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EVALUATION OF DIFFERENT POST-GRAFT HEALING CONDITIONS TO IMPROVE GRAFTING SUCCESS IN TOMATO (*Solanum lycopersicum* L.)

Vijaylaxmi[1*], S. Mallesh[2], Prasanna Holajjer[3], D. Vijaya[4] and J. Srinivas[5]

[1]Department of Vegetable Science, Post Graduate Institute for Horticultural Sciences, Sri Konda Laxman Telangana Horticultural University (SKLTGHU), Mulugu, Telangana, India

[2]Department of Vegetable Science, Horticultural Research Station, SKLTGHU, Adilabad, Telangana, India

[3]Agriculture Nematology, ICAR-National Bureau of Plant Genetic Resources, Regional Station, Hyderabad, Telangana, India.

[4]Department of Soil Science and Analytical Chemistry, PGIHS, SKLTGHU, Mulugu, Siddipet, Telangana, India.

[5]Department of Vegetable Science, Vegetable Research Station, Rajendranagar, Hyderabad, Telangana, India

*Corresponding author E-mail: vijaylaxmichincholi23@gmail.com

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ABSTRACT

Tomato (*Solanum lycopersicum* L.) grafting is an effective technique for improving plant survival and productivity; however, successful graft establishment depends largely on appropriate post-grafting healing conditions. This study was conducted at the Centre of Excellence (COE), Mulugu, Siddipet, Telangana, during 2025 to evaluate the effect of different post-grafting healing conditions on grafting success in tomato grafted onto brinjal (*Solanum melongena* L.) rootstock. The 25-day-old tomato scions and 30-day-old brinjal rootstocks were grafted using the cleft grafting method. Six post-grafting healing treatments were evaluated using 50 grafted seedlings per treatment with a uniform healing period of 10 days. Grafting success was assessed based on successful graft union formation and scion survival after healing and acclimatization. Significant differences were observed among the treatments. The highest grafting success (100%) was recorded in seedlings maintained under open conditions for the initial 3-days followed by transfer to the dark healing chamber for the remaining 7-days, followed by open conditions for 3-days and the plastic healing box for 7-days (92%). Continuous healing in the plastic healing box, open conditions, dark healing chamber, and plastic healing box within the dark healing chamber recorded grafting success of 88%, 80%, 70%, and 64%, respectively. Sequential post-grafting healing proved more effective than continuous maintenance under a single healing condition. This simple and economical healing strategy can improve grafting success and may be adopted by nursery growers and farmers for producing high-quality grafted tomato seedlings.

***Key words*:** Tomato, cleft grafting, post-graft healing conditions, grafting success.

Introduction

Tomato (*Solanum lycopersicum* L.) is a significant vegetable crop and is well known for its utilization as fresh vegetable and processed foods that provide high nutritional value for its consumers. Tomato is an excellent source of vitamins, minerals, antioxidants, and health-promoting compounds, making it one of the most commercially important vegetable crops suitable for year-round cultivation (Kohima *et al*., 2021). Fresh tomato fruits are in high demand throughout the year, necessitating continuous improvement in tomato production to meet the increasing requirements of both farmers and consumers (Pogonyi *et al*., 2005). However, tomato cultivation is constrained by several biotic and abiotic stresses, which adversely affect plant growth, productivity, and fruit quality. Efforts are being made by public and private sectors to develop tomato cultivars with the ability to perform optimally under constraint conditions through breeding and biotechnological tools, although these require considerable time. One alternative approach is grafting,

which emerged as a potential tool to quickly enhance the efficiency of high-yielding genotypes for wider adaptability or resistance to different biotic and abiotic stresses (Kumar *et al*., 2017).

Successful production of grafted plants depends not only on the compatibility between the scion and rootstock but also on the formation of a functional graft union. The establishment of close contact between the vascular tissues of the scion and rootstock, together with suitable environmental conditions, is essential for successful graft union formation (Davis *et al*., 2008). High-quality grafted seedlings are therefore critical for realizing the full benefits of grafting in tomato production. Rapid and successful vascular connection during the healing and acclimatization period is essential for producing vigorous grafted seedlings with higher survival and field establishment (Jang *et al*., 2014).

Although the grafting operation itself requires less than a minute per plant, the subsequent healing phase generally lasts for one week and represents the most critical stage determining graft survival (Davis *et al*., 2008; Fernandez-Garcia *et al*., 2004). During this period, callus tissue develops at the graft interface, followed by differentiation of new vascular tissues connecting the scion and rootstock. Healing of herbaceous grafts generally requires 5-8 days for complete vascular reconnection (Fernandez-Garcia *et al*., 2004; Turquois and Malone, 1996). Since the scion is temporarily unable to obtain sufficient water from the rootstock until vascular continuity is restored, maintenance of appropriate post-grafting environmental conditions is essential to minimize moisture loss, prevent scion wilting, and promote rapid graft union formation (Davis *et al*., 2008). Acclimatization following graft healing further strengthens the graft union and prepares the seedlings for successful establishment under greenhouse or field conditions (Lee and Oda, 2003).

Immediately after grafting, grafted seedlings are generally transferred to a healing chamber to facilitate callus formation and vascular reconnection between the scion and rootstock (Rivard and Louws, 2006). During the initial 24-48 hours, low-light conditions are recommended to reduce transpiration and evaporation from the scion. High relative humidity (85-100%) minimizes water loss, while temperatures between 25 and 30°C are considered favourable for graft healing (Johnson *et al*., 2011; Lee, 2007; Oda, 2007). Subsequently, humidity is gradually reduced, and light intensity is increased over the next several days to acclimatize the grafted seedlings. High relative humidity (RH) for a prolonged period may result in the development of adventitious roots from scion which become a source of entry for soilborne pathogens if it remains intact after transplanting into the field. The gradual decrease in RH and increase in light should take place over 4-8 d. The plants are ready to grow under normal greenhouse conditions 6-10 d after grafting, and with an increase in stem girth, the grafting clip or tube usually drops off itself (Guan and Hallet, 2016).

Despite the proven importance of controlled healing environments, the construction and maintenance of sophisticated healing chambers are often expensive and may not be feasible for small-scale nursery growers and farmers. While commercial nurseries generally use well-controlled healing facilities, many growers rely on simple and inexpensive structures where precise regulation of environmental conditions is difficult. Moreover, standard recommendations for managing low-cost healing structures under different climatic conditions are still limited. Grafting and the production of grafted seedlings are also associated with additional labour requirements, technical skills, and careful post-grafting management during the critical healing period of 7-10 days (Ashok and Sanket, 2017).

In India, many nursery growers and small-scale farmers interested in producing grafted tomato seedlings are discouraged by the high cost of commercially available grafted plants and the expense of specialized healing facilities. Consequently, growers often prefer to produce their own grafted seedlings using simple and economical healing structures. However, inadequate post-grafting care frequently results in poor graft union formation and graft failure. Therefore, identifying low-cost and effective post-grafting healing conditions that can improve graft success is of considerable practical importance for nursery production.

Therefore, the present study was undertaken to evaluate different post-grafting healing conditions for improving grafting success in tomato (*Solanum lycopersicum* L.) grafted onto brinjal (*Solanum melongena* L.) rootstock under nursery conditions. The findings of the study are expected to provide practical information on economical post-grafting healing approaches that can be adopted by nursery growers and small-scale farmers for efficient production of grafted tomato seedlings.

Materials and Methods

The experiment was carried out at the Centre of Excellence (Fruits), Mulugu, Siddipet, Telangana, during 2025 to evaluate different post-grafting healing conditions for grafting success in tomato (*Solanum lycopersicum* L.) grafted onto brinjal (*Solanum melongena* L.)

Table 1: Treatment details of different post-grafting healing conditions evaluated for grafting success in tomato grafted onto brinjal rootstock.

T_1	Grafted seedlings maintained under open conditions for 10 days
T_2	Grafted seedlings maintained inside plastic healing box for 10 days
T_3	Grafted seedlings maintained inside the dark healing chamber for 10 days
T_4	Grafted seedlings maintained inside plastic healing box placed within the dark healing chamber for 10 days
T_5	Grafted seedlings maintained under open conditions for 3 days, followed by the dark healing chamber for 7 days
T_6	Grafted seedlings maintained under open conditions for 3 days, followed by plastic healing box for 7 days

rootstock. Tomato was used as the scion and brinjal as the rootstock. Seedlings of both scion and rootstock were raised under partial shade conditions with regular irrigation. Initially, seedlings were raised in 98-celled protrays and shifted to 50-celled protrays with approximately 45 mm cell diameter two weeks before grafting to facilitate better root and stem development. Grafting was performed when the brinjal rootstock seedlings were approximately 30 days old with a stem diameter of 3-4 mm, while the tomato scion seedlings were approximately 25 days old, at the 2-3 true-leaf stage, with a stem diameter of 3-4 mm. Seedlings with compatible stem diameters were selected for grafting.

The tomato scion was grafted onto the brinjal rootstock using the cleft grafting method. The rootstock stem was cut horizontally with a sterilized blade at approximately 3-4 cm above the base of the root system, followed by a vertical incision of approximately 0.5 cm at the centre of the cut stem. Simultaneously, the basal portion of the tomato scion was cut into a V-shaped wedge of approximately 0.5 cm length. The wedge-shaped scion was carefully inserted into the vertical incision of the rootstock, ensuring proper contact between the cut surfaces. The graft union was firmly secured using a grafting clip (Fig. 1) (Lee *et al.*, 2010). Grafting was performed under shaded conditions during the cooler hours of the day to minimize moisture loss and desiccation of the grafted tissues. Immediately after grafting, the grafted seedlings were misted with water to minimize desiccation (Guan and Hallet, 2016) and subsequently transferred to the respective post-grafting healing conditions.

Six different post-grafting healing conditions (Fig. 2) were evaluated, with 50 grafted seedlings maintained under each treatment. The total healing period was 10 days for all treatments. The treatments comprised continuous and sequential post-grafting healing conditions were presented in Table 1.

For the dark healing chamber, a temporary enclosed structure was prepared by covering a designated area with silver polythene sheet, with the black surface facing inward and the silver surface facing outward. Wet gunny bags were placed over the structure, which was then



Fig. 1: Sequential procedure of cleft grafting.

closed from the top to provide a dark healing environment for the grafted seedlings. The chamber maintained a temperature of 25-30°C and a relative humidity of 85-95% throughout the healing period. A plastic healing box is a closed enclosure designed to maintain 70-85% relative humidity, a temperature of 25-30°C, and low-light conditions, thereby facilitating graft union formation and reducing desiccation of newly grafted seedlings.

In the combined treatment, the grafted seedlings enclosed in the plastic healing box were maintained inside the dark healing chamber. In the sequential healing treatments, the grafted seedlings were initially maintained under open conditions for 3 days and subsequently transferred either to the dark healing chamber or to the plastic box for the remaining 7 days. Thus, all treatments received a total post-grafting healing period of 10 days. During the 10-day healing period, the grafted seedlings were sprayed with water two times a day to maintain adequate moisture and prevent desiccation of the graft union.

After completion of the 10-day healing period, the grafted seedlings were transferred to a shade-net environment and maintained for one week for further healing and acclimatization. Following this period, the grafting clips were carefully removed from the graft unions. Grafting success was assessed after completion of the 10-day post-grafting healing period followed by one week of shade-net acclimatization, i.e., 17 days after grafting. Seedlings exhibiting successful establishment of the graft union and continued survival, and growth of the scion were considered successful grafts. Grafting success was expressed as the percentage of successful grafts relative to the total number of grafts made and calculated using the following formula:

$$\textit{Grafting success}\ (\%) = \frac{\textit{Number of successful grafts}}{\textit{Total number of grafts made}} \times 100$$

Results and Discussion

The grafting success of tomato varied markedly among the different post-grafting healing conditions evaluated (Table 2). Among the six treatments, the highest grafting success (100%) was recorded in T_5, in which grafted seedlings were maintained under open conditions for the initial 3 days followed by transfer to the dark healing chamber for the remaining 7 days.. This was followed by T_6 (92%), where grafted seedlings were maintained under open conditions for 3 days and subsequently transferred to the plastic healing box for 7 days. Continuous maintenance of grafted seedlings inside the plastic healing box (T_2) resulted in 88% grafting success, whereas continuous exposure to open conditions (T_1) recorded 80% graft survival. Comparatively lower grafting success was observed in T_3 (70%), where seedlings were maintained continuously inside the dark healing chamber, while the lowest grafting success (64%) was recorded in T_4, in which grafted seedlings were maintained continuously inside the plastic healing box placed within the dark healing chamber.

The results clearly demonstrate that post-graft healing management considerably influenced graft establishment in tomato. Among the treatments evaluated, sequential exposure of grafted seedlings to open conditions followed by dark healing environment proved more effective than maintaining the seedlings continuously under a single healing condition. The superior performance of T_5 and T_6 suggests that allowing grafted seedlings to remain under open conditions during the initial healing phase before transferring them to dark healing environment, was more favourable than continuous maintenance under a single healing condition. During the early stages after grafting, the vascular connection between the scion and rootstock has not yet been established, making the scion highly susceptible to water loss. Therefore, maintaining appropriate environmental conditions during this period is essential to minimize transpiration, prevent desiccation, promote callus formation, and facilitate vascular reconnection, thereby improving graft survival (Davis *et al*., 2008; Oda, 2007). Guan and Hallet (2016) reported that newly grafted seedlings should initially be maintained under low-light conditions to reduce transpiration, after which relative humidity should be gradually reduced and light intensity progressively increased to facilitate acclimatization. Proper management of the healing and acclimatization period has been shown to improve graft survival and produce vigorous grafted seedlings.

Table 2: Effect of different post-grafting healing conditions on grafting success in tomato grafted onto brinjal rootstock

Treat-ment	Post-grafting healing condition	Successful grafts (out of 50)	Grafting success (%)
T_1	Open conditions for 10 days	40	80
T_2	Plastic healing box for 10 days	44	88
T_3	Dark healing chamber for 10 days	35	70
T_4	Plastic healing box inside the dark healing chamber for 10 days	32	64
T_5	Open conditions for 3 days followed by the dark healing chamber for 7 days	50	100
T_6	Open conditions for 3 days followed by the plastic healing box for 7 days	46	92

The response of grafted seedlings to different healing environments observed in the present investigation is comparable with earlier reports evaluating conventional healing chambers and alternative healing methods. Johnson and Miles (2011) reported that healing chamber design significantly influenced graft survival in tomato, eggplant, and watermelon, emphasizing the importance of providing suitable environmental conditions during the initial healing period. Similarly, Davis *et al.,* (2008) and Oda (2007) highlighted that high relative humidity, moderate temperature, and reduced light during the early stages after grafting are essential for minimizing scion desiccation and promoting successful graft union formation.

The comparatively high grafting success recorded in T_5 is particularly noteworthy because it indicates that continuous maintenance under an enclosed healing environment throughout the entire healing period may not always be necessary for successful graft establishment. The initial exposure to open conditions for three days followed by transfer to the dark healing chamber may have provided a more favourable sequence of healing conditions, resulting in complete graft survival. Similar observations were reported by Gong *et al.,* (2021), who demonstrated that tomato seedlings healed under chamberless conditions achieved graft survival comparable to those healed in conventional healing chambers, indicating that successful graft establishment can be achieved through alternative healing approaches when appropriate post-grafting management is adopted.

Conversely, continuous maintenance inside the dark healing chamber (T_3) and inside the plastic healing box placed within the dark healing chamber (T_4) resulted in comparatively lower grafting success. During the healing period, the dark healing chamber maintained a temperature of 25-30°C with a relative humidity of 85-95%, whereas the plastic healing box maintained a temperature of 25-30°C and a relative humidity of 75-85%. Although these environmental conditions were maintained within the recommended range for graft healing, prolonged maintenance under a single enclosed healing condition appeared to be less effective than sequential exposure to different healing environments conditions. These findings indicate that, in addition to maintaining suitable temperature and relative humidity, the duration and sequence of exposure to the healing environment may also influence graft union formation and subsequent graft survival. The high grafting success achieved under the sequential healing treatment indicates that simple and low-cost post-grafting healing practices can effectively replace continuous enclosed healing



Dark healing chamber



Plastic healing box



Grafts kept inside the dark healing chamber



Grafts kept under open condition

Fig. 2: Different post-healing conditions.

conditions, making grafted tomato seedling production more feasible for small-scale nurseries and farmers.

Conclusion

Post-grafting healing conditions exerted a considerable influence on graft union establishment and seedling survival in tomato grafted onto brinjal rootstock. Among the healing treatments evaluated, maintaining grafted seedlings under open conditions for the initial three days followed by transfer to the dark healing chamber for the remaining seven days proved to be the most effective treatment, recording 100% grafting success. The findings indicate that the sequence of exposure to different healing environments plays an important role in successful graft establishment. Sequential post-grafting healing provides a simple, cost-effective, and efficient approach for improving graft success and can be recommended as a practical healing protocol to produce healthy grafted tomato seedlings under nursery conditions.

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