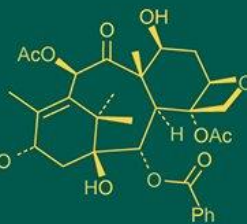
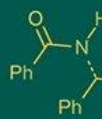


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Temporal influence on air layering success in grapevine

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Abstract

Air layering can be an effective method for grapevine propagation, provided that the appropriate time for its operation is standardized for optimum rooting, establishment and subsequent growth. The present study was conducted at ICAR-National Research Centre for Grapes, Pune, Maharashtra, during 2022-23 to evaluate the influence of different times of air layering on rooting, establishment, survivability and subsequent growth of grapevine layers. For this research trial, 6-7 months old vines of Dogridge rootstocks spaced at a spacing of 3 m × 1.8 m, established during 2022-23, were used and on these plants, matured and healthy pencil-thick active shoots of cv. Thompson seedless were selected and grafted. After the success of the graft, healthy plants were selected for layering at different times, viz., 15th October, 30th October, 15th November and 30th November, by using sphagnum moss as rooting media with the application of a standard dose of IBA at 3000 ppm concentration. The results revealed that the time of layering, i.e., 30th October, exhibited a higher characteristic effect on the rooting behaviour of layers, final survivability and establishment of detached layers, and growth of established layers. The findings clearly suggest that late October provides the most favourable physiological and environmental conditions for successful air layering in Thompson Seedless grapevine. This period can therefore be recommended for large-scale propagation to enhance planting material availability and improve establishment success in commercial vineyards.

Keywords: *Vitis vinifera*, air layering, thompson seedless, rooting behaviour, propagation timing

Introduction

Grape (*Vitis vinifera* L.) is a highly valuable horticultural crop among India's most important fruit crops, having an area of 162,000 hectares, occupying 2.3 % of the total area. The majority of the world's fresh grape exports come from India. A total of 2,67,950.39 MT of grapes worth Rs. 2,543.42 crores were exported from the nation to various countries, including the European Union, Saudi Arabia and African countries. (Anon., 2022) ^[1].

Thompson seedless is the most extensively cultivated commercial white table grape variety in India owing to its high yield and superior fruit quality. These vines are vigorous and adapt well to a variety of climates, making them a favored choice for grape growers. Dogridge (*Vitis champinii* Planch.) is a natural hybrid of *Rupestis candicans*, which imparts great vigor to the scion. It is tolerant to salinity and well suited for less fertile soil. It is moderately resistant to phylloxera and lime, making it one of the most widely adopted rootstocks in Indian viticulture. The Thompson Seedless-Dogridge combination is commonly used in commercial vineyards and therefore considered appropriate for the experiment.

Grapes are mainly propagated by vegetative methods, especially hardwood cuttings. Vegetatively propagated fruit plants are genetically identical and uniform in growth, fruit quality and yield. Consequently, various attempts have been made to propagate grapes by vegetative methods. Even with these approaches, there are some constraints in the propagation of grapes by these methods because rooting and survivability are low. Hence, such strategies are discouraging because of variable success rates and rooting difficulties.

Therefore, to satisfy the demand for genetically pure cultivars and better survivability, it is essential to go for an alternative method of propagation that is simple and, in a short time, can provide more progeny/offspring. Air layering is the simplest, easiest, cheapest and most convenient method for the propagation of grapes to obtain true-type plants with better characteristics viz., precocity, high yield and fruit quality.

This method has been found effective in litchi, guava and many other fruit crops which cannot be easily propagated from cuttings. Air layering is an easy and economical means of vegetative propagation. Horticulturists have long used air layering, initially discovered by the Chinese over 20 centuries ago, as a technique for propagating ornamental and cultivated plants. (Mergen, 1953) ^[2]. It is the oldest technique used by gardeners to propagate many woody plants (Hossain, 2007) ^[3]. The present study was undertaken to evaluate the influence of different times of air layering on rooting behaviour, establishment, survivability and subsequent growth of grapevine layers, with the aim of identifying the most suitable period for successful air-layer propagation.

Materials and Methods

Experimental site: The research work was conducted at ICAR-National Research Centre for Grapes, Manjari farm, Pune, Maharashtra, during the year 2022-23. The experimental site is located in Mid-West Maharashtra with an altitude of 559m above mean sea level and it lies at 18.32°N and 73.51°E longitudes. It comes under a tropical wet and dry climate, with an average temperature ranging from 20 to 28°C. It receives annual precipitation of 700 to 750 mm from June to September. The soil in the region is heavy black with pH 7.75 and EC 0.46 dS m⁻¹.

Plant material and experimental details: For this experiment, a mother block of Dogridge rootstocks, vegetatively propagated through hardwood cuttings, was established by planting rooted cuttings in the field at a spacing of 3m × 1.8m during June 2022. Further, in February 2023, well-matured, healthy, pencil-thick shoots (approximately 8–10 mm in diameter) of cv. Thompson Seedless were grafted onto the established Dogridge rootstocks. After the success of the graft union and 6-7 months of growth, healthy and uniform grafted vines were selected and used for layering on 15th October, 30th October, 15th November and 30th November, 2023. Each selected vine had 7 to 8 nodes, with an average spacing of 6-7 cm between them.

A ring of bark about 2 cm wide was completely removed between two nodes from each selected vine with the help of a sharp knife without injuring it, at a distance of 10 cm from the ground. A standard dose of IBA at 3000 ppm was applied at the girdled portion with the help of a cotton swab. Then the girdled portion was wrapped with approximately 100g of moist sphagnum moss, which was sterilized by soaking overnight in a broad-spectrum fungicide. Excess water was squeezed out before use. The moss was then securely enclosed with a transparent 200-gauge polythene sheet (approximately 15× 20 cm), and both ends were tied tightly using a thread.

Root emergence was monitored through the transparent polythene wrapper, and the air layers were detached five days after root emergence, following sufficient root development, by making a cut just below the lower portion of the air layer with the help of secateurs. The detached layers were brought to a nursery under a 50% shade net, where the polythene wrappers were removed gently without injuring the roots. The rooted layers were planted in planting bags containing growing media of soil, sand and vermicompost in a 2:1:1 ratio.

The observations on the rooting behavior of layers were recorded immediately after detachment, whereas the establishment, growth measurements, and final survivability were assessed 45 days after detachment. Each rooted air layer served as an individual observational unit, and observations were recorded separately for each layer.

Experimental Layout and Treatments: The experiment was laid out in a Randomized Block Design with four different treatments, viz., time of air layering, i.e., T₁ [15th October], T₂ [30th October], T₃ [15th November], and T₄ [30th November], with three replications. Each replication comprised ten genetically uniform grafted grapevines, and one air layer was prepared on each vine, resulting in 30 air layers per treatment and 120 air layers in total. The data presented represent observations recorded during a single experimental season (2022–23).

Statistical analysis: Experimental data were subjected to analysis of variance (ANOVA) using a Microsoft Excel-based statistical worksheet. The results are expressed as mean values and standard deviation (SD) following the procedure described by Panse and Sukhatme, 1967. Treatment means were compared using the Critical Difference (CD) test at the 5% level of significance. Percentage data were subjected to arcsine square-root transformation prior to statistical analysis to stabilize variance, whereas back-transformed means are presented in the tables for ease of interpretation.

Results and Discussion

The results revealed that the time of layering exhibited a significant effect on the rooting behaviour of layers, final survivability and establishment of detached layers, and growth of established layers as presented in Tables 1, 2 and 3.

Rooting Behavior of Layers: The minimum number of days taken for initiation of roots (50.60 days) was observed significantly earlier during 30th October (T₂), while the maximum days (76.80) were observed during 30th November (T₄). The days taken for root appearance were probably affected due to varying environmental conditions viz., optimum relative humidity with increased temperature and moderate rainfall, which resulted in early root initiation. The results are in conformity with Rymbai and Reddy (2010) ^[5] in guava, Vyas *et al.* (2016) ^[6] in red jamun and Gowda *et al.* (2006) ^[7] in rose apple. The maximum rooting percentage (78.67%) was recorded on 30th October (T₂), while the minimum rooting percentage (40.67%) was recorded on 30th November (T₄). The maximum rooting percentage might have happened probably because of the availability of moisture to the roots throughout their developmental stage. It depends on rainfall, temperature, evaporation, sunshine and relative humidity. The results are similar to the work of Bisen and Barholia (1995) ^[8] in jackfruit, Rymbai and Reddy (2010) ^[5] in guava and Gowda *et al.* (2006) ^[7] in rose apple.

The maximum length of the root (8.18 cm) was recorded on 30th October (T₂), which was statistically at par with T₁ (15th October) (8.16 cm) and T₃ (15th November) (8.13 cm). While the minimum length (6.92 cm) was recorded on the 30th of November (T₄). The formation of longer roots may be due to the impact of the time of layering on rapid cell

elongation and other responses of physiological modifications in the air-layered shoot, on top of that severity of the girdled portion additionally helps in the faster elongation of roots. The results are justified by the work of Tomar (2016) ^[9] in *Spondias pinnata*.

The layers that were prepared on 15th October (T₁) and 15th November showed a greater number of roots (40.60), which was statistically at par with T₂ (30th October) (39.93), while the minimum number (27.40) was observed in T₄ (30th November). The time of layering is an important factor for the production of rooting in layers because rooting is enhanced by the presence of enough moisture, light and optimum temperature. It might also be due to the reserved food present in the parent branch, which helps in the formation of a well-developed root system. Environmental conditions enhance the rooting capabilities, especially during the early monsoon and monsoon periods. Similar findings were observed by Tomar (2016) ^[9] in *Spondias pinnata* and Vyas *et al.* (2016) ^[6] in red jamun.

The maximum diameter of the thickest root (2.94 mm) was recorded as significantly superior on 30th October (T₂), while the minimum diameter (1.54 mm) was recorded in T₄ (30th November). The reasons for the larger diameter might be due to the creation of the most reliable conditions for the storage of photosynthates in the root zone and the further increase of cortex parenchymatous cells, which were responsible for the increased diameter of roots. The results are similar to the findings of Singh (2002) ^[10] and Naitani *et al.* (2016) ^[11] in guava.

The maximum root dry matter (18.36%) was recorded as significantly superior on 30th October (T₂), while less root dry matter (17.24%) was recorded on T₄ (30th November). The increased fresh and dry weight of roots may be due to the availability of required climatic and weather conditions during the period of root development. The results are similar to the findings of Baghel *et al.* (2016) ^[12] and Rymbai and Reddy (2010) ^[5] in guava. The maximum root volume (6.24 cm³) was recorded as significantly superior on 30th October (T₂), while the minimum volume (5.00 cm³) was recorded on 30th November (T₄). Higher root volume might be because of the presence of a greater number of roots per layer, and their weight has a greater impact on the root volume. The formation of more roots is largely influenced by environmental variations, rooting hormones, nutrient status of soil, parent branch and other supporting factors Vyas *et al.*, 2016 ^[6] in red jamun.

Final survivability and establishment of detached layers:

The least number of days required for the establishment of detached grafted layers (14.80 days) was noted on 30th October (T₂), which was at par with T₁ (15th of October) (15.00 days). Whereas, more days (24.60) were taken on 30th November (T₄). The suitable climatic conditions favor the early establishment and growth of the layers. Similar results have been reported by Tomar *et al.* (1999) ^[9].

The maximum percentage of final establishment of detached layers (91.20 %) was recorded on 30th October (T₂), which was at par with T₁ (15th October) (89.93%). In comparison, the minimum percentage (70.00%) was recorded in T₄ (30th November). This could be due to higher root number and length, and earlier initiation of roots, resulting in improved vigour and establishment. These findings agree with Chandrappa and Gowda (1998) ^[7], Rymbai and Reddy (2010) ^[5] in the guava air layer and Rahman *et al.* (2000) ^[15]

in the litchi air layer. The maximum percentage of layers showing secondary roots (97.33%) was recorded on 15th October (T₁), which was on par with T₂ (30th October) (96.00%) and T₃ (15th November) (94.67%). The minimum percentage (82.67%) was recorded in T₄ (30th November).

Growth measurements on established plant (45 days after detachment):

The maximum number of new shoots per planted layer (6.93) was recorded as significantly superior on 30th October (T₂), while the minimum number (2.60) was recorded in T₃ (15th November). The maximum length of the secondary shoot of the layer (4.84 cm) was recorded as significantly superior on 30th October (T₂), while the minimum length (2.42 cm) was recorded in the layers that were done on 30th November (T₄). The maximum layer height (48.58 cm) was recorded on 30th October (T₂), which is at par with T₃ (15th November) (47.83 cm), while the minimum height (31.39 cm) was recorded on 30th November (T₄). The maximum leaf area (53.15 cm²) was recorded significantly higher on 30th October (T₂), while the minimum leaf area (45.97 cm²) was recorded on 30th November (T₄). The effect on the number of new shoots per layer might be due to suitable environmental conditions, which stimulated a higher number of roots with faster growth, resulting in better absorption of food material and other necessary minerals. In this way, the plant will show higher growth, which results in a larger number of sprouts. Similar results have been reported by Bhagat *et al.* (1999) ^[16], Tomar *et al.* (1999) ^[9], Tyagi and Patel (2004) ^[17] in guava and Bandana (2004) ^[18] in the jackfruit air layer.

The maximum length of shoot per planted layer (12.52 cm) was recorded on 15th October (T₁), which is at par with T₂ (30th October) (12.45 cm), while the minimum length (9.16 cm) was recorded in the layers that were done on the 30th of November (T₄). This may be due to variations in climatic and environmental factors as reported by Chandrappa and Gowda (1998) ^[7] in guava. Rymbai and Reddy (2010) ^[5] also observed a similar result in guava. The maximum layer girth (1.00 cm) was recorded as significantly superior on 15th November (T₃), while the minimum girth (0.54 cm) was recorded on 30th November (T₄). Also, it might have been due to the constructive support of environmental factors and rooting hormones. The results are substantiated by the findings of Singh *et al.* (2014) ^[19] in mulberry and Rymbai and Reddy (2010) ^[5] in guava.

Based on the rooting behaviour, final survivability, establishment of detached layers and subsequent growth of established layers, it can be concluded that the time of air layering had a significant influence on the propagation success of grapevine. Among the different dates evaluated, air layering performed on 30th October resulted in superior rooting, establishment, survival and early growth performance compared with the other treatment dates. Therefore, 30th October may be considered the most suitable period for air layering of grapevine under the agro-climatic conditions of Pune, Maharashtra. Adoption of this period can help improve the production of healthy and well-established planting material through air layering and may provide a practical approach for enhancing propagation efficiency in grapevine. Further research across different seasons, agro-climatic conditions and grapevine cultivars is recommended to validate the optimum time of air layering and to develop a standardized protocol for large-scale propagation.

Table 1: Effect of time of layering on rooting behaviour of layers.

Treatment	Days taken for the initiation of roots	Rooting percentage (%)	Number of roots per layer	Length of root (cm)	Diameter of thickest root (mm)
T ₁ (October 15)	54.80	72.67 (59.77)*	40.60	8.16	2.47
T ₂ (October 30)	50.60	78.67 (64.11)*	39.93	8.18	2.94
T ₃ (November 15)	69.60	63.33 (53.08)*	40.60	8.13	2.84
T ₄ (November 30)	76.80	40.67 (39.43)*	27.40	6.92	1.54
SE m (±)	0.48	1.33	0.55	0.04	0.03
CD 5%	1.37	3.80	1.57	0.12	0.09

*Values represent the mean of three replications, each comprising ten vines. Data in parentheses indicates the arc sine transformation value

Table 2: Effect of time of layering on rooting behaviour and final survivability of detached layers.

Treatment	Percentage of layers showing secondary roots	Root dry matter (%)	Root Volume (cm ³)	Days required for the establishment of the removed grafted layers	Percentage of the final establishment of detached layers
T ₁ (October 15)	97.33	17.68 (24.67)*	5.70	15.00	89.93 (74.04)
T ₂ (October 30)	96.00	18.36 (25.11)*	6.24	14.80	91.20 (75.72)
T ₃ (November 15)	94.67	17.24 (24.09)*	5.61	17.20	89.40 (72.91)
T ₄ (November 30)	82.67	17.38 (24.51)*	5.00	24.60	70.00 (57.96)
SE m (±)	1.14	0.09	0.10	0.15	0.51
CD 5%	3.25	0.25	0.28	0.42	1.45

*Values represent the mean of three replications, each comprising ten vines. Data in parentheses indicates the arc sine transformation value

Table 3: Effect of time of layering on growth of established layers.

Treatment	Number of new shoots per planted layer	Length of shoot per planted layer (cm)	Length of side shoot of layer (cm)	Layer height (cm)	Layer girth (cm)	Leaf area (cm ²)
T ₁ (October 15)	5.73	12.52	4.36	44.40	0.84	50.19
T ₂ (October 30)	6.93	12.45	4.84	48.58	0.92	53.15
T ₃ (November 15)	5.20	11.40	4.71	47.83	1.00	51.33
T ₄ (November 30)	2.60	9.16	2.42	31.39	0.54	45.97
SE m (±)	0.18	0.10	0.04	0.29	0.01	0.40
CD 5%	0.52	0.30	0.12	0.83	0.02	1.16

*Values represent the mean of three replications, each comprising ten vines.

Conclusion

Based on the rooting behaviour, final survivability, establishment of detached layers and subsequent growth of established layers, it can be concluded that the time of air layering had a significant influence on the propagation success of grapevine. Among the different dates evaluated, air layering performed on 30th October resulted in superior rooting, establishment, survival and early growth performance compared with the other treatment dates. Therefore, 30th October may be considered the most suitable period for air layering of grapevine under the agro-climatic conditions of Pune, Maharashtra. Adoption of this period can help improve the production of healthy and well-established planting material through air layering and may provide a practical approach for enhancing propagation efficiency in grapevine. Further research across different seasons, agro-climatic conditions and grapevine cultivars is recommended to validate the optimum time of air layering and to develop a standardized protocol for large-scale propagation.

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