Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(3): 1285-1287
Received: 15-03-2020
Accepted: 18-04-2020

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Stenting: A new technique for rapid multiplication of plants

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Abstract
Stenting is a method of rapid multiplication of plants. stenting can be an innovative technique to reduce the duration of plant multiplication, where rooting of clonal rootstock is not a complex phenomenon. In this method cutting and grafting is performed simultaneously. Stenting also provides the benefits of rootstock used. In this method, the scion is grafted onto non-rooted rootstock cuttings and the success mainly depends on callus formation between the cut surfaces of scion and stock and root initiation on the rootstock. Stenting is now being used world-wide by rose growers and can also be used for apple, cherry, peach, pear and pomegranate propagation. Thus, it can be a valuable technique for rapid mass multiplication and year-around production of different plants to meet the increasing demand.

Keywords: Stenting, rapid multiplication, cutting, grafting, scion

Introduction
Stenting is a quick method of plant propagation (Van De Pol and Breukelear, 1982) [13]. In Dutch language, the word 'stenting' means 'to stem' it is combination of two words *'stekken'* (to strike a cutting) and *'enter'* (to graft). In this method cutting and grafting are done simultaneously. So, the formation of the graft union and adventitious roots takes place at a same time. In fruit trees, grafting has been practised with rooted rootstock for a long time; however, use of non-rooted rootstock is relatively new. The traditional method of grafting takes almost two years to produce plants of saleable size. During first year the rootstock are raised through seeds or by cuttings and when these rootstock attain the size of pencil thickness (takes 10-12 months), the grafting operations are done and thus it takes another one year to produce plants for planting in the field. On the other hand, in stenting technique, graft union formation and rooting occurs simultaneously. Thus, stenting is an innovative technique to reduce the duration of multiplication, where rooting of clonal rootstock is not a complex phenomenon. It is being used worldwide by rose growers (Nazari *et al*., 2009) [11] and also a valuable technique in propagating species of conifers and also apple, rhododendron, plum and pear (Hartman *et al*., 2002) [5]. The success of this method requires mainly callus formation between the cut surfaces of scion and stock and root initiation on the rootstock. Therefore, Growth promoting hormones enhances rooting of cuttings of many horticultural plants by influencing the growth and development of plant cells. Successful adventitious rooting during stenting propagation depends upon several factors, including physiological condition of the stock plants and environmental condition during adventitious root formation. The speed of root development in cuttings depends on the cutting types, the rooting medium and type and concentration of hormones used. Stenting is now being used in many ornamental and fruit crops. In case of rose propagation, it has become popular among propagators (Nazari *et al*., 2009) [11] and also in the case of apple, pear and plum (Hartman *et al*., 2002) [5].

Advantages
- Stenting reduces the nursery duration. We can get a grafted plant within a year to meet the increasing demand.
- Faster evaluation of new scion-stock combination and investigation of the interaction between shoots and roots.
- Stenting also provides the benefits of rootstock used. The rootstock shows the positive effect on a different aspect of scion ranging from tree size, productivity, uptake of nutrient, growth rate, time of defoliation, bloom date and tree survival.
- It is also known to affect the susceptibility of scion tree to a variety of disease and pest.
- It helps in achieving resistance to soil salinity, nutrient imbalance, disease and pest resistance and tolerance to other abiotic condition in lesser time span.

- Reduces the cost of nursery raising by using green house space only for a year instead of two years.

Uses of Stenting Methods in Different Crops

Flower crops: In roses it is a quick propagation method (stenting) in majorly growing countries like Netherlands. A scion with one leaf and a dormant bud is grafted on a single internode of the rootstock, bringing about production of complete plant within 3 weeks. Rootstock *R. chinensis* cv. 'Indica Major' gives the best outcomes after use of 5000 mg/l IBA. Pre-treatment of the rootstock by use of IBA and stored in 4 °C for 3 weeks improved rooting. Grafting on seedling rootstocks (bench-grafting) and stenting proved to give similar outcomes (Pol and Breukelaar, 1982) [13].

Similarly, Yeshiwas *et al.* (2015) [14] assessed the impact of softwood, semi hard and hardwood cuttings and IBA concentrations on the growth and development of stenting propagated roses. After the preparation of grafted cuttings they were treated with the respective IBA concentrations. Results uncovered that various levels of IBA had shown significant effects on growth parameters of grafted rose cutting. Cuttings treated with 1000 ppm of IBA had shown significant effects on most of the root and shoot parameters including root length, number of roots per cutting, root fresh weight, root dry weight, shoot fresh and dry weight, leaf number and shoot length. Among the diverse cutting types, hardwood showed significant effect on growth and development of rose cuttings. Also in Chinese Hibiscus stentings, IBA treatments significantly increased rooting percentage compared with the control. Interactions of rootstock and IBA concentration showed that the highest healing percentage was obtained in 'Blue Stain' in concentration of 5000 ppm and the highest root number were seen in stentlings with 'Jeanne d'Arc' in 3000 ppm (Izadi and Zarei, 2014) [7].

Fruit crops: This technique of propagation is also being used in nursery production of various fruit plants with successful results. Kuden and Gulen (1996) [9] acquire nursery plants by budded cuttings, MM 106 apple, Quince-A and Myrobalan-B plum used as a rootstock and apple (Anna and Golden Dorset apple), pear (June Beauty and Santa Maria) and plum (Santa Rosa and Formosa) as scion. Distinctive dosages of IBA @ 2500 ppm in apples, 500 ppm in pears and 2500 ppm of IBA in plums were applied to the chip or whip budded plants. Over 80% of rooting and more than 70% of sprouting were acquired in both the methods.

Different grape cultivars whip or wedge grafted on various rootstocks. Before planting them, they were treated with Indole butyric acid (IBA) at 8000 ppm in the form of powder. The outcomes showed a great variability in the rooting ability of the different rootstocks and the scion and in addition, the grafting method did not significantly influence the rooting ability of the rootstocks. The rootstock-scion combination indicated high healing ability with a significant interaction between both graft partners (Abu-Qaoud, 1999) [1].

Propagation of pomegranate utilizing the stenting method demonstrated that rootstock type and IBA treatment influenced bud-take and root formation. The highest bud-take percentage was acquired with Gorj-e-Dadashi in combination with 500 mg/l IBA (Karimi *et al.*, 2011) [8]. Mosalanejad *et al.* (2013) [10] reveled that IBA had the significant influence on rooting and the highest rooting percent obtained from IBA 3000 mg/l treatment. The effect of BA on the graft union percent and scion length was significant than GA_3 in citrus. Similarly in *Ficus benjamina*, highest rooting percentage and highest number of roots were found in 4000 mg/l and 6000 mg/l IBA, respectively. Longest root length and maximum of root dry weight were recorded in cuttings treated with 4000 mg/l IBA (Babaie *et al.*, 2014) [2].

Brar and Gill (2014) [3, 6] observed that pear stentlings semi soft pear (*Pyrus communis* L. *X Pyrus pyrifolia* Burm F.) cultivar 'Punjab Beauty' grafted on 'Kainth' i.e., *Pyrus pashia* Hamilton) when treated with higher doses of IBA exhibited positive results of the propagation of pear using stenting technique. In peach stentlings 'Shan-e-Punjab' and 'Early Grande' grafting on 'Floridaguard' rootstock showed the highest sprouting success, plant height, stem thickness and root length when treated with 2000 ppm IBA (Gill *et al*., 2014; Brar and Khera, 2017) [3, 6, 4]. Maximum bud take success was found in Baggugosha pear grafted onto non-rooted cuttings of Quince-A rootstock treated with different levels of IBA (Negi and Upadhyay, 2016) [12].

General procedure of stenting

Step 1. Preparation of scion and rootstock cuttings: Scion and rootstock should be about the same diameter. The stem of the scion and rootstock cultivar is cut into sections with two or more dormant bud.

Step 2. Secure the graft: The scion is either grafted by hand using a sharp grafting knife or machine grafted on the internode of the rootstock. Make sure the cambium tissue of the scion is seated against the cambium tissue of the rootstock.

Step 3. Protect the graft: Protect the graft by wrapping it with polythene strip, glued paper and grafting tape.

Step 4. Root treatment: A solution of plant rooting hormones (IBA) is applied to the basal part of the rootstock by the quick-dip method.

Fig 1: Flow chart for stenting method of propagation

Disadvantages

- As in case of stenting sometimes success percentage is low because the graft union formation and rooting is take place at a same time.
- This is an extensive method of propagation. It requires specialized skill.
- Life span of grafted plant is short as compared to seed propagated plant.
- Spread of viral diseases may occur through this method.

Conclusion

In the last decade, there has been a tremendous tendency towards using grafted plants in fruit orchards. The increasing demand requires a method of propagation which will produce a grafted plant within short duration of time. Several propagation methods are available, which may be used by plant propagators and farm owners. To our knowledge, this is the first review on stenting method of propagation. This method can be adopted for rapid multiplication of grafted plant, which takes only one year to develop a grafted plant. Furthermore, stenting method could be improved by using better growing media, rooting hormone, suitable growing conditions. The success however depends upon many factors like season of cutting, age and portion of the branch, growing media, moisture level, nutrient status and temperature, optimal growing conditions and proper timing may enhance the establishment and growth of the cutting. However, based on this mini review, several areas were identified that require further research, including:

1. Standardization of IBA concentration for the several plants
2. Planting of stents on appropriate media and under environmental conditions
3. Trials on protected conditions in different fruit crops

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