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Standardization of grafting technique in litchi

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ABSTRACT

The present experiment was conducted at the Research Centre, Ranchi of the ICAR Research Complex for Eastern Region, during the period from June, 2015 to December, 2016 to investigate the effect of girdling and defoliation of scion shoot on the success and growth of grafts in litchi cv. Shahi. The branches were girdled (removing of 3 mm ring from branches of 40-50 mm girth) one month before the collection of scion sticks for grafting. Defoliation was performed 7 days before the collection of scionsticks. Wedge grafting was performed under shadenet with temperature ranging from 26-32°C and RH 70-80%. The graft take success and vegetative growth were markedly improved as a result of girdling and defoliation. Among the different treatments, the minimum time required for bud sprout (15.40 days), highest scion height (24.25 cm), scion girth (7.14 mm), number of sprouts per graft (2.64), sprout length (4.80 cm), number of compound leaves (8.34), rachis length (9.33 cm), leaflet length (9.37 cm), leaflet width (3.37 cm) and graft success (56.43%) were observed in girdling + defoliation treatment. Scion which had higher girth after grafting was positively correlated with the number of compound leaves, leaflet length and leaflet width. The highest graft success rate (70.83%) was recorded during July. Hence, it was concluded that girdling of branches on scion varieties, one month prior to collection of scionstick and defoliation atleast 7 days before the collection, can enhance the success rate of grafting and plant growth of grafts in litchi.

Key words: Defoliation, grafting, girdling, litchi.

INTRODUCTION

The litchi (*Litchi chinensis* Sonn.), which belongs to family Sapindaceae, is a highly valued fruit throughout the world. It is very specific to its climatic and soil requirements and probably due to this reason the cultivation of litchi is restricted to the few countries in the world. Litchi is commercially propagated by air-layering. However, several factors have restricted the expansion of litchi production to serve the world market with fruits in great quantity and excellent quality. Among the factors low quantity and quality of planting material and problems in the field establishment with plants produced by air-layering, are some of the negative factors that hinder the rapid increase of production (Zaccaro *et al*., 10). Some of other factors that hinder the rapid expansion of area through air-layering are high mortality of newly established plants under water and nutrient stress conditions, besides mass uprooting of plants due to heavy wind. In the absence of tap root, the litchi plants are unable to exploit the deep water. According to Mee (5), air-layering is a method that enables a small amount of maiden trees to be produced per mother plant, hence it needs a large number of mature stock plants in order to obtain a significant number of maiden trees. However, using grafting on a small area with few mother plants, it will be possible to produce thousands of maiden trees of good quality. Thus, the growing interest in the cultivation of litchi has provoked critical thinking to search for more efficient methods of propagation by grafting or budding and *in vitro* propagation, the development of hybrid rootstocks, use of dwarfing rootstocks to allow high density planting and study of compatibility between rootstock and cultivar (Ghosh and Bhavan, 2). The percentage of successful grafting in litchi is highly variable and often is low, probably due to the incompatibility of the rootstock and the graft, poor contact of cambium, grafting at inappropriate physiological stage, and failure in the management of the plants after grafting (Menzel, 6). Grafting under Indian conditions has not yet been standardized till date, attempts are sporadic and the rate of success is very low (Pandey and Sharma, 7; Martins *et al*., 4). Hence, the present investigation was carried out to achieve success in grafting in litchi through prior girdling of scion shoot.

MATERIALS AND METHODS

This study was carried out in the Research Farm, ICAR-RCER, Research Centre, Ranchi during the year 2015-2016. For raising rootstock, ripe fruits of litchi cv. Shahi were harvested. The seeds were soaked in water for 24 h for enhancing germination. Sowing was done on 4 June, 2013 in plastic bags filled with a mixture of soil, FYM, sand (1:1:1) and 200 g of single superphosphate per cubic metre of potting mixture. Two-year-old generative rootstocks of the litchi were used for grafting. Scionstick used was from vigorous

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flushes of terminal shoot with prominent axillary buds. Scion stick of 10 cm long with at least two slightly swollen buds was selected. The parent trees from which the scion stick was collected had been forced into vigorous growth by ample quantity of fertilizers, water and pruning. There were three treatments comprising girdling with defoliation (T_1), Defoliation (T_2) and control (T_3). The branches were girdled (removing of 3 mm ring from branches of 40-50 mm girth) one month before the collection of scion sticks for grafting. Defoliation (removal of leaf blades with petioles intact on the shoot) was performed 7 days before the scion wood collection. Scion wood excised from non-girdled twigs and defoliated just prior to grafting served as control. Wedge grafting was performed under shadenet with temperature ranging from 26-32°C and RH 70-80%. Grafting was carried out starting last week of July, 2015. The union point was wrapped with a plastic strip. The exposed part of the scion above the wrapping area was covered by a small plastic cap. The grafted plants were maintained under natural shade nethouse conditions. Observations were recorded on graft success (%), number of days required for bud sprouting, number of sprouts/ graft, scion length (cm), scion girth (mm), sprout length (cm) and compound leaf characteristics, *viz*., number of total compound leaves per graft, rachis length (cm), leaflet length (cm), leaflet width (cm) and leaflet length to width ratio were recorded four month after grafting. After standardization of grafting technique in the first year, the appropriate month for grafting was then standardized during March to October, 2016. For this nearly one-year-old rootstock was used. The grafting was performed during first week of each month from March to October, 2016. The branches were girdled (removing of 3 mm ring from branches of 40-50 mm girth) one month before the collection of scion sticks for grafting. The success percentage was calculated two-month after grafting.

The experiment was set up under randomized block design. There were three replications, which had 125 grafts each. Different parameters were statistically analyzed for analysis of variance (ANOVA). Means were separated using Fisher's Least Significant Difference at 5 per cent level of significance. Correlation between the different parameters was determined at 5 and 1% levels of significance.

RESULTS AND DISCUSSION

Data on days taken for bud sprouting and success rate are presented in Table 1. Scion bud sprouting was earliest in treatment comprising girdling + defoliation (15.40 days), while it took 28.76 and 30.18 days only defoliation and control treatment, respectively. The graft success percentage was much higher in the girdling + defoliation treatment when compared with other treatments. The maximum graft success (56.43%) was recorded with girdling + defoliation treatment, whereas, defoliation resulted in higher success rate (43.06%) than the control (35.27%). It might be due to the favourable physiological condition of scion, which lead to better union of stock and scion and thereby making the nutrient and carbohydrate supply at desired level. Earlier, Pandey and Sharma (7) mentioned that the success rate with budding and grafting was usually less than 20%; however, in Hawaii, up to 80% of unions were successful when the scion wood (17 mm wide) was ringed (3 mm) 3-4 weeks before grafting. Xian Quan (9) also reported the highest graft success in "Feizixiao" (86.6%), "Guihuaxiang" (74.6%) and "Guifeihong" (71.3%) under south China conditions.

Scion height, scion girth, number of sprout per graft and sprout length as depicted in Table 2, are the important parameter of a successful graft. It is evident from the data that girdling and defoliation accounted for significant variation in these parameters. In the current study, scion height was significantly higher (24.25 cm) with girdling + defoliation treatment than defoliation and control treatment. Girdling along with defoliation treatment also recorded the maximum scion girth (7.14 mm), whereas, defoliation and control treatment found to be at par for scion girth. Number of sprout per graft

Table 1. Effect of girdling and defoliation on litchi grafts success and first initiation of sprouting.

Treatment	Days required for sprouting	Graft success (%)
Girdling + Defoliation	$15.40^{c} \pm 2.45$	$56.43^{a} \pm 3.46$
Defoliation	$28.76^{a} \pm 4.52$	$43.06^{b} \pm 5.32$
Control	$30.18^{a} \pm 5.87$	$35.27^{c} \pm 7.23$

Table 2. Effect of girdling and defoliation on litchi grafting performance.

Treatment	Scion height (cm)	Scion girth (mm)	No. of sprouts /graft	Sprout length (cm)
Girdling + Defoliation	$24.25^{a} \pm 2.19$	$7.14^{a} \pm 0.59$	$2.64^{a} \pm 0.28$	$4.80^{a} \pm 0.81$
Defoliation	$16.95^{b} \pm 2.94$	$5.93^{b} \pm 0.21$	$1.50^{b} \pm 0.58$	$2.31^{b} \pm 0.81$
Control	$13.75^{b} \pm 2.63$	$5.67^{b} \pm 0.87$	$1.50^{b} \pm 0.58$	$1.21^{b} \pm 0.62$

Data represent the mean ± standard deviation. Means within a column that did not differ significantly at 5% level of significance when compared with Fisher's Least Significant Difference are followed by the same superscript letters.

and sprout length was registered significantly maximum under the girdling + defoliation treatment. Girdling restricts the flow of carbohydrate in the lower part and reserves it in the scion wood, whereas, defoliation leads to higher meristamatic activity at the bud level and both combination is the sole cause of better grafting performance in girdling along with defoliation.

Girdling and defoliation showed significant variation in compound leaf characteristics. Total number of compound leaves were higher in girdling + defoliation treatment, *i.e*. 8.34. Girdling combined with defoliation produced the higher rachis length (9.33 cm) than defoliation and control treatment. Average leaflet length and width was also higher in case of girdling + defoliation treatment and it was 9.37 and 3.37 cm, respectively. Eralier, Sutarto and Anwarudin (8) found the highest graft success, the earliest time for scion bud break, leaf emergence and leaf number by prior girdling (4 weeks before grafting) of scion in soursop. Chen (1) also reported compatible combinations had higher SOD, POD and PPO activities than that in the incompatible ones.

Data in Table 4 show the correlation among the important variable used for grafting. The highest significant positive correlation was observed between scion height and shoot length ($r = 1.00$, $p \leq 0.01$), scion girth and No. of compound leaf ($r = 1.00$, $p \leq 0.01$) and between No. of compound leaf and leaflet width ($r = 1.00$, $p \leq 0.01$). Scion which had higher girth after grafting was positively correlated with the number of compound leaves, leaflet length and leaflet width. Carbohydrate, the main energy source for plant activity is thought to be one of the limiting factors in the successful vegetative propagation of plants. Higher accumulation of carbohydrates above the girdled point contributes towards good leaf characteristics, which leads to higher success rate of grafting.

Grating at different time showed highly significant effect on bud take success. The highest graft survival (70.83%) was recorded during July (Fig. 1). Grafting during June and August showed 58.33 and 62.50% success rate, respectively. The highest graft success rate was in July followed by in August and June might be due to the high relative humidity prevailing during rainy season, which might have favoured the graft union. Islam *et al.* (3) also reported similar findings in mango grafted by modified cleft and veneer grafting. The different stages of grafting in litchi performed with pre-girdled and defoliated scion sticks is shown in Fig. 2.

From the present study, it is obvious that pre-girdling (30 days) and defoliation (7 days before grafting) had significant effect on different growth parameters of litchi grafts and grafting during July performed under 50% shadenet conditions produced the highest successful grafts. Thus, this straitegy could be adopted commercially for expansion of litchi area.

Table 3. Effect of girdling and defoliation on compound leaf characteristic in litchi graft.

Treatment	No. of compound leaves/ graft	Rachis length (cm)	Leaflet length (cm)	Leaflet width (cm)	Leaflet length: width ratio
Girdling + Defoliation	$8.34^{a} \pm 0.98$	$9.33^{a} \pm 1.29$	$9.37^{a} \pm 0.97$	$3.37^{a} \pm 0.22$	$2.78^{a} \pm 0.14$
Defoliation	$5.35^{b} \pm 0.82$	$6.18^{b} \pm 1.14$	$6.78^{b} \pm 0.54$	$2.53^{b} \pm 0.26$	$2.70^{a} \pm 0.31$
Control	$4.80^{b} \pm 0.91$	$6.45^{b} \pm 0.48$	$6.47^{b} \pm 0.49$	$2.39^{b} \pm 0.20$	$2.72^{a} \pm 0.31$

Data represent the mean ± standard deviation. Means within a column that did not differ significantly at 5% level of significance when compared with Fisher's Least Significant Difference are followed by the same superscript letters.

Table 4. Correlation among the different parameters associated with grafting in litchi.

Parameter	SH	SG	NOS	SL	NOCL	RL	LL	LW
SH	-							
SG	0.991^{NS}	-						
NOS	0.955^{NS}	0.986^{NS}	-					
SL	1.000^{**}	0.991^{NS}	0.954^{NS}	-				
NOCL	0.988^{NS}	1.000^{*}	0.990^{NS}	0.987^{NS}	-			
RL	0.929^{NS}	0.970^{NS}	0.997^{*}	0.928^{NS}	0.975^{NS}	-		
LL	0.979^{NS}	0.998^{*}	0.995^{NS}	0.979^{NS}	0.999^{*}	0.985^{NS}	-	
LW	0.986^{NS}	0.999^{*}	0.991^{NS}	0.985^{NS}	1.000^{**}	0.978^{NS}	0.999^{*}	-

*,** = Significant at 5 and 1% levels of probability; SH = Scion height, SG = Scion girth, NOS = No. of shoots, SL = Shoot length, NOCL = No. of compound leaf, RL = Rachis length, LL = leaflet length, LW = Leaflet width

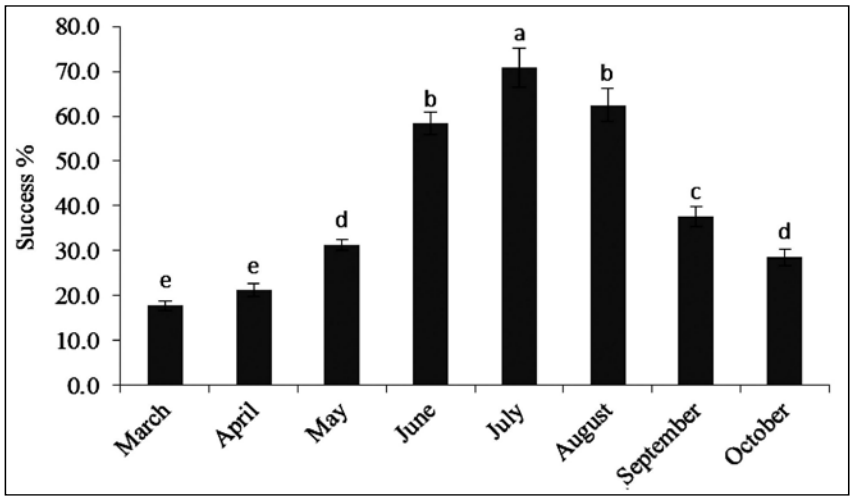

Fig. 1. Effect of time of grafting on success percentage in litchi. Data represent the mean ± standard deviation. Means within a column that did not differ significantly at 5% level of significance when compared with Fisher's Least Significant Difference are followed by the same superscript letters.

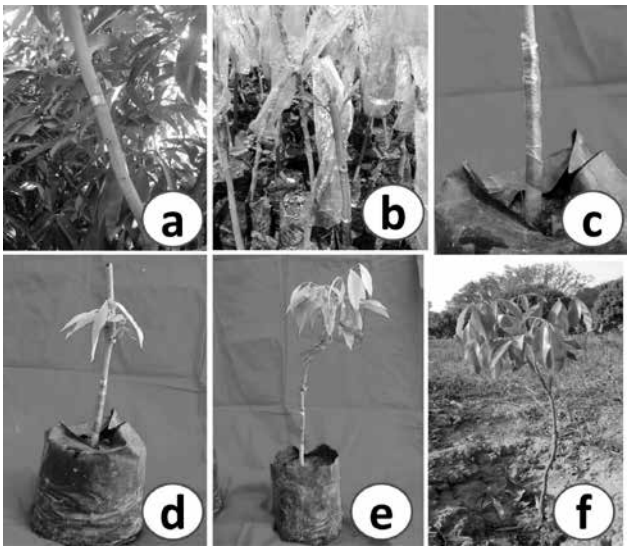

Fig. 2. Different stages of wedge grafting in litchi cv. Shahi. (a) Girdled branch in scion mother tree, (b) Bud sprouting, (c) Scion union, (d) Immature graft, (e) Mature grafted plant, (f) Grafted plant in the field.

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