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Performance of Tomato (*Solanum lycopersicum* L.) Grafts for Yield and Bacterial Wilt Resistance

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ABSTRACT

Bacterial wilt caused by *Ralstonia solanacearum* is one of the major biotic stress that affects tomato production and reduce the fruit yield and quality. Grafting was done using different public/ private sector determinate/ semi-determinate hybrids as scion onto the wilt resistant brinjal variety "Haritha" as rootstock. The investigation was carried out as two experiments, production of grafts and evaluation in a bacterial wilt infested field. The minimum number of days taken for graft union was observed in Unito and Swaraksha (3.67 days). Grafts of Thenito, Arka Rakshak and Vijay showed maximum grafting success rate (96.71 %) and most of the grafts showed cent per cent field establishment. The highest yield per plant was recorded in the grafts of NS-526 (801.15 g), followed by that of Sivam (770.42 g), Arka Rakshak (748.81 g) and Megha (730.61 g). Cent percent resistance to bacterial wilt disease was observed in all the grafted treatments, while non-grafted control Rasto showed cent per cent wilt incidence.

Keywords Tomato hybrids, Cleft grafting, Bacterial wilt, Rootstock, Scion.

INTRODUCTION

Tomato (*Solanum lycopersium* L.) is one of the most widely grown vegetable crops in the world. It is the most preserved and processed vegetable, grown all over the world from temperate to tropical and subtropical regions. Most of the researches done in tomato during recent years has concentrated on improving yield and quality as well as reducing the impact of stress factors (Kumar *et al.* 2017), both biotic and abiotic stresses, which affect the yield and production of tomato. Abiotic stresses include problems due to drought, flood, salinity, cold, heavy metal contamination, and mineral deficiencies. Problems due to weeds, pests, and soil-borne illnesses are the main biotic issues. Among the biotic factors hampering the production of tomato, bacterial wilt (*Ralstonia solancearum*), root knot nematode (*Meloidogyne incognita*), Fusarium wilt (*Fusarium oxysporum f.sp. lycopersici*) and tomato yellow leaf curl virus are the

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most devastating, which reduce the yield and quality of the fruit drastically. *Ralstonia solanacearum* is the most destructive soil borne pathogen among bacterial pathogens (Smith 1896) which cause severe yield loss in solanaceous vegetables (Yabuuchi *et al*. 1995) as well as in other crops which are grown in tropical, subtropical, and temperate regions of the World (Ghosh and Dutta 2014).

Vegetable grafting provided a solution to minimize or control these biotic and abiotic problems. Grafting of commercial tomato cultivars onto resistant rootstocks could be a potential tool as a rapid alternative to the relatively slow breeding methods to improve tomato cultivation (Ibrahim *et al*. 2014, Flores *et al*. 2010, Khah *et al*. 2006, Turhan *et al*. 2011). Grafting is fusion of plant parts to establish a vascular continuity between them and the process can be natural or deliberate (Pina and Errea 2005), which results in a genetically composite organism, which functions as a single plant (Mudge *et al*. 2009). Grafting of vegetables started in Japan and Korea in the late 1920s. In India, commercial vegetable grafting started after 2000 through different research institutes like IIHR Bangalore, NBPGR Regional Station, Thrissur, Kerala on cucurbits and by some SAUs.

Ralstonia solancearum causes severe destruction in acidic soil compared to alkaline soil. The disease is prevalent in Kerala, the soil being mostly acidic. Hence this study was conducted to assess the performance of tomato grafts for growth, yield and bacterial wilt resistance.

MATERIALS AND METHODS

The present study was conducted at College of Agriculture, Vellayani, during 2020-2021. The experimental site was located at 76º59'14" E longitude and 8º25'56" N latitude at an altitude of 15 m above MSL. The experimental materials used for the study comprised of twenty different tomato hybrid scions and bacterial wilt resistant rootstock of brinjal variety Haritha. Four non-grafted control plants were also used, in which two were bacterial wilt resistant and two were bacterial wilt susceptible varieties of tomato. The details of the treatments used for the study are given in Table 1. The method of grafting adopted was

Table 1. Details of hybrid scions used for grafting.

Sl. No.	Treatment no.	Name of hybrids	Source
1	T1	Thenito	Tropica Seeds Private Limited, Hosur, Tamil Nadu
2	T2	Rasam	East West Seed India Private Limited, Gangapur, Aurangabad
3	T3	INDAM-14301	Indo American Hybrid Seeds, Bangalore
4	T5	Sivam	Acsen HyVeg Private Limited, Coimbatore, Tamil Nadu
5	T6	Ruchi-Gold	Indo American Hybrid Seeds, Bangalore
6	T7	US-505	Ujwal Seeds Private Limited, Sonipat, Haryana
7	T8	Unito	Tropica Seeds Private Limited, Hosur, Tamil Nadu
8	T9	INDAM-1320	Indo American Hybrid Seeds, Bangalore
9	T10	Mahy-701	Maharashtra Hybrid Seeds Company Private Limited, Mumbai
10	T11	COTH3	TNAU, Coimbatore
11	T12	Arka Apeksha	IIHR, Bangalore
12	T13	Lakshmi	Nunhems India Private Limited, Hyderabad
13	T15	Swaraksha	Namdhari Seeds Private Limited, Uragahalli, Karnataka
14	T16	Bhagyawan	Sakata Seed India Private Limited, Bangalore
15	T17	Arka Rakshak	IIHR, Bangalore
16	T18	Mahy-Anagha	Maharashtra Hybrid Seeds Company Private limited, Mumbai
17	T20	NS-526	Namdhari Seeds Private Limited, Uragahalli, Karnataka
18	T21	Megha	Nisco Agritech Private Lmited, Bangalore
19	T23	Momento	Tropica Seeds Private Limited, Hosur, Tamil Nadu
20	T24	Vijay	Nisco Agritech Private Limited, Bangalore
21	T4	Arka Samrat (Resistant control-1)	IIHR, Bangalore
22	T22	Raksha (Resistant control-2)	R.K Seed farms, Delhi

Table 1. Continued.

Sl. No.	Treatment no.	Name of hybrids	Source
23	T14	Rasto (Susceptible control-1)	Tropica Seeds Private Limited, Hosur, Tamil Nadu
24	T19	Naveen (Susceptible control-2)	Indo American Hybrid Seeds, Bangalore

cleft grafting. Seeds were sown in different protrays for grafting, Tomato scions attained graftable size 20-25 days after germination while brinjal rootstock took 30-35 days. In cleft grafting, the stem of rootstock was cut horizontally to remove top portion of the plant and the scion was made into wedge shape by giving a slant cut from sides. Vertical incision was made in the rootstock and the wedge shaped scion was inserted into the slit made on the rootstock and a plastic clip was placed around the graft union to hold it tightly together (Kumar *et al*. 2015).

The grafted plants were immediately transferred to grafting chamber. The plants were kept for 5-7 days for the graft union to heal. After graft union was formed, the plants were transferred to the acclimatization chamber for hardening. Hardened grafts along with non-grafted control plants were transplanted to the main field for evaluation at 60 cm × 60 cm spacing. The crop was grown as per package of practices recommendations of Kerala Agricultural University (KAU 2016). The field selected for evaluation of tomato was bacterial wilt infected sick plot. The seedlings were transplanted in a Randomized Block Design (RBD) with three replications. Observations of grafting experiment and field experiment were taken separately. ANOVA on RBD was computed based on each character separately as per standard statistical procedure (Panse and Sukhatme 1985) and significance was tested based on F test (Snedecor and Cohran 1967).

RESULTS AND DISCUSSION

Performance of tomato grafts for grafting parameters are presented in Table 2. The results showed significant differences among the different grafting treatments for days taken for graft union. Number of days taken for graft union varied from 3.67 days to 5.67 days. The minimum number of days taken for graft union was observed in Unito and Swaraksha (3.67 days) which was statistically on par with INDAM-1320 (4.00 days), INDAM-14301 (4.00 days), Rasam (4.00 days), Ruchi-Gold (4.00 days), Mahy-Anagha (4.33 days), Arka Apeksha (4.33 days), Bhagyawan (4.33 days), COTH3 (4.33 days), Lakshmi (4.33 days), Momento (4.33 days), NS-526 (4.33 days), Sivam (4.33 days), Thenito (4.33 days) and Vijay (4.33 days) while the maximum was in Mahy-701 (5.61 days). Similar results were also observed by Rathod (2017) with a range of 4 to 5 days for graft union formation in brinjal. A range of 5 to 6 days for graft union was reported by Sudesh (2019) and 8.07 to 8.53 days by Raykar (2020) in brinjal.

Table 2. Performance of tomato grafts for grafting parameters.

Treatments		Days taken for graft union (days)	Grafting success (%) *	Establishment of grafts (%)
T1	Thenito	4.33	96.71 (100)	100
T2	Rasam	4.00	93.44 (96.67)	100
T3	INDAM-14301	4.00	81.00 (90)	100
T5	Sivam	4.33	81.00 (90)	100
T6	Ruchi- Gold	4.00	96.69 (98.33)	93.32
T7	US- 505	5.00	78.02 (88.33)	100
T8	Unito	3.67	87.11 (93.33)	100
T9	INDAM- 1320	4.00	93.44 (96.67)	100
T10	Mahy-701	5.67	96.69 (98.33)	97.78
T11	COTH3	4.33	90.25 (95)	100
T12	Arka Apeksha	4.33	78.02 (88.33)	95.55
T13	Lakshmi	4.33	84.02 (91.67)	100
T15	Swaraksha	3.67	90.25 (95)	100
T16	Bhagyawan	4.33	78.02 (88.33)	91.11
T17	Arka Rakshak	4.67	96.71 (100)	100
T18	Mahy-Anagha	4.33	93.44 (96.67)	100
T20	NS-526	4.33	93.44 (96.67)	100
T21	Megha	5.33	87.11 (93.33)	95.55
T23	Momento	4.33	96.69 (98.33)	100
T24	Vijay	4.33	96.71 (100)	100
	CD (0.05)	0.958	0.181 (5.255)	-
	SE (m±)	0.335	0.063 (0.397)	-

*Data transformation was done.

The grafting success was assessed on brinjal variety Haritha as rootstock, employing twenty different tomato hybrids as scions. The analysis of variance indicated that all the grafted plants exhibited an appreciable grafting success rate, which ranged between 78.02- 96.71 %. The data revealed high grafting success rate among hybrids. Maximum success rate was observed in Thenito, Arka Rakshak and Vijay (96.71 %) which were on par with Rasam (93.44 %), INDAM-1320 (93.44 %), Mahy-Anagha (93.44 %) and NS-526 (93.44 %). The lowest percentage of success was recorded by the graft of US-505 and Bhagyawan and Arka Apeksha (78.02 %). Marsic and Osvald (2004) reported a high percentage, i.e, 79-100 % of success in grafting of tomato using cleft and tube methods of grafting. Similar results were also reported by Singh (2020), Kumar *et al*. (2017), Johnson *et al.* (2014) and Soe *et al*. (2018).

The field establishment of grafts showed a high percentage of success. Most of the grafts showed 100 % field establishment. However, the graft of Bagyawan resulted in the lowest percentage of field establishment, i.e. 91.11 %. Gisbert *et al*. (2011) reported the highest graft survival rate in brinjal grafts, most of the plants showing cent per cent field establishment, while some treatments showing very low survival rate of 25 %. Soe *et al*. (2018) observed a maximum field survival of 92.70 % in grafted tomato.

The results on yield per plant showed significant differences among the treatments. Grafts of NS-526 recorded the highest yield per plant of 801.15 g, which was on par with grafts of Sivam (770.42 g), Arka Rakshak (748.81 g), Megha (730.61 g), Rasam (619.41 g), Unito (601.46 g), Mahy-701 (581.60 g), Lakshmi (578.37 g) and the non-grafted control Raksha (651.35 g). The lowest yield per plant was recorded by the graft of Thenito (91.39 g) (Table 3) (Fig. 1). The bacterial wilt affected plants showed reduction in yield. Manickam *et al*. (2021) reported that higher yield per plot was obtained from grafts of resistant rootstocks compared to that on susceptible, since resistant rootstocks were less or unaffected by bacterial wilt in the field.

Performance of tomato non-grafts on bacterial wilt disease are presented in Table 4. All the grafted treatments showed 100 % resistance to bacterial wilt disease. Two susceptible and two resistant checks were infected with bacterial wilt disease. The susceptible check Rasto showed the highest prevalence

Table 3. Performance of tomato grafts and non-grafts for yield per plant.

Sl. No.	Treatments		Yield plant^{-1} (g)
1	T1	Thenito	91.39
2	T2	Rasam	619.41
3	T3	INDAM-14301	450.14
4	T5	Sivam	770.42
5	T6	Ruchi- Gold	216.31
6	T7	US- 505	531.56
7	T8	Unito	601.46
8	T9	INDAM- 1320	499.57
9	T10	Mahy-701	581.60
10	T11	COTH3	338.02
11	T12	Arka Apeksha	98.35
12	T13	Lakshmi	578.37
13	T15	Swaraksha	394.05
14	T16	Bhagyawan	397.92
15	T17	Arka Rakshak	748.81
16	T18	Mahy-Anagha	249.97
17	T20	NS-526	801.15
18	T21	Megha	730.61
19	T23	Momento	444.63
20	T24	Vijay	538.62
21	T19	Naveen	243.12
22	T22	Raksha	651.35
	CD (0.05)		235.02
	SE (m±)		82.348

Table 4. Performance of non-grafts for bacterial wilt disease.

Sl. No.	Treatments		Bacterial wilt incidence (%)	Number of days to bacterial wilt incidence (days)
1	T4	Arka Samrat	62.22	32.81
2	T22	Raksha	26.67	37.16
3	T14	Rasto	100	69.43
4	T19	Naveen	48.89	34.93

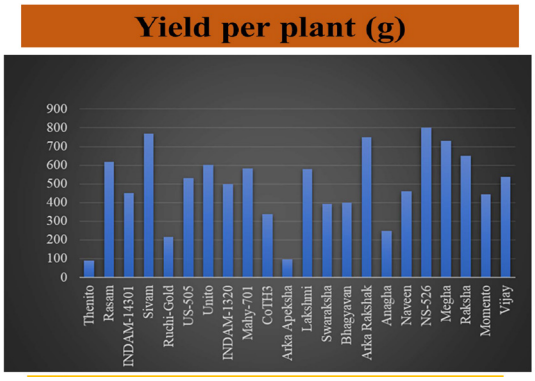

Fig. 1. Performance of grafts and non-grafts for yield per plant (g).

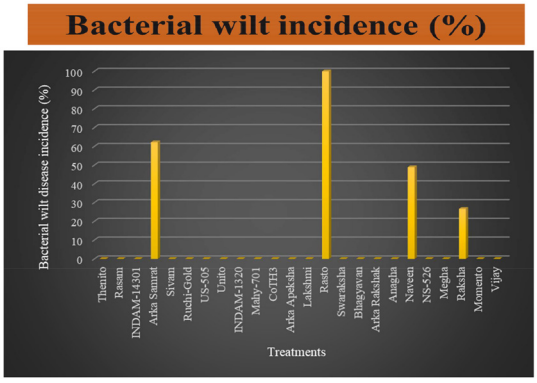

Fig. 2. Performance of grafts and non-grafts for bacterial wilt disease incidence (%).

of bacterial wilt with 100C plant mortality, whereas the resistant check Raksha showed minimum bacterial wilt incidence (26.67 %). Other two checks showed intermediate bacterial wilt incidence (Fig. 2).

Kumbar (2019) evaluated 10 rootstocks of brinjal (*Solanum* sp.) for bacterial wilt resistance and observed a range of 16.60 to 96.60 % for wilt incidence. Genotypes such as Surya, Haritha, SM3 and SM116 were found highly resistant to bacterial wilt disease, without showing any wilting symptoms. In the present study also, grafts on brinjal variety Haritha showed cent percent resistance to bacterial wilt disease. Similar results were also reported by Manickam *et al.* (2021) with very low incidence of bacterial wilt, when tomato was grafted on wilt resistant brinjal rootstocks. Ganiyu *et al*. (2020) also recorded reduction in bacterial wilt incidence in tomato, grafted on wild resistant tomato rootstock. Screening of tomato lines for bacterial wilt resistance was done by Kumar *et al*. (2018) and reported a range of 0 to 94.44 % for bacterial wilt incidence in different lines of tomato.

In the present investigation, only 4 treatments out of 24 exhibited an incidence of bacterial wilt. The lowest number of days taken for bacterial wilt incidence was by Arka Samrat (32.81 days) followed by Naveen (34.93 days). However, Rasto took maximum number of days for bacterial wilt incidence (69.43 days) followed by Raksha (37.16 days). Similar results was reported by Kumbar (2019) with a range of 23.40 to 32.30 days for bacterial wilt incidence.

From the present study it can be concluded that bacterial wilt disease of tomato can be controlled by grafting with resistant root stocks. The grafted plants of NS 526, Megha and Arka Rakshak on the brinjal variety Haritha as rootstock, were found superior based on the fruit yield characters and bacterial wilt resistance.

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