

Original Research Article

Studies on Graft Compatibility and Effect of Grafting on 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. Cleft grafting method was adopted in this study. The non-grafted plants were used as control under open field condition. *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 number of primary branches per plant respectively followed by *Solanum chrysotrichum*. Though *Solanum capsicoides* performed well throughout grafting process their growth performance was poor in open field condition. 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 crop, adapted to a wide range of climatic conditions of the country. Brinjal finds its place as the poor man's vegetable in Indian curries. Furthermore, brinjal is a region specific crop where consumer acceptance is based on their preference for color, shape and taste suited for their specific locality (Chinthagunti *et al.*, 2018).

In India the major constraints in brinjal production is their susceptible nature to soil borne diseases, pest and nematodes which results in heavy yield loss. With few resistant varieties and region specific preference nature by 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 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.

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* as rootstocks and two cultivated brinjal namely Dhruva and CO 2 a cultivar from TNAU were used as scion for grafting.

2.1 GRAFTING

Grafting was performed in the rootstock which attained pencil size stem thickness and 35 days old scion seedlings. The grafting method adopted in this experiment was cleft grafting (Pugalendhi *et al.*, 2020). Grafting was done under greenhouse condition during morning and evening hours. Immediately after grafting the plants are covered with 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 successful graft union (Fig 1). 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 greenhouse followed Completely Randomized Design (CRD) with three replications. Graft compatibility was assessed in terms of 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 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 minimum number of days for graft union compared to other rootstock. Rasool *et al.* (2020) reported that graft union is the key factor for grafting success and further growth of the plant. Graft union is associated with cohesion between rootstock and scion (i.e., callus formation, vascular bundle differentiation and connectivity at the graft interface) that insures the balanced development of both scion and rootstock. (Soltan *et al.*, 2017). Hence the process of graft union and wound healing might be faster in *Solanum torvum* and *Solanum chrysotrichum* than other species.

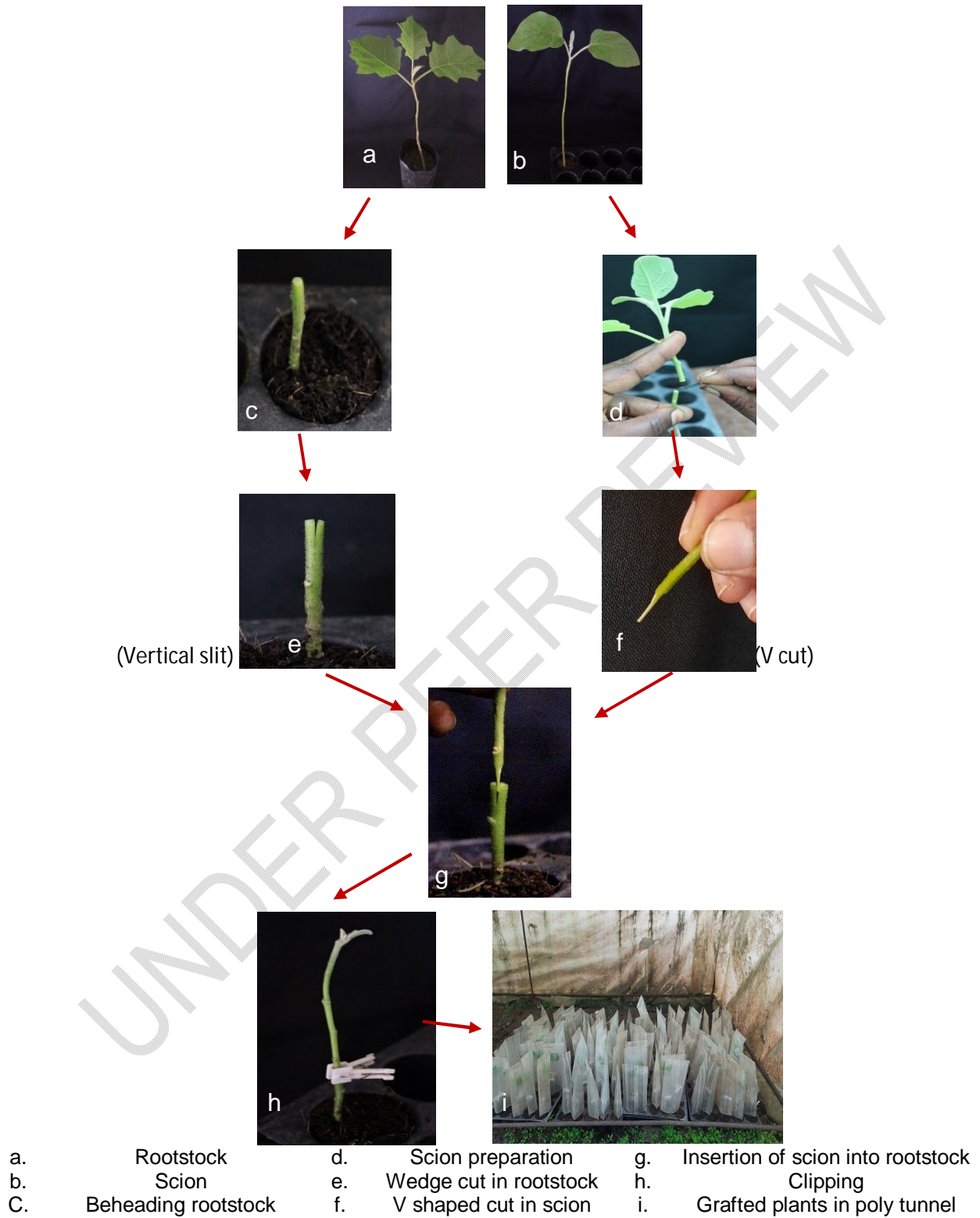


Figure 1. Steps in cleft grafting

Dhruva (17.52) and CO 2 (18.36) grafted onto *Solanum sisymbriifolium* recorded maximum number of days for graft union. Similar results reported by Subba *et al.* (2021) that *Solanum sisymbriifolium* took 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 graft union. Failure in graft union may be due to lack of cellular recognition, interference in the wounding response or incompatible toxins which forms distorted unions and eventually leading to graft failure (Wang *et al.*, 2011).

From the table 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 formation of 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.

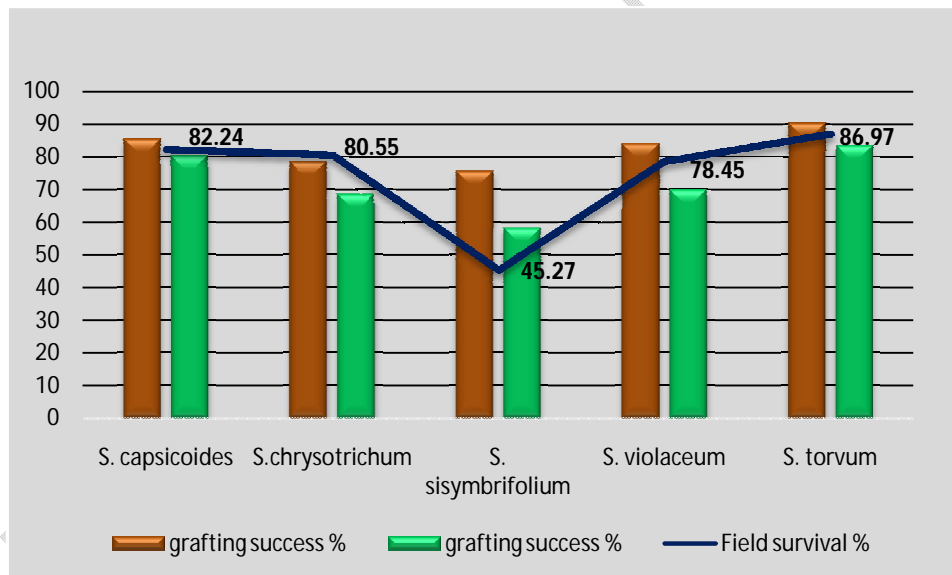


Figure 2. Effect of rootstocks on grafting success % in brinjal scions at 15 and 30 days after grafting (DAG) and field survival % at 30 days after transplanting (DAT)

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 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 lower survival rate was observed in Dhruva (51.73%) and CO 2 (38.82%) grafted onto *Solanum sisymbriifolium* as shown in Fig 2. (average on performance of rootstock). The findings were in line with Sherly (2011) that *Solanum torvum* grafted onto COBH 2 recorded high survival rate and robust growth of the plant in open field and Dhivya (2013) when *Solanum torvum* grafted on tomato recorded better growth and survival followed by *Solanum incanum*. The establishment of wound repair mechanism between scion and rootstock might have contributed in recording high survival rate after transplanting.

While Tamilselvi (2013) reported that lower survival rate might be caused by anatomical mismatching, resulting in 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 might be due to availability of more congenial conditions in the establishment of seedlings/grfts under nursery conditions.

The mean performance of plants are considered as the key parameters to assess the potential of different graft combinations under open field condition. The morphological parameters especially plant height and number of primary branches per plant were substantially better for most of the grafted combinations than non-grafted control as shown in Table 1. Vigorous plant growth 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 larger and vigorous root growth of the rootstock which ensured better plant height and vigorous growth through absorption of optimal level 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 vigour of the rootstock is essential in conferring scion vigour. Gisbert *et al.* (2011) reported that 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 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 and minerals, thereby resulting in a greater number of branches in grafted plants (Khah *et al.*, 2011). While 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 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 high grafting success percentage with field survival capacity.

4. CONCLUSION

Grafting of CO 2 and Dhruva with five wild *Solanum* rootstocks revealed that *Solanum torvum* exhibited less 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 higher graft success percentage and field survival rate than *Solanum chrysotrichum*, it exhibited poor growth performance in open field condition. 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 grafting and translocation of molecules through graft union in a precise way.

REFERENCES

- Aloni B, Cohen R., Karni L, Aktas HAKAN, Edelstein M. Hormonal signaling in rootstock–scion interactions. *Scientia Horticulturae*, 2010:127(2):119-126.
- Bletsos FA. Grafting and calcium cyanamide as alternatives to methyl bromide for greenhouse eggplant production. *Scientia Horticulturae*, 2006: 107(4):325-331.
- Carmina G, Prohens J, Raigón MD, Stommel JR, Nuez F. Eggplant relatives as sources of variation for developing new rootstocks: Effects of grafting on eggplant yield and fruit apparent quality and composition. *Sci. Hort.* 2011; 128:14-22.
- Chinthagunti H, Sarnaik DA, Sharma D. Evaluation of brinjal (*Solanum melongena* L.) genotypes for flowering and yield parameters. *Int. J. Curr. Microbiol. App. Sci.* 2018;**7(12)**: 3101-3105.
- Dharman AK and Anilkumar M. Pharmacognostic studies in *Solanum capsicoides* all. *Journal of Pharmacognosy and Phytochemistry*. 2018:7(4),397-410.
- Dhivya R. Screening studies of wild rootstocks for biotic stresses and its performance on grafting in tomato. Ph. D (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore; 2014.
- Dhivya R, Sadasakthi A, Sivakumar M. Reaction of wild *Solanum* rootstocks & tomato scions against root knot nematode (*Meloidogyne incognita* Kofoid and White). *Ad. Rsrch. J. of Crop. Imp.* 2016;**7(1)**: 10-13.
- Dietmar S, Youssef R, Giuseppe C, Venema JH. Grafting as a tool to improve tolerance of vegetables to abiotic stresses: Thermal stress, water stress and organic pollutants. *Sci. Hort.* 2010:127:162-171
- Gisbert C, Prohens J, Raigón MD, Stommel JR, Nuez F. Eggplant relatives as sources of variation for developing new rootstocks: Effects of grafting on eggplant yield and fruit apparent quality and composition. *Sci. Hort.* 2011:128:14–22

Khah EM. Effect of grafting on growth, performance and yield of aubergine (*Solanum melongena* L.) in greenhouse and open-field. *Int. J. Plant. Prod.* 2011;5: 1735–8043.

Kumar BA, Pandey AK, Raja P, Singh S, Wangchu L. Grafting in Brinjal (*Solanum melongena* L.) for Growth, Yield and Quality Attributes. *Int. J. Bio-Resource & Stress Management.* 2017;8(5): 611-616

Mahbou STG, Ntsomboh-Ntsefong G, Aminatou MF, Lessa FT, Onana GE, Youmbi E. Effect of Grafting on Growth and Shelf Life of Tomatoes (*Solanum lycopersicum* L.) Grafted on Two Local *Solanum* Species. *Advances in Bioscience and Biotechnology.* 2022;13(9):401-418.

Pugalendhi L, Bharathi S, Selvi NT, Devi HUN. Grafting of Tomato with Interspecific Solanaceous Rootstocks: An Approach to Anatomical and Histological Findings. *Recent Progress in Plant and Soil Research.* 2022;5:37-46.

Pugalendhi L, Usha Nandhini Devi H, Karthikeyan G. Biotic and abiotic stress management in vegetable crops through grafting. *International Journal of Chemical Studies* 2020;8(5):2268-2272

Rasool A, Mansoor S, Bhat KM, Hassan GI, Baba TR, Alyemeni MN, Alsahli AA, El-Serehy HA, Paray BA, Ahmad P. Mechanisms underlying graft union formation and rootstock scion interaction in horticultural plants. *Frontiers in Plant Science.* 2020.: 1:590847.

Sherly J. Studies on grafting of brinjal accessions (*Solanum melongena* L.) with wilt *Solanum* rootstocks. Ph. D (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore; 2011.

Soltan M, ElAidy F, Scheerens J, Kleinhenz M. Grafting, scion and rootstock effects on survival rate, vegetative growth and fruit yield of high tunnel-grown grafted pepper (*Capsicum annuum* L.) plants. *Adv. Crop. Sci. Tech.* 2017;5(312):2.

Subba KS, Thapa T, Dukpa P, Tamang A. Characterization of *Solanum* spp for Grafting and its Interpretation on Morphological, Production and Nutritional Quality of Fruit Under Polyhouse. *Int.J.Curr.Microbiol.App.Sci.* 2021;10(10):77-89

Surve NR, Khandekar RG, Parulekar YR, Sanap PB, Joshi MS. Comparative Performance of Brinjal (*Solanum melongena* L.) Grafts under Polyhouse and Open Field Conditions. *Int.J.Curr.Microbiol.App.Sci.* 2020;110:571-584.

Tamilselvi N.A. Grafting studies in bitter gourd (*Momordica charantia* L.). Ph. D (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore; 2014.

Tamilselvi NA, Pugalendhi L. Studies on effect of grafting technique on growth and yield of bitter gourd (*Momordica charantia* L.)” *Journal of Scientific and Industrial Research* 2017;76:654-661.

Vorontsova, M. S., and S.A. Knapp. A new species of *Solanum* (*Solanaceae*) from South Africa related to the cultivated eggplant. *PhytoKeys.* 2012;8:1–11.

Wang, Y. Plant grafting and its application in biological research. *Chinese Sci. Bull.* 2011;56:3511–3517.