribution towards major fruit crops production is 0.7 per cent. Bihar rank 1st in area (32 thousand hectare) and production (198 thousand hectare) followed by West Bengal and Jharkhand.

Litchi tree grows to a height of 6 to 9 m with spreading branches and dense light green shinning foliage. The leaf is compound, mostly paripinnate with three pairs of leaflets. Colour of leaves varies from light green to dark green. The inflorescence is terminal and branching pattern is hapaxanthic. Three distinct waves of flowering occur in litchi inflorescences, the first wave consists of M_1 (male type) flowers, the second of F (hermaphrodite) flowers, and the third of M_2 (psedu-hermaphrodite) flowers (Goren *et al*., 1998) [5]. Litchi is a monoecious plant bearing separate male and hermaphrodite flowers on terminal panicles. Flowers are apetalous which are devoid of corolla and flower colour is greenish white to greyish.

Girdling is basically an intervention in the phloem transport between canopy and roots, in an attempt to manipulate the distribution of photosynthate (carbohydrate), mineral nutrients, and plant bio-regulators. Girdling is a procedure by which a ring of bark (or, in some cases, bark and sapwood) is removed from the trunk or branch of a tree.

Girdling has immediate and long-term effects, and local, as well as whole-plant, effects. The accumulation of carbohydrates in the canopy provides a rich source of energy for all the stages of reproductive development; flowering, fruit set, fruit enlargement, and ripening.

Materials and Methods

The present investigation was carried out at Sainik Farm, Patharchatta, Pantnagar, District Udham Singh Nagar, Uttarakhand. Pantnagar is situated in foot hills of Himalayas and falls in the humid subtropical climate. It is situated between 29′5^0 N latitude, 79′3^0 E longitudes and an altitude of 243.84 meters above the mean sea level. The experiment was laid out in Randomized Block Design. There were seven treatment combinations including control with three replications and in each replication one tree served as a treatment unit. Thus 21 trees were marked for the experiment.

Results and Discussion

Flushing time

The data on flushing time presented on Table 1 show that winter flush in litchi cv. Late Bedana under pantnagar conditions was started from 10th to 11th February 2016.The data indicates that there was no any appropriate difference between flushing times in all the treatments including control.

Flushing intensity (number of shoots per branch)

The data on number of shoots per branch presented in Table 1 revealed that the maximum number of shoots per branch (2.63) was recorded in T_7 (ungirdled) and the minimum number of shoots per branch (1.82) was recorded in T_4 (girdling of 50% of primary branches + 4 mm wide). Girdling blocks the downward flow of photo-assimilates andauxin from the leaves to roots and also blocks the movement of cytokinin from root to leaves (Lomax *et al*., 1995) [7], which can reduce root and shoot growth.

Table 1: Effect of girdling on flushing time and flushing intensity

Treatments		Flushing time	Flushing intensity (no. of shoots per branch)
T_1	Girdling of 25% of primary branches (2 mm wide)	10-Feb	2.10
T_2	Girdling of 50% of primary branches (2 mm wide)	11-Feb	2.08
T_3	Girdling of 25% of primary branches (4 mm wide)	10-Feb	2.04
T_4	Girdling of 50% of primary branches (4 mm wide)	10-Feb	1.82
T_5	Girdling of 25% of primary branches (6 mm wide)	11-Feb	2.11
T_6	Girdling of 50% of primary branches (6 mm wide)	10-Feb	1.99
T_7	Control (no girdling)	10-Feb	2.63
C.V.		-	7.364
C.D. at 5%		-	0.280

Date of panicle initiation

As shown in Table 2 the panicle initiation in litchi cv. Late Bedana under Pantnagar conditions was started from 21st to 24th February 2016. In the treatments T_1, T_4, T_6, the panicle initiation was started in 21stFebruary while in treatments T_2 and T_5, the time of panicle initiation was started from 22th February. The results of present experiment were supported with Chang and Chang (2001) [3] who observed that there was no significant effect of girdling on influencing the date of panicle initiation in litchi.

Flowering intensity

The data on flowering intensity presented in Table 2 indicate that girdling has a significant effect on increasing flowering intensity in litchi cv. Late Bedana. The maximum flowering intensity (57.70%) was observed in the treatment T_4 (girdling of 50% of primary branches + 4 mm wide) and minimum flowering intensity (44.88%) was recorded in control (T_7).The reason behind that the girdling blocks the downward flow of photo-assimilates (carbohydrates) and auxin from the source to sink (Lomax *et al.*, 1995) [7], which can restricted root growth, vegetative growth and increase flowering percentage.

Date of flower opening

The data on date of flower opening present in Table 2 show that the date of flower opening in cv. Late Bedana under Pantnagar conditions was varied between, 16th to 20th March. In the treatment T_7 (control) date of flower opening was 20th March and for the rest of treatments which are subjected to different severity of girdling the date of flower opening varied between, 16th to 17th March. The opening of flowers was 3 to 4 days earlier in girdled trees as compare to control.

Date of full blooms

As shown in Table 2 the date of full bloom was varied from 27thMarch to 2nd April 2016. The date of full bloom was earliest (27th March) in the treatment girdling of 50% of primary branches + 2 mm wide (T_2) and it was latest in the control that is 2nd April. These results were significant with the results of Arakawa (1997) [2] who reported that girdling has significant effect on date of flower opening and date of full bloom in apple.

Duration of Flowering

The data on flowering duration present in Table 2 revealed that the duration of flowering in cv. Late Bedana during 2016 was ranged from 12 to 16 days.The maximum flowering duration (16 days) were recorded in T_7 and T_4. The minimum flowering duration (12 days) was recorded in T_2 and T_5 treatments. There was no clear cut trend was found regarding flowering duration in girdled and ungirdled trees. Singh and Dhillon (1983) who recorded that a flowering duration of different litchi cultivars in different years may vary between 11 to 15 days.

Advancement of Flowering

The data on flowering advancement present in Table 2 indicate that girdling of litchi trees has a significant impact on advancement of flowering. The maximum advancement (4 days) was recorded in the treatment T_2 and T_4 as compared to control. The results of our experiment was supported by Menzal and Simpson (1987) [8] who reported that autumn girdling in litchi trees significantly increased flowering and it also flowered earlier as compare to control.

Table 2: Effect of girdling on date of panicle initiation and flowering

Treatments		Date of panicle initiation	Flowering intensity (%)	Date of flower opening	Date of full bloom	Duration of flowering (days)	Advancement of flowering (days)
T_1	Girdling of 25% of primary branches (2 mm wide)	21-Feb	54.69	17-March	29- March	13	3
T_2	Girdling of 50% of primary branches (2 mm wide)	22-Feb	54.54	16-March	27-March	12	4
T_3	Girdling of 25% of primary branches (4 mm wide)	23-Feb	51.59	17-March	1-April	15	3
T_4	Girdling of 50% of primary branches (4 mm wide)	21-Feb	57.70	16-March	31-March	16	4
T_5	Girdling of 25% of primary branches (6 mm wide)	22-Feb	53.58	17-March	28-March	12	3
T_6	Girdling of 50% of primary branches (6 mm wide)	21-Feb	53.45	17-March	29-March	13	3
T_7	Control (no girdling)	24-Feb	44.88	20-March	2-April	16	0
C.V.		-	6.694	-	-	-	-
C.D. at 5%		-	6.468	-	-	-	-

Sex ratio and number of flowers per panicle

The data on sex ratio presented in Table 3indicate that girdling of litchi trees branches have a significant impact on sex ratio (male: female) and also on improving number of female flowers. Statistically the maximum sex ratio (2.08%) was recorded in control (T_7) and the minimum sex (1.61%) ratio was recorded in treatment T_4. Ramburn (2001) observed similar findings and showed that the girdling has a significant effect on sex ratio. As shown in Table 3 the maximum number (232.66) of female flower per panicle was found in the treatment $T_4$and the minimum number (167.66) of female flowers per panicle was recorded in control (T_7). The results were supported with Chen and Luo (1998) [4] who reported that girdling or ringing significantly increased in number of female flower in litchi.

As shown in Table 3, the maximum number (232.66) of female flower per panicle was found in the treatment $T_4$and the minimum number (167.66) of female flowers per panicle was recorded in control (T_7). The results were supported with Chen and Luo (1998) [4] who reported that girdling or ringing significantly increased in number of female flower in litchi.

The data on number of male flower present in Table 4.4 show that number of male flowers in litchi cv. Late Bedana may vary between 347.33 to 381.66 male flowers per panicle. However, the results indicate that there was no girdling impact on number of male flowers

Table 3: Effect of girdling on sex ratio and number of flowers per panicle

Treatments		Female flowers/ panicle	Male flowers/ panicle	Total flower/ panicle	Sex ratio (M: F)
T_1	Girdling of 25% of primary branches (2 mm wide)	217.00	375.00	592.00	1.72
T_2	Girdling of 50% of primary branches (2 mm wide)	221.33	+364.33	585.66	1.66
T_3	Girdling of 25% of primary branches (4 mm wide)	226.33	367.00	593.33	1.62
T_4	Girdling of 50% of primary branches (4 mm wide)	232.66	374.66	607.33	1.61
T_5	Girdling of 25% of primary branches (6 mm wide)	225.00	381.66	606.66	1.70
T_6	Girdling of 50% of primary branches (6 mm wide)	221.33	380.66	602.00	1.72
T_7	Control (no girdling)	167.66	347.33	515.00	2.08
C.V.		7.624	7.742	6.234	9.011
C.D. at 5%		29.608	NS	NS	0.281

Date of fruit set

The data on date of fruit set present in Table 4 revealed that fruit set in cv. Late Bedana under Pantnagar conditions were started from 30th March to 1stApril 2016. The earliest fruit set was started in Treatment T_2 on 30 March and it was latest (2 April) in the treatment T_3.

Time taken to fruit set

The data presented in Table 4 shows that time taken to fruit set may vary in different treatments from 14 to 16 days. The results obtained from present experiment show that there is no significant correlation among date of fruit set, time taken to fruit set and girdling of litchi trees. However, different researches reported that girdling improved fruit set in litchi and other fruit crops but there is no correlation of girdling with date of fruit set. Huang (2012) [6] concluded that spiral girdling trees were fruited six year earlier to ungirdled tree but there is no effect of girdling on date of fruit set and time taken to fruit set.

Fruit set

The data present in Table 4indicate that girdling has significant role in fruit set percentage in litchi cv. Late Seedless. Statistically minimum number(32.19%) of fruit set was observed in ungirdled trees and maximum number (38.44%) of fruit set was recorded in treatment girdling of 50% of primary branches +6 mm wide (T_6). Girdling block the downward movement of photo-assimilates thus this assimilates accumulates above the girdled portion so there is significantly increased levels of carbohydrates can be found throughout the canopy. Haung (2012) [6] also reported that spiral girdling in litchi significantly increased fruit set.

Fruit retention

The data shown in Table 4indicated that girdling in litchi cv. Late Bedana was significantly increased fruit retention percentage in litchi fruits. Maximum number of fruit retained per panicle at harvest was observed in treatment T_4 (Girdling of 50% of primary branches +4 mm wide) and minimum fruit retention was recorded in control (T_7). The reason behind that in girdled trees there was higher level of gibberellins and low level of ABA as well as higher level of carbohydrates. Similar results were observed in finding of Rani and Brahamachari (2002) [11] who examined that girdling of litchi trees was significantly increased fruit retention percentage in litchi.

Table 4: Effect of girdling on date of fruit set, time taken to fruit set, fruit set and fruit retention

Treatments		Date of fruit set	Time taken to fruit set (days)	Fruit set (%)	Fruit retention (%)
T_1	Girdling of 25% of primary branches (2 mm wide)	1-April	15	34.14	12.98
T_2	Girdling of 50% of primary branches (2 mm wide)	30-March	14	36.11	13.32
T_3	Girdling of 25% of primary branches (4 mm wide)	2-April	15	35.44	13.20
T_4	Girdling of 50% of primary branches (4 mm wide)	1-April	16	35.41	14.07
T_5	Girdling of 25% of primary branches (6 mm wide)	1-April	14	37.21	12.86
T_6	Girdling of 50% of primary branches (6 mm wide)	31-March	14	38.44	13.60
T_7	Control (no girdling)	1-April	14	32.19	11.89
C.V.		-	-	2.268	2.981
C.D. at 5%		-	-	1.451	0.704

Conclusion

The results indicated that all the litchi trees which were subjected to different severity and width of girdling have more flowering intensity, fruit set and fruit retention and it also reduce fruit drop as compared to control. The conclusion of the current research revealed that girdling of 50% of primary branches + 4 mm wide at the time of first week of October was significant way for improving flowering and fruiting of litchi cv. Late Bedana.

References

1. Anonymous. Indian Horticulture Database. National Horticulture Board, Gurgaon, Haryana, India 2015-16.
2. Arakawa O, Kanno K, Kanetsuka A, Shiozaki Y. Effects of girdling and bark inversion on tree growth and fruit quality of apple. Acta Horticulturae 1997;451:579-585.
3. Chang JW, Cheng CY. Effect of pruning and girdling on flowering of litchi. Journal of Chinese Society of Horticulture Science 2001;47(3):245-258.
4. Chen JK, Luo XZ. Advances in research on modulation of flower sex of litchi trees. South China Fruits 1998;27(6):26-27.
5. Goren M, Degani O, Gazit S. Flowering phenology of 10 lychee cultivars in the Volcani Center, Israel. Alon Hanotea 1998;52:59-63.
6. Haung H. Unfruitfulness of young litchi trees in relation to their peculiar root growth behavior- an overview. Acta Horticulturae 2012;575(2):737-743.
7. Lomax TL, Muday GK, Rubery PH. Auxintransport. In, Davies PJ. (ed.) Plant Hormones, Physiology, Biochemistry and Molecular Biology. Kluwer Academic, Boston, Massachusetts 1995;30:509-530.
8. Menzel CM, Simpson DR. Effect of cincturing on growth and flowering of lychee over several seasons in subtropical Queensland. Australian Journal of Experimental Agriculture 1987;27:733-738.
9. Menzel CM, Simpson DR. Effect of temperature on growth and flowering of litchi (*Litchi chinensis* Sonn.) cultivars. Journal of Horticultural Science 1988;63:349-360.
10. Nakasone HK, Paull RE. Tropical Fruits. CAB International, Wallingford, UK 1998;27:445-447.
11. Rani R, Brahamachari VS. Effect of growth substances and girdling on fruit set, fruit drop and quality of litchi. Horticulture Journal 2002;15(3):1-8.
12. Singh D, Dhillon WS, Singh NP, Gill PS. Effect of girdling on leaf nutrient levels in pear cultivars Patharnakh and Punjab Beauty. Indian Journal of Horticulture 2015;72(3):319-324.