Effect of different grafting time and growing conditions on success of wedge grafting in custard apple (*Annona squamosa* L.) cv. Sindhan

Abstract

The present investigation evaluated the effect of six grafting times and three growing conditions on the success of wedge grafting in custard apple *cv.* Sindhan. Conducted from February to July 2024 at the College of Horticulture, Jagudan, the experiment followed a factorial CRD with 18 treatment combinations and three replications. Grafting was done at 15-day intervals from late February to early May under shade net, naturally ventilated polyhouse and fan and pad polyhouse conditions. Under grafting time, 3rd week of March (T_3) was showed best grafting time, with fastest sprouting (11.53 days), highest sprouting (90.56%), better growth (more leaves, longer and thicker scions) at 45 and 90 DAG and highest graft survival (90.56%) at 90 days after grafting. Among the growing conditions, naturally ventilated polyhouse (G_2) gave better results with faster sprouting (14.82 days), higher sprouting (76.11%), higher growth at 45 and 90 DAG and 76.11% graft survival at 90 DAG. The best combination was T_3G_2 (3rd week of March in naturally ventilated), showing fastest sprouting (10 days), highest sprouting (93.33%), best growth and highest graft survival (93.33%) at 90 DAG. Based on results obtained from present investigation, it can be concluded that wedge grafting done at 3rd week of March in naturally ventilated polyhouse recorded better growth and higher graft survival per cent.

Keyword: Wedge grafting, custard apple, growing conditions, time of grafting

Introduction

Custard apple (*Annona squamosa* L.), an important dryland fruit crop of India, belongs to the family Annonaceae which comprises about 40 genera and 120 species of which only five are edible. Native to the tropical regions of the Americas, including the West Indies and South America, it is widely cultivated in India across Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Tamil Nadu, Gujarat and Odisha, covering 51.73 thousand hectares with a production of 548.27 thousand tonnes (Anon., 2023). In Gujarat, Bhavnagar district leads cultivation with 7,900 hectares producing 79.56 thousand tonnes annually. Custard apple is

often called the “poor man’s fruit” due to its ability to thrive under marginal, low-fertility soils and its adaptability to diverse conditions. Despite its economic and nutritional importance, large-scale expansion is constrained by the lack of quality planting materials and non-uniform propagation methods. Seed propagation, though common, is unsuitable as the crop is highly heterozygous, leading to loss of varietal traits and non-uniformity. Vegetative propagation through wedge grafting is considered reliable as it ensures true-to-type plants, faster establishment and better survival. However, graft success depends greatly on seasonal and climatic factors. Protected structures such as shade nets, fan-and-pad polyhouses and naturally ventilated polyhouses are used to improve grafting success. Naturally ventilated polyhouses offer significant benefits by passively controlling temperature and humidity, which reduces plant stress and enhances graft survival rates. The timing of grafting also plays a crucial role; Chauvatia and Singh (1999) reported that March to May is favorable in South Gujarat, but specific recommendations are required for North Gujarat due to different climatic conditions. Hence, standardizing the ideal grafting period under local conditions is vital for mass multiplication of elite genotypes, ensuring timely supply of quality planting material and enhancing the overall productivity of custard apple in the region

Materials and methods

The study followed a Factorial Completely Randomized Design (FCRD), comprising 18 treatment combinations with three repetitions. The custard apple variety ‘Sindhan’ was used and the treatments were based on different grafting timings and environmental growing conditions: T_1 – 3rd week of February, T_2 – 1st week of March, T_3 – 3rd week of March, T_4 – 1st week of April, T_5 – 3rd week of April and T_6 – 1st week of May. Each treatment included 20 plants per replication, totaling 1080 plants in the experiment. Grafting was performed using polythene bags filled with a potting mixture made of farmyard manure, vermiculite and soil in equal proportions (1:1:1 v/v/v). The grafted plants were maintained under three types of growing environments: shade net (G_1), naturally ventilated polyhouse (G_2) and fan-and-pad polyhouse (G_3). Irrigation was provided manually and appropriate plant protection measures were undertaken as needed. For grafting, uniform-length, healthy scions with pencil-thick stems were selected. These scion sticks were taken from mature, current-year terminal shoots of the mother plants of the ‘Sindhan’ variety and were defoliated 10 days prior to grafting. Wedge grafting was conducted at 15-day intervals according to the treatment schedule. Observations were recorded at 30, 45 and 90 days after grafting to assess graft success. The survival percentage (%) was calculated using the standard formula.

$$\text{Survival percentage} = \frac{\text{Total number of grafts success}}{\text{Total number of grafts prepared}} \times 100$$

Table 1: Treatment combinations details

The experiment involved a series of treatment combinations, outlined in the details below.

Sr. No.	Notation	Treatment combinations
1.	T_1G_1	3rd week of February and Shade net
2.	T_2G_1	1st week of March and Shade net
3.	T_3G_1	3rd week of March and Shade net
4.	T_4G_1	1st week of April and Shade net
5.	T_5G_1	3rd week of April and Shade net
6.	T_6G_1	1st week of May and Shade net
7.	T_1G_2	3rd week of February and Naturally ventilated polyhouse
8.	T_2G_2	1st week of March and Naturally ventilated polyhouse
9.	T_3G_2	3rd week of March and Naturally ventilated polyhouse
10.	T_4G_2	1st week of April and Naturally ventilated polyhouse
11.	T_5G_2	3rd week of April and Naturally ventilated polyhouse
12.	T_6G_2	1st week of May and Naturally ventilated polyhouse
13.	T_1G_3	3rd week of February and Fan and Pad polyhouse
14.	T_2G_3	1st week of March and Fan and Pad polyhouse
15.	T_3G_3	3rd week of March and Fan and Pad polyhouse
16.	T_4G_3	1st week of April and Fan and Pad polyhouse
17.	T_5G_3	3rd week of April and Fan and Pad polyhouse
18.	T_6G_3	1st week of May and Fan and Pad polyhouse

Results and discussion

Days taken for sprouting of grafts

The data in table 2 shows that, grafting time significantly influenced sprouting, with the earliest (11.53 days) recorded in the 3rd week of March (T_3) and the maximum (23.04 days) in the 1st week of May (T_6). Similar findings were reported in custard apple by Panchal *et al.* (2022) and Chauvatia and Singh (1999). Among environments, the naturally ventilated polyhouse (G_2) showed the least sprouting period (14.82 days), whereas the fan-and-pad polyhouse recorded the maximum (17.78 days). The interaction was significant, as grafting in the 3rd week of March under a naturally ventilated polyhouse (T_3G_2) resulted in the fastest sprouting (10.00 days). This could be due to optimum temperature and humidity promoting better cambial union and assimilate translocation, corroborating earlier reports in mango (Sivudu *et al.,* 2014), sapota (Ashutosh *et al.,* 2020) and ber (Sonia *et al.,* 2022).

Sprouted grafts (%) at 30 DAG

At 30 days after grafting (DAG), the maximum sprouting (90.56%) was recorded in the 3rd week of March (T_3), while the minimum (48.89%) was observed in the 1st week of May (T_6)

(Table 2), owing to favorable temperature and humidity enhancing graft union healing (Nithya *et al.,* 2022). Similar reports were made by Gotur *et al.* (2017) and Kholia *et al.* (2022) in guava. Among environments, the naturally ventilated polyhouse (G_2) recorded the highest sprouting (76.11%) compared to shade net (65.00%), as also reported by Kumar (2022) in guava and Mithapara *et al.* (2020) in sapota. The interaction effect was significant, with T_3G_2 showing the highest sprouting (93.33%). These results align with Beer *et al.* (2013), highlighting March as the most favorable period for successful graft sprouting.

Number of fully opened leaves at 45 and 90 DAG

The number of fully opened leaves was maximum in grafts prepared during the 3rd week of March (T_3) (14.73 at 45 DAG and 20.07 at 90 DAG) and minimum in the 1st week of May (T_6) (7.44 and 11.20 at 45 and 90 DAG, respectively) (Table 2), due to unfavorable temperature and humidity affecting callus differentiation and assimilate transport (Bhandari *et al.,* 2021; Panchal *et al.,* 2022). Among environments, the naturally ventilated polyhouse (G_2) produced the highest leaf count at 45 DAG and 90 DAG (13.10 and 17.87, respectively), while the fan-and-pad polyhouse (G_3) recorded the lowest (10.06 and 13.81 at 45 and 90 DAG, respectively) owing to favorable microclimate enhancing photosynthesis and sprout growth (Parmar *et al.,* 2019; Padmapriya *et al.,* 2021). The interaction effect was significant, with T_3G_2 recording the highest leaves at 45 and 90 days after grafting (16.66 and 22.33), supported by auxin activity and favorable conditions promoting meristematic growth (Taiz and Zeiger, 2012; Joshi *et al.,* 2014).

Length of scion (cm) at 45 and 90 DAG

The data in table 3 shows that, scion length was maximum in grafts prepared during the 3rd week of March (T_3) (52.24 cm at 45 DAG and 60.24 cm at 90 DAG), while the minimum was recorded in the 1st week of May (T_6) (42.57 cm and 48.56 cm at 45 and 90 DAG, respectively). Enhanced scion elongation during March–April may be attributed to early sprouting, rapid union formation and favorable temperature and humidity supporting photosynthesis and nutrient transport (Nithya *et al.,* 2022; Chauvatia and Singh, 1999; Sweeti *et al.,* 2016). Among environments, the naturally ventilated polyhouse (G_2) recorded the highest scion length (47.90 and 54.92 cm at 45 and 90 DAG, respectively), whereas the fan-and-pad polyhouse (G_3) showed the lowest (46.04 and 52.94 cm), corroborating the findings of Panchal *et al.* (2022). The interaction effect was significant, with T_3G_2 producing the longest scion (54.53 cm, 61.83 cm at 45 and 90 DAG, respectively) in agreement with earlier reports highlighting the role of favorable microclimate in enhancing scion elongation (Islam *et al.,* 2004; Parmar *et al.,* 2019).

Girth of scion (mm) at 45 and 90 DAG

Scion girth was maximum in grafts prepared during the 3rd week of March (T_3) (8.68 mm at 45 DAG and 10.99 mm at 90 DAG) and minimum in the 1st week of May (T_6) (6.53 and 9.25 mm) (Table 3), due to better sprouting, leaf production and assimilate supply supporting cambial activity (Hiwale *et al.,* 2008; Kamble *et al.,* 2024). Among environments, the naturally ventilated polyhouse (G_2) produced the highest girth (7.86 and 10.33 mm at 45 and 90 DAG, respectively) (Table 3), while the fan-and-pad polyhouse (G_3) and shade net (G_1) recorded lower values, owing to less favorable microclimatic conditions (Teli, 2021; Shinde *et al.,* 2010). The interaction effect was significant, with T_3G_2 recording the highest girth (8.98 mm, 11.51 mm at 45 and 90 DAG, respectively) in agreement with earlier reports that favorable humidity and temperature enhance graft union healing and cambial growth (Mourya *et al.,* 2018; Yadav *et al.,* 2019; Kumar *et al.,* 2022)

Graft survival per cent at 90 DAG

Survival percentage was maximum in grafts prepared during the 3rd week of March (T_3) (90.56%) and minimum in the 1st week of May (T_6) (48.89%) (Table 3), owing to favorable climatic conditions and higher carbohydrate reserves enhancing stock–scion union (Majumder *et al.,* 1972; Panchal *et al.,* 2022). Among environments, the naturally ventilated polyhouse (G_2) recorded the highest survival (76.11%) compared to shade net (65.00%) and fan-and-pad (G_3), due to favorable temperature and humidity supporting cambial activity (Nithya *et al.,* 2022; Sonia et al., 2022). The interaction effect was significant, with T_3G_2 producing the maximum survival (93.33%) in line with earlier reports highlighting the role of rapid callus formation and carbohydrate accumulation in graft success (Nithya *et al.,* 2022; Kumar *et al.,* 2020).

Conclusion

Based on results obtained from present investigation, it may be concluded that the 3rd week of March and naturally ventilated polyhouse represents the most suitable period and growing conditions for wedge grafting in custard apple, ensuring improved graft establishment, accelerated growth and higher survival rates thereby offering significant potential for enhancing nursery efficiency and grower profitability.

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Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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Table 2: Effect of grafting time and growing conditions on growth parameters

Treatments	Days taken for sprouting of grafts	Sprouted grafts (%) at 30 DAG	Number of fully opened leaves at 45 DAG	Number of fully opened leaves at 90 DAG
Time of Grafting (T)				
T_1: 3rd week of February	17.29	63.89	11.33	15.04
T_2: 1st week of March	15.22	80.00	13.56	15.69
T_3: 3rd week of March	11.53	90.56	14.73	20.07
T_4: 1st week of April	13.49	72.78	13.47	17.78
T_5: 3rd week of April	19.84	61.67	8.98	13.98
T_6: 1st week of May	23.04	48.89	7.44	11.20
S.Em.	0.33	1.50	0.23	0.30
C.D. at 5%	0.94	4.28	0.64	0.86
Growing Condition (G)				
G_1: Shade net	17.61	65.00	11.60	15.20
G_2: Naturally ventilated polyhouse	14.82	76.11	13.10	17.87
G_3: Fan and pad polyhouse	17.78	67.78	10.06	13.81
S.Em.	0.23	1.06	0.16	0.21
C.D. at 5%	0.66	3.03	0.46	0.61
Interaction (T_3G_2)	10.00	93.33	16.33	22.33
Interaction (T*G)				
S.Em.	0.57	2.61	0.39	0.53
C.D. at 5%	1.62	7.42	1.12	1.50
C.V. %	5.89	6.48	5.83	5.82

Table 3: Effect of grafting time and growing conditions on growth parameters

Treatments	Length of scion (cm) at 45 DAG	Length of scion (cm) at 90 DAG	Girth of scion (mm) at 45 DAG	Girth of scion (mm) at 90 DAG	Graft survival per cent at 90 DAG
Time of Grafting (T)					
T_1: 3rd week of February	43.80	52.05	7.61	9.91	63.89
T_2: 1st week of March	47.19	54.32	7.85	10.12	72.78
T_3: 3rd week of March	52.24	60.24	8.68	10.99	90.56
T_4: 1st week of April	51.17	56.90	7.91	10.06	80.00
T_5: 3rd week of April	42.93	50.45	6.92	9.46	61.67
T_6: 1st week of May	42.57	48.56	6.53	9.25	48.89
S.Em.	0.71	0.70	0.15	0.18	1.50
C.D. at 5%	2.01	2.00	0.43	0.51	4.28
Growing Condition (G)					
G_1: Shade net	46.00	53.40	7.47	9.68	65.00
G_2: Naturally ventilated polyhouse	47.90	54.92	7.86	10.33	76.11
G_3: Fan and pad polyhouse	46.04	52.92	7.42	9.88	67.78
S.Em.	0.50	0.50	0.11	0.13	1.06
C.D. at 5%	1.42	1.42	0.30	0.36	3.03
Interaction (T_3G_2)	54.53	61.83	8.98	11.51	93.33
Interaction (T*G)					
S.Em.	1.22	1.22	0.26	0.31	2.61
C.D. at 5%	3.48	3.47	0.74	0.89	7.42
C.V. %	4.54	3.93	5.93	5.43	6.48