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Grafting studies of tomato with wild *Solanum* rootstocks

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Abstract

A grafting study was conducted with three rootstocks viz., *Solanum torvum*, *Solanum sisymbriifolium* and *Solanum capsicoides* and two scion viz., TNAU tomato hybrid CO 3 and Shivam. Among the rootstocks *Solanum capsicoides* took less time to germinate and germination percentage was more in *Solanum sisymbriifolium* both at 15 and 25 days after sowing. Success percentage was more in graft combination of Shivam with *Solanum sisymbriifolium* on 30th and 45th day. The highest plant height was observed in Shivam grafted with *Solanum torvum* rootstock, whereas total number of branches per plant, days to first flowering, per cent fruit set and yield per plant was high in TNAU tomato hybrid CO 3 grafted with *Solanum sisymbriifolium* rootstock. Days to fifty percent flowering and fruit weight was positive in non-grafted Shivam compared to other treatments. Days to first fruit set was observed earlier in non-grafted tomato hybrid CO 3. The combination of TNAU tomato hybrid CO 3 grafted with *Solanum sisymbriifolium* rootstock performed well under field condition for yield and yield contributing characters.

Keywords: Grafting, *Solanum species*, success, performance

Introduction

Tomato is one of the essential vegetables without which, most of the dishes cannot be made. Because of its wide nutritional and therapeutical value (Dorais *et al.*, 2008) [3], it is considered as protective food (Waheed *et al.*, 2020) [20]. Ripen tomato fruits are used in various forms such as salad, ketchup, sauces, paste and puree (Ugonna *et al.*, 2015) [19] while unripe fruits are famous for its use in pickles, through which its notable value can be understood. Tomato being an outstanding crop for its excellent usage and demandable value added products and its cultivation is affected by various biotic and abiotic factors that leads to poor growth and yield loss (Pugalendhi *et al.*, 2019) [13, 16-18]. Developing a new hybrid with all the desirable traits can be done to overcome the problems, but the time taken to develop such a hybrid is also considerable. Hence, grafting can be a better alternative to overcome those hindrances. To obtain successful grafts, it is necessary to observe the days taken for germination, germination percentage of rootstocks and graft success percentage. Hence, the study was undertaken to identify the compatible graft combination and assess the field performance of three wild solanum rootstocks and two tomato scions.

Materials and Methods

The present study was carried out at the Department of Vegetable Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, during the period of 2019 and 2020 to evaluate the success percentage and performance of grafted tomato plants with wild solanum rootstocks. Three wild solanum species viz., *Solanum torvum*, *Solanum sisymbriifolium* and *Solanum capsicoides* were chosen as rootstock to graft with two tomato hybrids viz., TNAU tomato hybrid CO 3 and Shivam. Cleft grafting method was used in this study and the grafting experiment was conducted in Completely Randomized Design (CRD) with three replications.

Seed treatment

Poor seed germination limits the use of different *Solanum* species in the genus as rootstock for grafting. Hence, seed treatment method was followed to get uniform seed germination. The seeds collected from matured fruits were soaked in 100 ppm GA3 using alternate wetting and drying method for 24 hours (Ibrahim *et al.*, 2001) [6]. The treated seeds are sown in 98 celled pro trays and maintained in three replication. Scion were sown after 15 days to attain graftable thickness.

Grafting

Rootstock were taken at 35th day after sowing and transplanted into polybags filled with Soil:

FYM: Sand in the ratio of 3:2:1 to attain graftable size. Rootstocks and scion of equal thickness were taken for grafting at 25 days after transplanting in polybag and cleft grafting method was adopted. Rootstocks were beheaded at the top and a slit of 2.5 cm was made at the centre for the scion to insert. Top portion of scion was taken and a wedge cut of 2.5 cm was made at the bottom portion and inserted into the slit of rootstock. To fix the scion and rootstocks in position, clips were placed at the graft joint and seedlings were kept under mist chamber for 15 days by covering with polythene bag of 1000 gauge thickness. Polythene cover was removed after sprouts appear in the seedlings and hardened by keeping under greenhouse for seven days (Dhivya, 2014; Priyanka *et al.*, 2019)^[2].

Performance of tomato grafted plants under field condition

Transplanting of grafted plants was done after hardening (15 days after grafting). Six graft combinations and their respective scions with three replications were maintained. The grafted plants were planted in the main field and their performance was evaluated. A total of 15 grafts were maintained per treatment per replication. The experiment was laid through Randomized Block Design (RBD). The observations *viz.*, days to germination, germination percentage and success percentage of the rootstocks were recorded and plant height, number of branches per plant, days to first flowering, days to 50% flowering, days to first harvest, fruit number per plant, fruit weight and fruit yield per plant in all the graft combinations and scions were subjected to data analysis.

Statistical analysis

Data on germination percentage, graft success percentage, days taken for graft union, plant height, number of branches, days to first flowering, days to 50% flowering, days to first fruit set, fruit weight, fruit number per plant and fruit yield per plant were found significant when analysed using SPSS software.

Result and Discussion

Germination of rootstocks

Among the three wild solanum species used in the study, *Solanum capsicoides* took less number of days (10.26 days) for germination followed by *Solanum sisymbirifolium* (13.75 days) and *Solanum torvum* took more number of days for germination (14.90 days). *Solanum sisymbirifolium* recorded the highest germination percentage of 78.27 and 90.61 on 15 and 25 days after sowing (DAS) respectively (Table 1), which is similar to the report given by Ibrahim *et al.* (2001)^[6]. *Solanum capsicoides* recorded the least germination percentage (63.87 and 80.22) followed by *Solanum torvum* (65.67 and 85.26).

Table 1: Performance of rootstocks on days to germination and germination percentage

Treatments	Days to germination	Germination percentage (%)	
		15 DAS	25 DAS
<i>Solanum torvum</i>	14.90	65.67	85.26
<i>Solanum Sisymbirifolium</i>	13.75	78.27	90.61
<i>Solanum capsicoides</i>	10.26	63.87	80.22
S. Ed	2.31	2.31	2.81
CD (P=0.05)	6.59	6.59	8.02

Graft success percentage

Different graft combinations were studied for the graft success percentage on 15th, 30th and 45th days after grafting. Among them TNAU tomato hybrid CO 3 grafted with *Solanum torvum* rootstock showed higher percentage of grafting success (91.23) on 15th day after grafting followed by Shivam grafted onto *Solanum torvum* (90.00). But on 30th and 45th Day after grafting, Shivam grafted onto *Solanum sisymbirifolium* showed higher success percentage (88.76 and 86.77) followed by TNAU tomato hybrid CO 3 grafted with *Solanum torvum* (85.67 and 80.91) which indicates both rootstock and scion influences success of grafting. (Dhivya, 2014)^[2] conducted similar study, where tomato plants grafted with *Solanum torvum* as rootstock obtained 90.67 of success at 15 days after grafting. Cell division at the graft union site of scion and rootstock followed by vascular connection causes grafting success in grafted bitter melon (Tamilselvi and Pugalendhi, 2017)^[13, 16-18]. However, TNAU tomato hybrid CO 3 grafted with *Solanum capsicoides* rootstock showed poor performance on graft success percentage (64.12, 60.92 and 59.89) on 15th, 30th and 45th days after grafting respectively (Table 2).

Table 2: Performance of grafted plants on success percentage

Treatments	Success percentage (%)		
	15 DAG	30 DAG	45 DAG
TNAU tomato hybrid CO 3 grafted on to <i>Solanum torvum</i> rootstock	91.23	85.67	80.91
TNAU tomato hybrid CO 3 grafted on to <i>Solanum sisymbirifolium</i> rootstock	71.66	69.85	65.44
TNAU tomato hybrid CO 3 grafted on to <i>Solanum capsicoides</i> rootstock	64.12	60.92	59.89
Shivam grafted on to <i>Solanum torvum</i> rootstock	90.00	88.76	85.77
Shivam grafted on to <i>Solanum Sisymbirifolium</i> rootstock	69.57	64.37	63.00
Shivam grafted on to <i>Solanum capsicoides</i> rootstock	64.23	62.14	61.73
S. Ed	2.12	2.04	1.91
CD (P=0.05)	4.80	4.60	4.41

Performance of grafted plants under field condition vegetative growth

Plant height was more in Shivam grafted onto *Solanum torvum* rootstock (92.43cm) followed by Shivam grafted with *Solanum sisymbirifolium* rootstock (92.35cm) at 90 days after transplanting. Considerable increase in plant height was noticed in most of the grafted plants that is related to the fact that grafted eggplants were vigorous than the non-grafted one (Khah, 2012)^[7, 8]. Also, in relation to the study, positive effects was observed in the plants grafted with *Solanum torvum* and *Solanum sisymbirifolium* rootstocks (Bletsos *et al.*, 2003)^[11]. Lower plant height was recorded in plants of TNAU tomato hybrid CO 3 grafted on to *Solanum capsicoides* rootstock (84.59cm) (Table 3). Increased water and nutrient uptake and vigorous root system in grafted bitter melon plants showed improvement in plant growth (Tamilselvi and Pugalendhi, 2018)^[13, 16-18]. TNAU tomato hybrid CO 3 grafted on to *Solanum sisymbirifolium* rootstock recorded the highest number of branches at 90 days after transplanting (DAT) (19.83) but the lowest number of branches were observed among the grafted plants of Shivam with *Solanum capsicoides* rootstock (13.63) (Table 3). Similarly, when tomato plants were grafted onto

Sunchalo rootstock, increase in number of branches were observed (Hossain *et al.*, 2019) [4].

Flowering

Earliest number of days for first flowering was observed in case of Shivam grafted on to *Solanum sisymbriifolium* rootstock (60.03 days). TNAU tomato hybrid CO 3 grafted on to *Solanum torvum* rootstock took more number of days to start flowering (64.55 days). The non-grafted TNAU tomato hybrid CO 3 took 58.28 days for flowering, which was the earliest among all the treatments (Table 3). Delayed flowering up to seven to ten days was observed in grafted plants which was due to heavy stress caused during graft union process (Tamilselvi and Pugalendhi, 2015) [13, 16-18]. Fifty per cent of flowering was noticed earlier in non-grafted TNAU tomato hybrid CO 3 (66.71 days) followed by non-grafted Shivam plants (67.26 days). TNAU tomato hybrid CO 3 grafted on to *Solanum torvum* took less number of days for 50% flowering (73.37 days) than the other graft combinations (Table 3).

Yield parameters

Fruit set was observed early in non-grafted TNAU tomato hybrid CO 3 (68.73 days) followed by non-grafted Shivam (69.98). Among the grafted plants, Shivam grafted on to *Solanum sisymbriifolium* rootstock showed early fruit set (71.98 days) and delayed fruit set was observed in TNAU tomato hybrid CO 3 grafted on to *Solanum capsicoides* rootstock (75.62 days) (Table 4). Earliness in growth and production might be due to less stress in non-grafted plants (Khah *et al.*, 2006) [7, 8]. Delayed flowering causes delayed fruit set, which is due to stress produced during healing process of the graft union (Dhivya, 2014) [2].

The highest percentage of fruit set (62.39) was recorded in TNAU tomato hybrid CO 3 grafted on to *Solanum sisymbriifolium* followed by 61.97% in Shivam grafted on to

Solanum sisymbriifolium. The least fruit set (52.17%) was observed in non-grafted Shivam (Table 4). Similarly, more water and nutrient uptake in grafted plants and increased fruit set percentage was observed by Rivero *et al.* (2003) [14]. Scion vigour is also enhanced by vigorous root growth which increases hormone production (Zijlstra *et al.*, 1994) [21].

The highest fruit weight (83.68g) was observed in plants of non-grafted Shivam followed by Shivam grafted on to *Solanum sisymbriifolium* rootstock (79.45 g). The lowest (58.54 g) was observed in TNAU tomato hybrid CO 3 grafted on to *Solanum capsicoides* (Table 4). Positive correlation of fruit size with fruit weight might be the reason behind this (Dhivya, 2014) [2]. Contrarily, fruits of non-grafted plants were smaller than the grafted one (Hoyos Echevarría *et al.*, 2010).

Among the grafted combination, number of fruits per plant was more in Shivam grafted on to *Solanum sisymbriifolium* rootstock (112.37) followed by TNAU tomato hybrid CO 3 grafted on to *Solanum sisymbriifolium* rootstock (102.27). The least number of fruits were recorded in Shivam grafted on to *Solanum capsicoides* rootstock (85.34). Among non-grafted plants, TNAU Tomato hybrid CO 3 recorded high number of fruits (70.86) than Shivam (69.00).

Yield was higher in TNAU tomato hybrid CO 3 plants grafted on to *Solanum sisymbriifolium* rootstock (5.73 kg) followed by Shivam grafted on to *Solanum sisymbriifolium* rootstock (5.61 kg). Fruit yield was lower in non-grafted TNAU Tomato hybrid CO 3 (4.51 kg) (Table 4). Yield of grafted plants were high comparing the non-grafted one (Marsic and Osvald, 2004; Tamilselvi and Pugalendhi, 2018) [13, 16-18]. Similar to this enhancement of yield in tomato plants were noticed which might be due to the enhanced vigour of the scion gained through grafting with effective rootstock (Romano and Paratore, 2000; Pogonyi *et al.*, 2005; Milenković *et al.*, 2020) [15].

Table 3: Performance of grafted plants on growth and flowering characters

Treatments	Plant height (cm) at 90 DAT	Total no. of branches/plant at 90 DAT	Days to first flowering	Days to 50% flowering
TNAU tomato hybrid CO 3 grafted on to <i>Solanum torvum</i> rootstock	86.91	19.20	64.55	73.37
TNAU tomato hybrid CO 3 grafted on to <i>Solanum sisymbriifolium</i> rootstock	88.74	19.83	61.22	69.73
TNAU tomato hybrid CO-3 grafted on to <i>Solanum capsicoides</i> rootstock	84.59	17.97	63.45	70.15
Shivam grafted on to <i>Solanum torvum</i> rootstock	92.43	13.97	63.41	71.55
Shivam grafted on to <i>Solanum sisymbriifolium</i> rootstock	92.35	14.90	60.03	67.89
Shivam grafted on to <i>Solanum capsicoides</i> rootstock	87.97	13.63	62.92	68.55
TNAU Tomato hybrid CO 3	88.26	17.10	58.28	66.71
Shivam	89.14	13.75	60.66	67.26
S. Ed	1.20	0.46	1.67	1.88
CD (P=0.05)	2.61	0.99	3.62	4.08

Table 4: Performance of grafted plants on fruiting and yield characters

Treatments	Days to first fruit set	Fruit set percentage (%)	Fruit weight (g)	Number of fruits per plant	Fruit yield per plant (kg)
TNAU tomato hybrid CO 3 grafted on to <i>Solanum torvum</i> rootstock	74.75	59.22	61.65	92.13	5.50
TNAU tomato hybrid CO 3 grafted on to <i>Solanum sisymbriifolium</i> rootstock	72.45	62.39	63.27	102.27	5.73
TNAU tomato hybrid CO 3 grafted on to <i>Solanum capsicoides</i> rootstock	75.62	57.37	58.54	87.18	4.68
Shivam grafted on to <i>Solanum torvum</i> rootstock	74.22	60.09	75.38	98.26	5.54
Shivam grafted on to <i>Solanum sisymbriifolium</i> rootstock	71.98	61.97	79.45	112.37	5.61
Shivam grafted on to <i>Solanum capsicoides</i> rootstock	75.21	59.24	70.66	85.34	4.52
TNAU Tomato hybrid CO 3	68.73	54.78	67.17	70.86	4.51
Shivam	69.98	52.17	83.68	69.00	4.80
S. Ed	1.97	1.45	1.88	2.54	0.14
CD (P=0.05)	4.28	3.14	4.08	5.51	0.31

Conclusion

Among the three different wild rootstocks used, germination percentage was more in *Solanum sisymbriifolium* and it performed well in most of the characters followed by *Solanum torvum*. Both *Solanum sisymbriifolium* and *Solanum torvum* can be used as a rootstock for tomato grafting to improve growth and yield. However, further studies to be carried to analyse the quality and biochemical characters of tomato fruits of grafted and non-grafted plants.

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