

## Original Research Article

# Studies on Graft Compatibility and the Effect of Grafting on the Growth of Brinjal (*Solanum melongena* L.)

### ABSTRACT

A study was carried out to determine the graft compatibility of brinjal scions (Dhruva and CO 2) with five wild *Solanum* rootstocks and their growth performance in open field ~~condition~~ conditions. ~~Cleft~~ The cleftgrafting method was adopted in this study. The non-grafted plants were used as control under open field ~~condition~~ conditions. *Solanum torvum* recorded less number of days for graft union with Dhruva (10.36) and CO 2 (10.54) followed by *Solanum capsicoides* and *Solanum chrysotrichum*. The results on grafting success at 30 days after grafting revealed that the highest success percentage was observed in Dhruva (83.42%) and CO 2 (82.08%) grafted with *Solanum torvum* rootstock followed by *Solanum capsicoides* and *Solanum chrysotrichum*. The field survival rate was higher in Dhruva (88.75%) and CO 2 (85.20%) grafted onto *Solanum torvum* followed by *Solanum capsicoides* and *Solanum chrysotrichum*. The plant height and number of primary branches per plant were significantly affected by grafting. Dhruva (90.52cm, 9.15) and CO 2 (80.17cm, 7.29) grafted onto *Solanum torvum* recorded maximum plant height and more primary branches per plant respectively followed by *Solanum chrysotrichum*. Though *Solanum capsicoides* performed well throughout the grafting process their growth performance was poor in open-field conditions. Hence *Solanum torvum* and *Solanum chrysotrichum* could be used as compatible rootstock for grafting with brinjal scions.

Keywords: Grafting, rootstock, scion, compatibility, *Solanum*.

### 1. INTRODUCTION

Brinjal (*Solanum melongena* L.,  $2n = 24$ ) belonging to the family Solanaceae is a native crop of India with China as its secondary center of origin (Vorontsova and Knapp, 2012). It is a ~~warm season~~ warm-season crop, adapted to a wide range of climatic conditions ~~of-in~~ the country. Brinjal finds its place as the poor man's vegetable in Indian curries. Furthermore, brinjal is a ~~region-specific~~ region-specific crop where consumer acceptance is based on their preference for color, shape, and taste suited for their specific locality (Chinthaguntiet *al.*, 2018).

In India, the major ~~constraints~~ constraint in brinjal production is their susceptible nature to ~~soil-borne~~ soil-borne diseases, ~~pest-pests~~ and nematodes which results in heavy yield loss. With few resistant varieties and ~~region-specific~~ region-specific preference nature by a consumer, grafting has become an alternate approach in brinjal to mitigate the yield loss. Grafting of brinjal cultivars with perennial and wild Solanaceous species as rootstock, proved to increase the yield and long availability period of the fruits through ratooning (Carmina *et al.*, 2011). Grafting is also highly effective in ameliorating crop losses caused by adverse

environmental conditions (Dietmar *et al.*, 2010). Hence proper selection of rootstock with resistance to biotic and abiotic stress can provide ~~perenniality~~perennially nature along with disease and pest free plants, increased yield and fruit quality. Thus, the aim of this study was to identify the compatible rootstock for grafting with brinjal based on the success percentage of graft combination, field survival rate, and their growth performance in open field ~~condition~~conditions.

## 2. MATERIAL AND METHODS

The experiment was conducted in College Orchard, Department of Vegetable Science, HC & RI, TNAU, Coimbatore during 2021-22. The experimental materials for the present study comprised ~~of~~ five wild *Solanum* species namely *Solanum capsicoides*, *Solanum chrysotrichum*, *Solanum sisymbriifolium*, *Solanum violaceum* and *Solanum torvum* rootstocks and two cultivated brinjal namely Dhruva and CO 2 a cultivar from TNAU were used as scion for grafting.

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### 2.1 GRAFTING

Grafting was performed in the rootstock which attained ~~pencil-size~~pencil-size stem thickness and 35 days old scion seedlings. The grafting method adopted in this experiment was cleft grafting (Pugalendhiet *al.*,2020). Grafting was done under greenhouse ~~condition~~ conditions during morning and evening hours. Immediately after grafting the plants are covered with a 1000 gauge polythene bag and transferred inside the mist chamber to maintain optimum humidity (RH >95%) and temperature (25-30 °C). The plants were kept inside the mist chamber for seven days to form a successful graft ~~union~~union (Fig1). Once the scion started sprouting the polythene cover was removed and the plants were transferred to shade net condition for five to seven days. After acclimatization, the plants were transplanted into the open field. The grafting experiment under ~~the~~ greenhouse followed a Completely Randomized Design (CRD) with three replications. Graft compatibility was assessed in terms of ~~the~~ Number of days taken for graft union and graft success percentage at 15 and 30 days after grafting (DAG). While open field condition followed Randomized Block Design (RBD) with three replications including 10 plants for each replication. The observations *viz.*, field survival rate at 30 days after transplanting (DAT), plant height at 90 days after transplanting (DAT) and No. of primary branches per plant at 90 days after transplanting (DAT) were recorded in open field (Table 1).

### 2.2 STATISTICAL ANALYSIS

The analysis was carried out using the statistical software SPSS v.25; Data were subjected to analysis of variance (ANOVA) at two significant levels (P<0.05 and P<0.01) and critical difference (CD) values ~~were~~ calculated each time.

## 3. RESULTS AND DISCUSSION

The graft compatibility study indicated that grafting Dhruva (10.36) and CO 2 (10.54) grafted onto *Solanum torvum* recorded significantly faster graft union followed by Dhruva (10.95) and CO 2 (11.03) grafted onto *Solanum chrysotrichum* through cleft grafting. These findings were in line with Sherly (2011) and Kumar *et al.*(2017) that *Solanum torvum* recorded a minimum number of days for graft union compared to ~~other rootstock~~another rootstock. Rasool *et al.* (2020) reported that graft union is the key factor for grafting success and further growth of the plant. ~~Graft-~~The graft union is associated with cohesion between rootstock and scion (i.e., callus formation, vascular bundle differentiation, and connectivity at the graft ~~interface~~interface) that insures the balanced development of both scion and rootstock.

(Soltanet *al.*, 2017). Hence the process of graft union and wound healing might be faster in *Solanum torvum* and *Solanum chrysotrichum* than in other species.

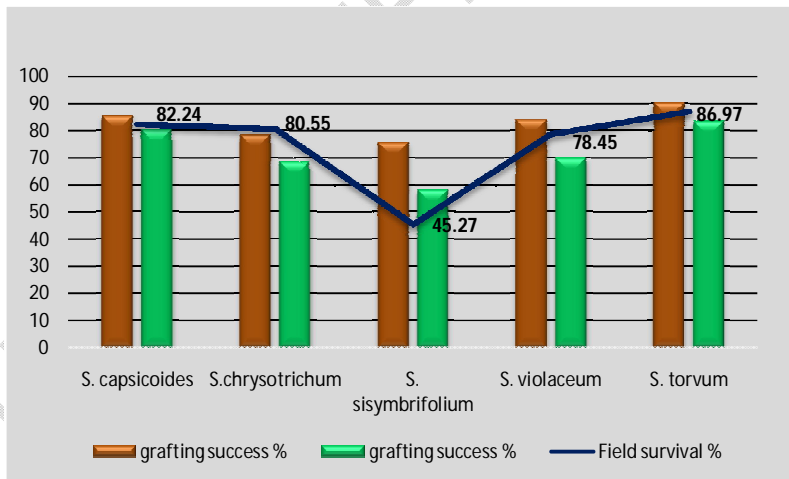


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|----|---------------------|----|---|----|---|
| a. | Rootstock           | d. | Scion preparation                         | g. | Insertion of scion into rootstock                   |
| b. | Scion               | e. | Wedge cut in rootstock                    | h. | Clipping  |
| c. | Beheading rootstock | f. | <del>V-shaped</del> V-shaped cut in scion | i. | Grafted plants in <del>poly</del> <u>polytunnel</u> |

**Figure 1. Steps in cleft grafting**

Dhruva (17.52) and CO 2 (18.36) grafted onto *Solanum sisymbriifolium* recorded maximum number of days for graft union. Similar results reported by Subbaet *al.* (2021) that *Solanum sisymbriifolium* took a maximum number of days for graft union with Bhangor (24.05 days) through cleft grafting method and complete failure of grafts found during 30 DAG. In addition, Pugalendhi *et al.* (2021) reported that TNAU tomato hybrid CO3 and Shivam grafted on *Solanum torvum* took the least number of days for graft union (9.5 days) while *Solanum sisymbriifolium* and *Solanum capsicoides* did not show vascular connection on 21 days of grafting. It took more time for the graft union. Failure in graft union may be due to a lack of cellular recognition, interference in the wounding response, or incompatible toxins which forms distorted unions and eventually leading-lead to graft failure (Wang *et al.*, 2011).

From the table 1, it is evident that Dhruva (90.32%, 83.42%) and CO 2 (89.17%, 82.08%) grafted onto *Solanum torvum* recorded the highest grafting success percentage at 15 DAG and 30 DAG followed by *Solanum capsicoides* with Dhruva (87.43%, 81.62%) and CO2 (85.36%, 79.21%) and *Solanum chrysotrichum* with Dhruva (85.11%, 80.71%) and CO 2 (83.46%, 79.14%) respectively. The success of a graft combination is determined by cell division at the graft union site followed by the formation of a new vascular connection as reported in grafted bitter melon by Tamilselvi and Pugalendhi (2017). Grafting success percentage was recorded the lowest in *Solanum violaceum* when grafted with Dhruva (78.94%, 57.89%) and CO2 (70.83%, 53.12%). This is confirmed by high mortality rate of the plants during the experiment at 15 DAG and 30 DAG.



Comment [A1]: add the units of measure of the y-axis

**Figure 2. Effect of rootstocks on grafting success % in brinjal scions at 15 and 30 days after grafting (DAG) and field survival % at 30 days after transplanting (DAT)**

Table 1. Performance of grafted plants on graft compatibility characters and growth of brinjal plants

Treatments	Days taken for graft union	Grafting success %		Field Survival rate %	Plant height (cm) 90* DAT	No. of primary br/pl 90* DAT
		15* DAG	30* DAG	30* DAT		
CO. 2 grafted on <i>Solanum capsicoides</i>	12.20	85.36 (67.50)	79.21 (62.87)	81.03 (64.18)	32.67	3.50
Dhruva grafted on <i>Solanum capsicoides</i>	11.25	87.43 (69.24)	81.62 (64.61)	83.45 (66.00)	39.17	4.07
CO. 2 grafted on <i>Solanum chrysotrichum</i>	10.95	83.46 (66.01)	79.14 (62.83)	79.43 (63.03)	76.05	7.27
Dhruva grafted on <i>Solanum chrysotrichum</i>	11.03	85.11 (67.30)	80.71 (63.95)	81.67 (64.65)	85.53	8.51
CO. 2 grafted on <i>Solanum sisymbriifolium</i>	18.36	71.87 (57.97)	56.18 (48.55)	38.82 (38.54)	45.54	4.52
Dhruva grafted on <i>Solanum sisymbriifolium</i>	17.52	80.23 (63.60)	63.30 (52.71)	51.73 (45.99)	49.42	4.67
CO. 2 grafted on <i>Solanum violaceum</i>	14.53	70.83 (57.31)	53.12 (46.79)	75.83 (60.55)	73.67	7.05
Dhruva grafted on <i>Solanum violaceum</i>	15.47	78.94 (62.69)	57.89 (49.54)	80.66 (63.91)	81.59	8.19
CO. 2 grafted on <i>Solanum torvum</i>	10.54	89.17 (70.79)	82.08 (64.96)	85.20 (67.38)	80.17	7.29
Dhruva grafted on <i>Solanum torvum</i>	10.36	90.32 (71.87)	83.42 (65.97)	88.75 (70.41)	90.52	9.15
CO 2	-	-	-	-	73.22	6.51
Dhruva	-	-	-	-	81.18	8.04
Mean	13.22	65.43	58.28	60.46	67.29	6.56
S. Ed	0.87	0.78	0.67	0.62	1.47	0.61
CD (P=0.05)	1.81	1.63	1.41	1.31	3.05	1.26

DAG – Days after grafting; DAT – Days after transplanting

\*Mean of three replications.

(Figures in parentheses are arc sine transformed values)

Among the five rootstocks used for grafting, Dhruva (88.75%) and CO 2 (85.20%) grafted onto *Solanum torvum* recorded the highest survival rate under open field ~~condition~~ ~~conditions~~ followed by Dhruva (83.45%) and CO 2 (81.03%) grafted onto *Solanum capsicoides* and Dhruva (81.67%) and CO 2 (79.43%) grafted onto *Solanum chrysotrichum*. ~~Significantly A significantly~~ lower survival rate was observed in Dhruva (51.73%) and CO 2 (38.82%) grafted onto *Solanum sisymbriifolium* as shown in Fig 2. (~~average~~ ~~Average~~ on ~~the~~ performance of rootstock). The findings were in line with Sherly (2011) that *Solanum torvum* grafted onto COBH 2 recorded ~~a~~ high survival rate and robust growth of the plant in ~~the~~ open field and Dhivya (2013) when *Solanum torvum* grafted on tomato recorded better growth and survival followed by *Solanum incanum*. The establishment of ~~a~~ wound repair mechanism between scion and rootstock might have contributed ~~in-to~~ recording ~~a~~ high survival rate after transplanting.

While Tamilselvi (2013) reported that ~~a~~ lower survival rate might be caused by anatomical mismatching, resulting in ~~the~~ misalignment of cambial regions of rootstock and scion. This misalignment led to tissue death in the wounded areas of the rootstock, scion, and subsequent scion death. Similar findings by Mahbou *et al.* (2022); Surve *et al.* (2020) reported that, despite ~~of~~ the high graft success percentage at the nursery level, lower survival rate in open field ~~condition-conditions~~ might be due to ~~the~~ availability of more congenial conditions in the establishment of seedlings/grfts under nursery conditions.

The mean performance of plants ~~are-is~~ considered ~~as~~ the key ~~parameters-parameter~~ to assess the potential of different graft combinations under open field ~~condition-conditions~~. The morphological parameters especially plant height and number of primary branches per plant were substantially better for most of the grafted combinations than ~~for~~ non-grafted control as shown in Table 1. Vigorous plant growth ~~was~~ observed in most of the grafts, as reflected in maximum plant height and more no. of primary branches per plant than non-grafted plants. This could be attributed ~~by-to~~ larger and ~~more~~ vigorous root growth of the rootstock which ensured better plant height and vigorous growth through ~~the~~ absorption of optimal ~~level~~ ~~levels~~ of water and nutrients (Musa *et al.*, 2020).

The maximum plant height was recorded in Dhruva (90.52cm) and CO 2 (80.17cm) grafted onto *Solanum torvum* followed by *Solanum chrysotrichum* with Dhruva (85.53cm) and CO2 (76.05cm) and *Solanum violaceum* with Dhruva (81.59cm) and CO 2 (73.67cm). Though grafting success percentage and survival rate was higher in *Solanum capsicoides*, it recorded poor growth in open field condition. This might be due to the morphology of the rootstock which grows only 0.50-1m in height (herbaceous shrub) (Dharman and Anilkumar, 2018). The result showed that ~~the vigour-vigor~~ of the rootstock is essential in conferring scion ~~vigourvigor~~. Gisbert *et al.* (2011) reported that ~~a~~ vigorous root system of the rootstock enhances the ability to absorb water and nutrients compared to ~~the~~ non-grafted plants while serving as a better supplier of endogenous plant hormones.

Similarly, Dhruva (9.15) and CO 2 (7.29) grafted onto *Solanum torvum* recorded ~~a~~ higher number of primary branches per plant followed by *Solanum chrysotrichum* with Dhruva (8.51) and CO2 (7.27) and *Solanum violaceum* with Dhruva (8.19) and CO 2 (7.05). The effect of rootstock on the mineral content in the aerial portion of the plant may be related to the physical properties of the root system, such as lateral and vertical development. This may lead to improved uptake ~~of water of water~~ and minerals, thereby resulting in a greater number of branches in grafted plants (Khahet *et al.*, 2011). While ~~the~~ number of primary branches per plant was lower in Dhruva (4.07) and CO 2 (3.50) grafted onto *Solanum capsicoides*. Sherly (2011) reported that brinjal grafted onto *Solanum torvum* exhibited maximum plant growth than non-grafted plants. Similar findings were reported by Dhivya (2013) and Bharathi *et al.*, (2021) when ~~the~~ tomato was grafted to *Solanum torvum*.

Though *Solanum violaceum* performed well under open field condition with low grafting success percentage Dhivya *et al.* (2016) reported that this species is highly susceptible to ~~root-knot~~ nematode infestation. Hence this species can be narrowly used in areas where ~~root-knot~~ nematode infestation is devoid. Whereas *Solanum torvum* is highly resistant to ~~root-knot~~ nematode and exhibited a high grafting success percentage with field survival capacity.

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Grafting is a horticultural technique in which a scion (a plant with desirable traits) is attached to a rootstock (a plant with strong roots). This technique is often used in the production of vegetables as it allows for the transfer of specific traits from the scion to the rootstock, resulting in a plant with improved growth and yields. However, the success of grafting depends on a variety of factors, which can influence the success of the graft and the overall growth of the grafted vegetable.

One of the main factors that influence the success of grafting is the genetic compatibility between the rootstock and the scion. The rootstock must be able to provide the scion with the necessary nutrients and water, while the scion must be able to thrive on the rootstock. If the rootstock and scion are not genetically compatible, the graft may fail, or the grafted plant may be weak and prone to disease. Another important factor is the climate in which the grafted vegetable is grown. Different vegetables have different climatic requirements, and it is important to ensure that the grafted plant is grown in conditions that are suitable for its growth (Olivares *et al.*, 2016; Olivares & Hernandez, 2019b; Olivares *et al.* 2020). Factors such as temperature, sunlight, and humidity can all influence the success of the graft and the overall growth of the vegetable.

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The quality of the soil is also a crucial factor in the success of grafting and the growth of vegetables. Soil that is well-draining and has the right balance of nutrients is essential for healthy plant growth. Inadequate soil quality can lead to poor growth and reduced yields (Olivares & Hernandez, 2019a; Olivares *et al.* 2021; Olivares *et al.* 2022a). Proper watering is also important for the growth of grafted vegetables (Olivares & Lopez, 2019). Overwatering can lead to root rot, while underwatering can cause plants to wilt and become stressed. It is important to find the right balance and provide the grafted vegetable with the appropriate amount of water. Pest and disease management is another key factor that can impact the success of grafting and the growth of vegetables. Pests and diseases can cause serious damage to vegetables and significantly impact their growth (Bertorelli & Olivares, 2020). Proper pest and disease management is important to ensure a healthy and productive crop (Olivares *et al.* 2022b).

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Finally, proper fertilization is important for the growth of grafted vegetables (Olivares *et al.* 2019). Adding the right nutrients to the soil can help plants grow strong and produce high yields. It is important to choose the appropriate fertilizers and apply them at the right time and in the right amount to ensure optimal growth (Olivares, 2016).

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In conclusion, the success of grafting and the growth of vegetables is influenced by a variety of factors, including genetic compatibility, climate (Olivares *et al.* 2016; Casana & Olivares, 2020), soil quality (Olivares & Hernandez, 2020), watering, pest and disease management, and fertilization (Olivares *et al.* 2018a; 2018b). Understanding and managing these factors can help ensure the success of the graft and the overall growth of the grafted vegetable.

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#### 4. CONCLUSION

Grafting of CO 2 and Dhruva with five wild *Solanum* rootstocks revealed that *Solanum torvum* exhibited ~~less fewer~~ no. of days for graft union, higher graft success percentage, field survival rate, plant height, and no. of primary branches per plant. Though *Solanum capsicoides* recorded a higher graft success percentage and field survival rate than *Solanum chrysotrichum*, ~~it—they~~ exhibited poor growth performance in open field ~~condition~~ conditions. Finally, the result of the study indicated that *Solanum torvum* and *Solanum chrysotrichum* can be the most compatible rootstock for brinjal grafting. The study can be extended to anatomical and biochemical changes in the grafting and translocation of molecules through graft union in a precise way.

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