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Performance of low-cost healing chamber for healing and survival of brinjal grafts

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Abstract

Brinjal is a versatile, nutritious solanaceous vegetable cultivated extensively in rice-based cropping system of Konkani region during rabi season. Its commercial cultivation is severely hampered by bacterial wilt caused by *Ralstonia solanacearum* causing 30-100% yield loss. Grafting of susceptible commercial scions onto resistant rootstock 'Konkan Prabha' is a proven eco-friendly management strategy. However, graft success depends on optimum post-graft healing environment. The present investigation was undertaken at College of Horticulture, Dapoli during rabi-summer 2025-26 to evaluate a low-cost designed healing chamber (MS square pipe frame + polycarbonate sheet + polythene + fogger system) for acclimatization of brinjal grafts. Three graft combinations viz., T₁ - Harsh on Konkani Prabha, T₂ - Trivani on Konkani Prabha and T₃ - Janak on Konkani Prabha were evaluated by cleft grafting in RBD. Microclimate inside chamber was recorded at 7:30 AM, 2:30 PM and 6:00 PM up to 15 DAG. Temperature inside chamber ranged from 12.5-16.5 °C in morning, 20.1-31.7 °C in afternoon and 22.4-25.6 °C in evening with average of 19.23-23.93 °C, which is near optimum for healing (21-22 °C). Relative humidity ranged 82.6-97.4% in morning (peak 97.4% on Day 6), 72.8-88.8% in afternoon and 51.9-93.4% in evening. Average RH was 82.30-92.40% during 0-7 DAG and 73.47-77.67% during 8-15 DAG, required for hardening. Graft survival was significantly high. At 7 DAG survival was 99.29-100% (mean 99.76%) with 100% in T₂ and T₃. Final survival at 21 DAG was 97-100% with highest (100%) in T₂ - Trivani on Konkani Prabha and T₃ - Janak on Konkani Prabha and 97% in T₁. This indicates excellent acclimatization and high compatibility of brinjal grafts. Days to sprouting ranged 3.81-4.57 days (mean 4.28 days) with earliest in T₂ (3.81 days) and delayed in T₃ (4.57 days). Days to graft union ranged 3.42-4.07 days (mean 3.79 days) with earliest union in T₂ (3.42 days) followed by T₁ (3.90 days) and late in T₃ (4.07 days), indicating faster healing in Trivani on Konkani Prabha. Girth at graft union at transplanting varied significantly from 3.55-6.04 mm (mean 4.68 mm) with maximum in T₃ - Janak on Konkani Prabha (6.04 mm) followed by T₁ (4.44 mm) and minimum in T₂ (3.55 mm), indicating better vascular continuity and compatibility in T₃. It is concluded that designed chamber maintaining average temperature 19.23-23.93 °C and RH more than 80% for first 7 days is highly suitable for healing of brinjal grafts. Among combinations, Trivani and Janak grafted on Konkani Prabha recorded 100% final survival at 21 DAG, while Trivani on Konkani Prabha showed earliest sprouting (3.81 days) and graft union (3.42 days), proving most suitable for Konkani region.

Keywords: Brinjal grafting, healing chamber, konkani prabha, survival, graft compatibility

Introduction

Eggplant is a versatile vegetable that can be cooked in various ways, such as frying, roasting, grilling, or baking. It's a staple in many traditional dishes and cuisines, offering numerous health benefits, including supporting digestive health, reducing inflammation and protecting against certain diseases. Rich in dietary fiber, vitamins and minerals, eggplant is a nutritious addition to a balanced diet. It's also packed with antioxidants like anthocyanin, chlorogenic acid and nasunin. Consumption of brinjal helps to mitigate the risk of chronic diseases like heart disease and certain cancers. The potassium and vitamin B6 in eggplant support healthy blood pressure, while its low calorie and high fiber content make it an excellent choice for weight management. In Ayurvedic medicine, eggplant is believed to have a cooling effect, stimulating digestion and appetite. Its bitter flavour is thought to ignite the digestive fire, helping to break down food. Topically, eggplant paste or poultice may be used to alleviate swelling, inflammation and joint pain. Due to its unique flavour and texture, eggplant is a

popular ingredient, available in a range of sizes, colours and shapes, from purple to green, white and yellow. Brinjal is also known to have some medicinal properties and anti-cholesterol property due to presence of poly-unsaturated fatty acid (Linolenic and Lenoleic acid) present in flesh and seeds of fruit in higher amount to about 65%. Presence of magnesium and potassium salt in fruits are important in anti-cholesterol action. Brinjal is used in curing diabetic patient, asthma, liver complaints, cough due to allergy, cololithiasis leucorrhea, rheumatism, intestinal worms and cholera (Gopalkrishnan, 2007) ^[1].

Brinjal is popularly cultivated in rice-based cropping system during rabi season in entire Konkan region. However, the commercial cultivation of these vegetables poses limitations and one of them is incidence of bacterial wilt disease. Grafting is one possible way in which bacterial wilt resistant tolerant types can be used as rootstock and commercial varieties as scion.

These solanaceous fruit vegetables mainly grafted by tongue, cleft and splice method of grafting and their success varies according to crops. Investigations conducted on tomato, brinjal, cucumber and watermelon revealed that grafting had a pronounced positive effect on yield, quality, tackling soil borne diseases, stress due to water and salinity, heavy chemicals etc. (Lee *et al.*, 2010) ^[2]. Also introduction of new rootstocks with desirable traits compatible with locally selected scions can boost the status of grafting technology (Yassin and Hussien, 2015) ^[13]. Therefore, application of grafting in fruit vegetables has bright prospects in future. As a result of its benefits and value, demand for high-quality grafted seedlings by growers is increasing.

The varieties have been recommended viz., Konkan Prabha (brinjal) as resistant to bacterial wilt having better field adaptation (Anonymous, 2020) ^[4]. However, the size, shape and fruit quality of these varieties is not much acceptable to the consumers in the production belts of these vegetables. As the choice of fruit colour, shape and size differs with the market demand. Hence, it is very essential to find out the technology which will provide solution to the problem so that the consumer preferred varieties can be commercially grown in agro-climatic conditions of Konkan region especially during rabi-summer season.

Vegetable production with grafted plants was originated in Japan and Korea to avoid the serious crop loss caused by infection of soil-borne diseases aggravated by successive cropping. Grafting is now rapidly spreading and expanding over the world. Vegetable grafting has been safely adapted for the production of organic as well as environmentally friendly produce and minimizes use of undesirable agrochemical residues (Lee *et al.*, 2010). In tomato and brinjal grafting is becoming a well-developed practice worldwide with many horticultural advantages. Specific to a particular agro-climatic region. Studies have shown that grafting can increase yields, promote robust root systems and enhance photosynthesis and disease resistance (Xu *et al.*, 2005; Qi *et al.*, 2006; Wu *et al.*, 2006) ^[5].

Vegetable grafting offers numerous benefits over traditional methods, including reduced chemical pesticide use, improved resource efficiency and enhanced disease resistance. However, grafting requires specialized knowledge and skills, which can be a barrier for farmers. Limited access to formal training and reliance on traditional practices can hinder the adoption of grafting techniques. To use research is needed to standardize grafting methods and acclimatization processes. Successful grafting requires optimal temperature and humidity control as well as proper

air circulation and ventilation. Challenges such as inadequate temperature control, low humidity and poor air circulation can impede graft healing, while bacterial and fungal infections can also pose risks. Additionally, lighting conditions, including intensity, duration and consistency, can impact graft healing and plant growth.

In India, the production of solanaceous vegetables, especially brinjal and tomato is severely hampered by the bacterial wilt disease (Ramesh *et al.*, 2014) ^[6]. There are numerous strains of the bacterial wilt pathogen and it can persist longer in the soil even in the absence of a host hence its management is a very difficult task. The bacterium is quickly transmitted and can enter uninfested areas through water, soil, contaminated plant material or mechanical means. In brinjal, bacterial wilt may result in yield losses of 30-100% (Ramesh), or 4-86% (Sabitha *et al.*, 2000) ^[7]. In India, many commercial varieties and local cultivars of brinjal exhibit high susceptibility to the disease (Gopinath and Madalageri, 1986) ^[8]. A soil borne bacterium *Ralstonia solanacearum* is a causal organism for bacterial wilt. In all solanaceous vegetable the bacterium get entered into the plant through wounds in the roots caused during transplantation, infestation by nematodes and through natural wounds. After entering the plant, it quickly grows in the vascular system and fills the xylem components with bacterial cells, obstructing the flow of water. Plant infected with bacterium shows symptoms of yellowing, wilting and dying rapidly (Huet, 2014) ^[9]. Number of methods with varying degrees of success, have been reported for managing the bacterial wilt disease, including resistant varieties, soil amendments, soil solarization, grafting on resistant root stocks, bio-fumigants, plant growth-promoting rhizobacteria, the use of SAR inducers and biocontrol agents etc (Phadake, 2012). Out of these the least expensive and most straight forward method of bacterial wilt management is breeding for host resistance (Huet, 2014) ^[9]. Source of bacterial wilt resistance has been reported in many improved varieties and landraces of brinjal (Rakha *et al.*, 2020) ^[11].

Bacterial wilt poses a barrier to the successful cultivation of the brinjal and tomato crop in regions with high temperatures and humidity levels especially under tropical coastal conditions. The complete failure of a crop may occasionally cause the vegetable grower to suffer significant financial losses. The farmers of konkan region are small and marginal. The grafting protocol which can be adopted by small and marginal farmers will help the growers prepare the grafts at lower level will be feasible for preparing required number of grafts on farm without requirement of sophisticated climatic control facilities standardization of such protocol will be also cost effective way for preparation of tomato and brinjal grafts for commercial utilization of bacterial wilt susceptible scion varieties in the region.

Vegetable grafting originated as a method to boost resistance to biotic stresses, but it has since been explored for its potential to enhance tolerance to abiotic stresses like extreme temperatures, drought, salinity and flooding. By combining resistant rootstocks with desirable scions, grafting aims to mitigate both biotic and abiotic stresses, ultimately increasing crop yields. This technique reduces the need for chemical treatments, making it a valuable tool for organic farming. As an eco-friendly approach, grafting promotes sustainable production by controlling soil-borne diseases and minimizing reliance on agrochemicals, thereby supporting a more environmentally friendly method of vegetable cultivation.

Resistant breeding remains the most effective and eco-friendly approach to managing Bacterial wilt. Alternatively,

grafting onto resistant rootstocks offers a viable solution for controlling soil-borne pathogens in crops like tomatoes and eggplants. Eggplant rootstocks are often preferred over tomato rootstocks due to their enhanced resistance to Bacterial wilt and improved tolerance to flooding, making them a popular choice for grafting tomatoes globally (Wang *et al.*, 2011).

Grafting and cultivating grafted seedlings pose several challenges. Key issues include the labor-intensive grafting process, requiring specialized techniques and post-graft care for 7-10 days to facilitate healing. Skilled grafters can produce around 1200 seedlings daily, depending on the skill of person and method to be adopted. Post-graft handling also varies as per the situation. Environmental factors like high temperature, humidity and light can hinder healing if not managed properly. Excessive light can stress newly grafted plants, while insufficient light can impede growth. Poor sanitation and uneven plant aging can lead to disease onset and spread. Additionally, high costs associated with rootstock seeds and grafting equipment can be a significant drawback (Tirupathamma *et al.*, 2019) ^[12]. Thus, unavailability of suitable acclimatization condition and improper management during acclimatization may drastically reduce the grafting success there by increasing the cost and poor establishment of these grafts in the field.

Material and Methods

Experimental Details

Table 1: Details of crop, varieties, experimental design, treatments, replications, and plant population used in the experiment

1	Crop	:	Brinjal
2	Variety	:	Rootstock- Konkani Prabha
			Scion
			i. Harsh
			ii. Trivani
			iii. Janak
3	Design of experiment	:	Randomized Block Design (RBD)
4	Number of treatments	:	3
5	Number of replications	:	7
6	Total no. of plants/ treatment/ replication	:	100

Treatment Details

Table 2: Treatment details of grafted brinjal (*Solanum melongena* L.) plants using konkani prabha rootstock

Brinjal (<i>Solanum melongena</i> L.)	
T ₁	Grafts of Harsh on Konkani Prabha
T ₂	Grafts of Trivani on Konkani Prabha
T ₃	Grafts of Janak on Konkani Prabha

Sterilization of Potting Media

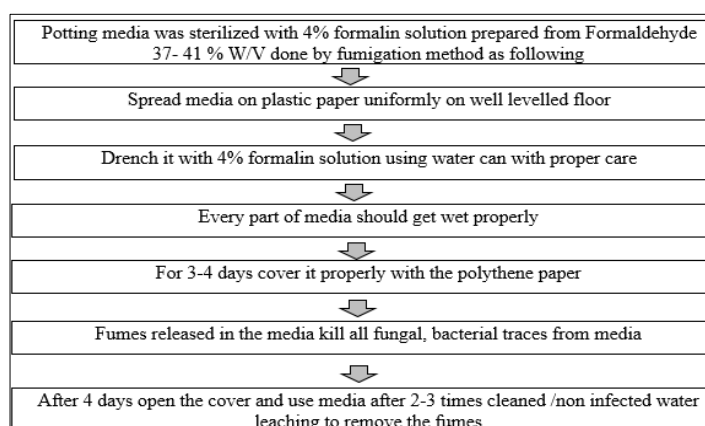


Fig 1: Procedure for sterilization of potting media using 4% formalin by fumigation method

Grafting Method

Cleft grafting method was adopted for preparation of the grafts

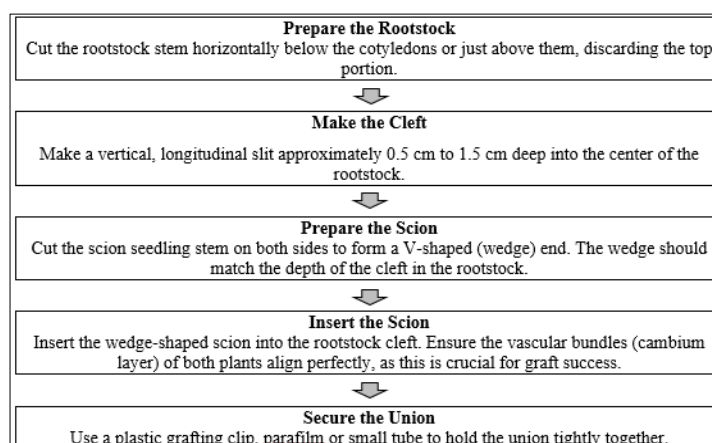


Fig 2: Step-by-Step procedure for cleft grafting in brinjal using konkani prabha rootstock

Result and Discussion

1. Temperature and relative humidity inside the chamber

The data presented in Table revealed variation in temperature as well as humidity inside the designed chamber for acclimatization of tomato grafts. It was recorded daily from the day of grafting up to 15 DAG at

7:30 am, 2:30 pm, and 6:00 pm. The temperature ranges morning hours (7.30 am) the temperature in grafting chamber was in the range of 12.5 °C to 16.5 °C during the 15 day period. The afternoon temperature (2:30 pm) was 21.1 to 31.7 °C whereas, evening temperature (6.00 pm) was in the range of 22.4 to 25.6 °C.

Table 3: Daily temperature and relative humidity recorded at morning, afternoon, and evening intervals for 15 days

Days	Morning (7:30 AM)		Afternoon (2:30 PM)		Evening (6:00 PM)		Average (Temp.)	Mini (Temp.)
	Temp. (°C)	RH (%)	Temp (°C)	RH (%)	Temp. (°C)	RH (%)		
Day 1	14.2	82.6	30.1	72.8	22.6	74.5	22.03	15.6
Day 2	12.6	94.3	29.2	79.3	22.4	78.3	21.24	12.4
Day 3	13.1	94.7	30.4	79.1	23.5	79.4	22.33	12.8
Day 4	13.9	94.5	29.8	85.8	23.3	78.1	22.33	14.2
Day 5	13.5	95.0	28.0	88.8	23.4	93.4	21.63	13.3
Day 6	16.5	97.4	28.6	85.1	25.6	83.8	23.56	16.4
Day 7	14.9	95.9	31.7	80.3	25.2	84.8	23.93	14.8
Day 8	13.3	89.6	23.3	81.7	25.0	61.7	20.53	13.2
Day 9	12.5	88.0	20.1	83.6	25.5	52.9	20.23	12.4
Day 10	13.6	86.1	23.5	82.6	24.4	52.0	20.50	13.2
Day 11	13.0	85.0	24.2	84.6	25.0	52.0	20.73	12.9
Day 12	13.4	85.3	23.5	83.6	24.6	53.3	20.50	12.6
Day 13	12.6	86.2	24.6	83.2	24.9	52.8	20.70	13.3
Day 14	13.5	85.2	20.3	88.5	23.9	51.9	19.23	12.1
Day 15	13.2	84.6	23.3	83.0	25.4	52.8	20.63	13.5

The optimum temperature range for grafted tomato to healing is between 21 and 22 °C, with a maximum range of 28 to 29 °C which also helped to keep the appropriate humidity levels and provided the optimum growth condition required for healing of grafts.

The key environmental factor for a successful graft union is humidity. It should be maintained in the range of 85-95%. In this study, relative humidity was measured daily at 7:30 am, 2:30 pm and 6:00 pm throughout the healing period, from the day of grafting up to 15 DAG.

The relative humidity inside the healing chamber showed variation across different times of the day till 15-day period. RH was recorded at 7:30 am, 2:30 pm, and 6:00 pm daily.

The morning relative humidity (7:30 AM), ranged from 82.6-97.4% (peak 97.4% on Day 6). The afternoon RH inside the chamber was 79.1-88.8% and evening 51.9-

93.4%. Average RH was 82.30-92.40% during 0-7 DAG and 73.47-77.67% during 8-15 DAG.

The temperature and relative humidity inside the healing chamber showed variation across different times of the day over the 15-day period. The temperature peaked in the afternoon due to maximum outside solar radiation, heat entrapment inside polycarbonate sheet and MS pipe structure and low air circulation as chamber was covered with polythene to maintain humidity. This was a normal greenhouse effect. In Konkan region, rabi season nights was cool (12-16 °C). Due to radioactive cooling at night and no fogging operation in early morning, the lowest temperature is recorded at 7:30 am. Evening temperature (22.4-25.6 °C) was lower than afternoon because solar intensity decreases after 3 pm, fogging and misting was done, which causes evaporative cooling.

2. Per cent survival on 7 days and at 21 days of brinjal grafts in grafting chamber

Table 4: Effect of different rootstock-scion combinations on graft survival at 7 and 21 days

Sr. No.	Treatment (Rootstock + scion)	Per cent survival on 7 days	Final survival at 21 days
1	T ₁ : Grafts of Harsh on Konkan Prabha	99.29	97.00
2	T ₂ : Grafts of Trivani on Konkan Prabha	100.00	100.00
3	T ₃ : Grafts of Janak on Konkan Prabha	100.00	100.00
	Range	99.29-100.00	97-100.00
	Mean	99.76	100.00
	Result	SIG	SIG
	S.E.m ±	0.37	0.37
	CD@5%	1.16	1.16

The data related to survival percentage after removal of grafts from the healing chamber and during acclimatization are presented Table. The data revealed that the survival rate declined between 7 DAG and 21 DAG throughout the acclimatization and healing phase.

On 7th DAG, graft survival was significantly affected in various treatments. (100.00%) was recorded in T₂ - Grafts of

Trivani on Konkan Prabha and T₃ - Grafts of Janak on Konkan Prabha was significantly superior, T₁ - Grafts of Harsh on Konkan Prabha recorded 99.29% survival. Thus overall survival on 7th day ranged from 100.00 to 99.29%.

Final survival percentage after 21 DAG also differed significantly among treatments. The highest final survival was recorded in T₂ - Grafts of Trivani on Konkan Prabha

and T₃ - Grafts of Janak on Konkan Prabha was significantly superior, T₁ - Grafts of Harsh on Konkan Prabha recorded 97% final survival. Thus overall survival on 21th day ranged from 100.00 to 97%.

Thus, all graft combinations exhibited high days after grafting. The high survival percentage on 7th day can be attributed to existence of high relative humidity.

Which later declined subsequently up to 21 DAG. Which resulted in decline in survival percentage of the vegetable grafts. Hardening of grafts by gradual lowering the humidity is important step in hardening the grafts. The difference in the survival percentage recorded in various treatments can be attributed to scion stock availability in respective combination.

3. Per cent survival on 7 days and at 21 days in brinjal grafts in grafting chamber

Table 5: Effect of different rootstock-scion combinations on sprouting and graft union formation in days

Sr. No.	Treatment (Rootstock + scion)	Days required for sprouting after grafting	Days required for graft union
1	T ₁ : Grafts of Harsh on Konkan Prabha	4.47	3.90
2	T ₂ : Grafts of Trivani on Konkan Prabha	3.81	3.42
3	T ₃ : Grafts of Janak on Konkan Prabha	4.57	4.07
	Range	3.81-4.57	3.42-4.07
	Mean	4.28	3.79
	Result	SIG	SIG
	S.E.m ±	0.10	0.14
	CD@5%	0.30	0.43

The data presenting to days required for sprouting and graft union after grafting in brinjal are presented in the Table.

The present investigation indicated that scion selection had a significant effect on healing and early establishment of brinjal grafts on 'Konkan Prabha' rootstock. Grafts of Trivani on Konkan Prabha showed the fastest sprouting and earliest graft union at 3.81 days and 3.42 days respectively. In contrast, grafts of Janak on Konkan Prabha took maximum days for both sprouting 4.57 days and graft union 4.07 days.

The data revealed that, the earliest sprouting was observed in T₂ - Grafts of Trivani on Konkan Prabha with 3.81 days. Which was at par with T₁ - Grafts of Harsh on Konkan Prabha with 4.47 days. The maximum time for sprouting was observed in T₃ - Grafts of Janak on Konkan Prabha with 4.57 days. The overall mean value for sprouting was 4.28 days with a range of 3.81 to 4.57 days. The difference among treatments was found to be statistically significant.

Days required for graft union also varied significantly the minimum time was recorded in T₂ - Grafts of Trivani on Konkan Prabha with 3.42 days. Which was at par with T₁ - Grafts of Harsh on Konkan Prabha with 3.90 days. The maximum days required for graft union was recorded in T₃ - Grafts of Janak on Konkan Prabha with 4.07 days. The overall mean value for graft union was 3.79 days with a range of 3.42 to 4.07 days.

The present study indicated that the choice of rootstock had a significant effect on early healing and establishment of brinjal grafts. Grafts of Trivani on Konkan Prabha (T₂) exhibited the fastest sprouting at 3.81 days, while Grafts of Harsh on Konkan Prabha (T₁) formed graft union earliest at 4.47 days. In contrast, Grafts of Janak on Konkan Prabha (T₃) took maximum time for sprouting at 4.57 days. The variation in time and percentage in healing and graft union may be because of degree of compatibility between rootstock and scion.

4. Girth at graft union at transplanting in brinjal grafts

Table 6: Effect of different rootstock-scion combinations on girth at graft union

Sr. No.	Treatment (Rootstock + scion)	Girth at graft union (mm)
1	T ₁ : Grafts of Harsh on Konkan Prabha	4.44
2	T ₂ : Grafts of Trivani on Konkan Prabha	3.55
3	T ₃ : Grafts of Janak on Konkan Prabha	6.04
	Range	3.55-6.04
	Mean	4.68
	Result	SIG
	S.E.m ±	0.37
	CD@5%	1.16

The data presenting to girth at graft union in different brinjal grafts are presented in the Table.

Significant differences were observed among the treatments for girth at the graft union at the time of transplanting. The maximum girth at graft union was recorded in T₃ - Grafts of Janak on Konkan Prabha (6.04mm), which was at par with T₁ - Grafts of Harsh on Konkan Prabha (4.44 mm). The minimum girth was recorded in T₂ - Grafts of Trivani on Konkan Prabha (3.55 mm), the overall girth at graft union ranged between 3.55 mm to 6.04 mm.

The results indicated that girth at graft union varied significantly among different graft combinations. The consistent graft girth in all the treatments indicated that the acclimatization and healing of graft union was consistent in all the treatments indicating the successful translocation of water and nutrients through union. Higher girth at the graft union suggests better compatibility and vascular connection between rootstock and scion, which is important for successful graft establishment in brinjal.

Conclusion

- The following conditions of healing designed chamber was found suitable for healing of brinjal grafts. Average temperature range of healing chamber 19.23 °C-23.93 °C
Relative humidity more than 80% for first 7 days.
- The highest survival percentage in brinjal T₂ - Trivani on Konkan Prabha and T₃ - Janak on Konkan Prabha recorded 100% survival at 21 days. However, T₂ - Grafts of Trivani on Konkan prabha observed early sprouting and graft union after grafting in the healing designed chamber.
- Rootstock-scion compatibility significantly influences graft success and establishment.

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