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Compatibility of the tomato scions with wild brinjal rootstocks

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ABSTRACT

The present study aimed to investigate the compatibility of tomato scions, namely, Kashi Anupam, Kashi Sharad, and Kashi Vishesh, with four wild brinjal rootstocks like *S. torvum, S. violaceum, S. xanthocarpum*, and *S. incanum.* Among the rootstocks, *S. violaceum* exhibited the shortest germination period at (17.17 days), with *S. torvum* taking 18.33 days to germinate after sowing, marking the highest day of germination. In the case of scions, Kashi Anupam showed the quickest germination at (9.33 days), while Kashi Vishesh took (11 days), displaying the highest germination percentage a *S. torvum* 79.83%. In contrast, Kashi Vishesh had a minimum germination percentage at 63.31%. The rootstock *S. violaceum* reached a graftable size in the shortest time at (41.99 days), while *S. torvum* took (49.17 days). Among the scions, Kashi Anupam achieved graftable size in (31.72 days), with Kashi Vishesh taking the least time at (29.77 days). The longest duration for graft union was observed in the combination of T_{12} (*S. incanum* + Kashi Vishesh), requiring 8.14 days. Graft hardening took the maximum time in the combination of T_9 (*S. xanthocarpum* + Kashi Vishesh) scion, lasting (23.05 days). The grafting combination of T_1 (*S. torvum* + Kashi Anupam) exhibited higher graft success rates, minimal mortality, and the maximum survival percentage. The compatibility of the rootstock is crucial for the successful cultivation of grafted plants.

Key words: *Solanum torvum*, Graft Success, Germination, Survival.

INTRODUCTION

Lately, there has been a growing interest in vegetable grafting, driven by its diverse advantages, particularly in intensive high-input farming systems. The method has spread extensively across Korea, Japan, the Mediterranean region, and various European countries. Rootstocks play a crucial role in combating soil-borne diseases that arise due to continuous farming practices. Apart from offering resistance to diseases, grafted plants often display increased yield and resilience to low soil temperatures by improving the absorption of nutrients and water, as supported by studies (Rivero *et al*., 12). Grafting commercial tomato varieties onto resilient rootstocks holds promise as an effective method for cultivating tomatoes in challenging conditions. Grafting serves several purposes, such as battling soil pests and diseases, fortifying resilience against environmental pressures, improving nutrient and water uptake, and overall elevating plant health. This technique has gained popularity in several European nations.

The germination period of wild brinjal surpasses that of various tomato varieties. Success in graft plants is influenced by the stem girth of both rootstock and scion materials. It is essential to assess the germination duration of scion and rootstock seeds and subsequently adjust the planting dates, aiming to harmonize the stem girth of the two components in order to ensure optimal grafting outcomes. This strategic alteration in seed planting schedules can significantly enhance graft success and is crucial for farmers and growers from an economic standpoint. A higher germination rate can lead to cost savings, as fewer seeds may be required to achieve the desired crop stand. This is particularly relevant when dealing with wild varieties, where seed availability might be limited. A higher germination percentage indicates that a greater proportion of seeds are viable and likely to develop into healthy seedlings. Grafting success provides valuable information about the compatibility between the wild brinjal or tomato variety used as the scion and the rootstock (Kumar *et al*., 5). Different rootstocks have varying impacts on plant growth and development. Studying grafting success assists in the selection of appropriate rootstocks that complement the characteristics of the wild brinjal or tomato scion, ensuring a harmonious and successful grafting process. Mortality percentage provides insights into the effectiveness of grafting techniques. A low mortality rate indicates successful grafting and a higher likelihood of healthy plant development (Shipepe and Msogoya, 14). Survival percentage has direct implications for the economic viability of grafting operations, increasing the return on investment by ensuring a greater number of marketable plants.

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MATERIALS AND METHODS

Over two years, the present investigation extended across the *Kharif* seasons of 2022-23 and 2023-24. The experiment was conducted using the Randomized Block Design, consisting of 15 treatments (Table 1) with three replications in each replication of 9 plants. The analysis was done using OPSTAT, an open-source agricultural data analysis tool provided by CCSHAU, Hissar.

The seeds of rootstocks and scions were collected from the ICAR-Indian Institute of Vegetable Research, Varanasi, while the grafts were prepared at NAI, SHUATS, Prayagraj. To address concerns regarding uneven germination, both rootstock and scion seeds were planted in protrays (540 mm × 280 mm) filled with sterilized cocopeat. In order to ensure synchronized growth, the rootstock seeds were sown four weeks ahead of the scion seeds. The rootstocks comprised 4–5 weeks-old seedlings of wild eggplant, while the scions were 3–4 weeks-old tomato seedlings. The most commonly employed grafting methods were splice grafting or tube grafting. Percentage of grafting success was calculated by using the formula given below:

$$\text{Graft success (\%)} = \frac{\text{Number of grafts survived}}{\text{Aggregate count of grafted plants}} \times 100$$

The measurements were recorded in terms of days to germination for wild brinjal and tomato varieties. The number of days to germinate was counted from the day of sowing to the emergence of seedlings in both tomato varieties used as scion and the brinjal rootstocks sown, recorded as the number of days taken for germination. Germination percentage (%) was calculated by dividing the number of seedling emergences by the total seeds sown and multiplying by hundred.

The number of days to attain a graftable size for wild brinjal and tomato varieties was nearly two weeks. This period represents the time required for seedlings to become ready for grafting. The days taken for graft union were counted from the day scions were grafted over rootstocks until the healing of the graft union was fully established, and recorded as the days taken for graft union. Regarding the duration for graft hardening or the process by which the graft union strengthens and becomes more resistant to external stressors, it was recorded as the days taken for graft hardening. The percentage of grafting success was calculated by dividing the number of surviving grafts by the aggregate count of grafted plants and multiplying by a hundred. Mortality percentage was calculated by the number of grafted plants that did not develop, divided by the total number of plants grafted, multiplied by a hundred. Survival percentage was calculated by the number of transplanted plants that survived, divided by the total number of graft transplants, multiplied by a hundred.

Four rootstocks were employed in the study, namely, *S. torvum*, *S. violaceum*, *S. xanthocarpum*, and *S. incanum*. At the same time, three served as scions: tomato varieties Kashi Anupam, Kashi Sharad, and Kashi Vishesh.

Table 1. Details of scion-rootstock combinations.

Sl. No.	Treatment	Treatment combination
1.	T_1	*S. torvum* + Kashi Anupam
2.	T_2	*S. torvum* + Kashi Sharad
3.	T_3	*S. torvum* + Kashi Vishesh
4.	T_4	*S. violaceum* + Kashi Anupam
5.	T_5	*S. violaceum* + Kashi Sharad
6.	T_6	*S. violaceum* + Kashi Vishesh
7.	T_7	*S. xanthocarpum* + Kashi Anupam
8.	T_8	*S. xanthocarpum* + Kashi Sharad
9.	T_9	*S. xanthocarpum* + Kashi Vishesh
10.	T_{10}	*S. incanum* + Kashi Anupam
11.	T_{11}	*S. incanum* + Kashi Sharad
12.	T_{12}	*S. incanum* + Kashi Vishesh
13.	T_{13}	Kashi Anupam (non-grafted)
14.	T_{14}	Kashi Sharad (non-grafted)
15.	T_{15}	Kashi Vishesh (non-grafted)

RESULTS AND DISCUSSION

No substantial difference was observed in the mean data for days taken for germination due to grafting in both the years 2022-23 and 2023-24. The mean pooled data is presented in Table 2. Among the four rootstocks, *S. torvum* exhibited the maximum days for germination (18.83 days), followed by *S. incanum* (18.33 days) and *S. xanthocarpum* (17.67 days), while the minimum germination time was observed for *S. violaceum* (17.17 days). Among the scions, Kashi Anupam showed the shortest germination period (9.33 days), while Kashi Vishesh took the maximum days (11.00) during the combined years of 2022-23 and 2023-24. Various researchers consistently reported similar findings, including Gisbert *et al.* (3) Kumar *et al.* (5). Gisbert *et al.* (3) observed that *S. torvum* exhibits an extended germination period due to its tough seed coat, experiencing prolonged seed dormancy, resulting in slow and inconsistent germination. Additionally, Gisbert *et al.* (3) specifically emphasized that,

Table 2. Assessment of germination dynamics and growth parameters in rootstock and scion genotypes for optimal grafting conditions (pooled data for 2022-23 & 2023-24).

Particulars	Duration of germination (days)	Germination (%)	No. of days taken to attain graftable size
Rootstock			
Solanum violaceum	17.17	69.17	41.99
S. torvum	18.83	79.83	44.42
S. xanthocarpum	17.67	64.44	48.54
S. incanum	18.33	67.71	49.17
Scion			
Kashi Anupam	9.33	66.83	31.72
Kashi Sharad	10.83	64.50	31.65
Kashi Vishesh	11.00	63.31	29.77
F test	S	S	S
SEm (±)	0.61	0.67	0.94
CD at 5%	1.83	2.00	2.93

although *S. torvum* is a robust brinjal species, its practicality as a rootstock is limited due to erratic and variable germination, primarily caused by prolonged seed dormancy.

Out of all the treatments involving rootstocks, the highest germination percentage (79.83%) was noted for *S. torvum*, followed by *S. incanum* (67.71%) and *S. xanthocarpum* (64.44%). Among the scions, Kashi Anupam showed the highest germination percentage (66.83%), succeeded by Kashi Sharad (64.50%), while the lowest was observed in Kashi Vishesh (63.31%) during the years 2022-23 and 2023-24, respectively. These findings are consistent with the results reported by Shipepe and Msogoya (14) and Hossain *et al.* (4).

Among the various treatments involving rootstocks, *S. violaceum* displayed the shortest duration (41.99 days) from germination to reaching the grafting stage. Conversely, *S. torvum* required a longer duration (49.17 days) to get the same grafting stage. Concerning the scions, Kashi Vishesh achieved graftable size in the shortest time (29.77 days), while Kashi Anupam took a comparatively longer period (31.72 days) to attain graftable size. The natural swift germination of *S. violaceum* led to the shortest time required to get the grafting stage. In contrast, *S. torvum*, due to its extended germination period, required the longest duration to reach the grafting stage, as illustrated in (Table 2 and Fig.1). These findings are consistent with prior research conducted by Bahadur *et al.* (1), Pilli *et al.* (11), Shipepe and Msogoya (14), Hossain *et al.* (4), and Sharma *et al.* (13).

Among all the rootstocks, the shortest duration (6.64 days) for graft union was observed under T_8 (*S. xanthocarpum* + Kashi Sharad), followed closely by T_1 (*S. torvum* + Kashi Anupam) with 6.70 days. In contrast, the longest duration was recorded under T_{12} (*S. incanum* + Kashi Vishesh) with 8.14 days, followed by (*S. xanthocarpum* + Kashi Vishesh) at 8.00 days. These observations were derived from combined data collected across the years 2022-23 and 2023-24 for both scion and rootstock during the graft union process. These findings align with the research of Shipepe and Msogoya (14), Maurya *et al.* (6), Kumar *et al.* (5), Hossain *et al.* (4), Singh *et al.* (15), and Surve *et al.* (16). Petran and Hoover (10) demonstrated that when the 'Celebrity' scion was grafted onto *S. torvum* rootstock, the process of graft union took the most extended duration. Interestingly, when tomato hybrids were grafted onto the Arka Vikas rootstock rather than the *S. pimpinellifolium* rootstock, the graft union occurred at a quicker pace. This could be attributed to the enhanced compatibility between

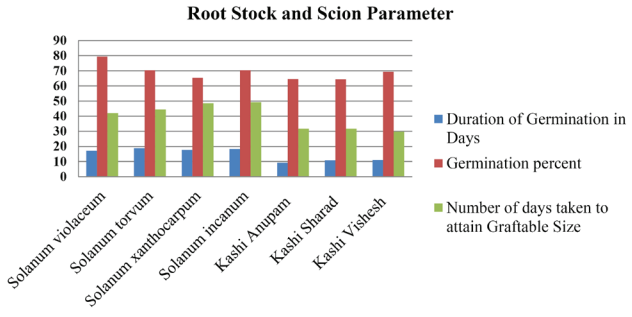

Fig. 1. Comparative analysis of rootstock and scion parameters in grafted and non-grafted tomato plants.

rootstocks and scions of the same species, fostering improved vascular tissue union, as proposed by Surve *et al.* (16).

Among all the rootstocks, the shortest duration for graft hardening was observed under T_1 (*S. torvum* + Kashi Anupam) at 12.63 days, followed by T_2 (*S. torvum* + Kashi Sharad). Conversely, the longest duration was found under (*S. xanthocarpum* + Kashi Vishesh) at 23.05 days, followed by (*S. xanthocarpum* + Kashi Sharad) at 20.26 days. These observations were recorded during the years 2022-23 and 2023-24, as outlined in Table 3. Following graft healing, the grafted seedlings were transitioned out of the healing chamber and exposed to sunlight for acclimatization, aiming to harden them before transplantation and reduce transplanting shock. These results align with findings reported by Mohamed *et al.* (7), Maurya *et al.* (6), Sharma *et al.,* (13), Kumar *et al.* (5), Hossain *et al.* (4), Palanikumar *et al.* (9), and Nkansanh *et al.* (8) concluded that plants grafted were transferred to main field 16 days after the grafting process, while Hossain *et al.* (4) indicated that plants were prepared for transplanting into the field three weeks after grafting Palanikumar *et al*. (9). These studies support and provide additional insights into the duration and practices involved in the hardening and transplantation processes after grafting.

Out of all the rootstocks and scion combinations, the most significant percentage of successful grafts (73.83%) was recorded in the graft combination with T_1 (*S. torvum* + Kashi Anupam), followed by T_3 (*S. torvum* + Kashi Vishesh) (69.08%). The lowest percentage (60.93%) was observed in T_5 (*S. violaceum* + Kashi Sharad), followed by T_9 (*S. xanthocarpum* + Kashi Sharad) (63.05%) during the years 2022-23 and 2023-24, respectively. Overall, the maximum graft success percentage following grafting was noted during treatment T_1. Certainly, the observed outcomes, such as improved graft union and the conducive environment within the healing chamber, could contribute to the variations in graft hardening durations. These findings align and corroborate with the research conducted by Kumar *et al.* (5), Shipepe and Msogoya (14) and Singh *et al.* (15). Such consistency in results across different studies suggests a shared understanding regarding the impact of grafting conditions and healing environments on the duration required for graft hardening. The graft combination with T_1 had the lowest percentage of graft failure (19.62%) among all the rootstock and scion treatment combinations T_1 (*S. torvum* + Kashi Anupam), followed by T_{11} (*S. incanum* + Kashi Sharad) (21.78%).

The highest percentage (28.12%) was observed in T_6 (*S. violaceum* + Kashi Vishesh), followed by T_{12} (*S. incanum* + Kashi Vishesh) with 27.61%, based

Table 3. Growth and survival of grafts as affected by rootstock-scion combinations (pooled data from 2022-23 & 2023-24).

Treatment	Treatment details	Days taken for graft union	Days taken for graft hardening	Grafting success (%)	Mortality (%)	Survival (%)
T_1	*S. torvum* + Kashi Anupam	6.70	12.63	73.83	19.62	91.54
T_2	*S. torvum* + Kashi Sharad	7.17	13.93	68.26	23.45	81.62
T_3	*S. torvum* + Kashi Vishesh	8.04	20.09	67.43	22.95	84.60
T_4	*S. violaceum* + Kashi Anupam	7.34	18.93	64.59	24.12	88.13
T_5	*S. violaceum* + Kashi Sharad	7.40	18.26	60.93	27.12	88.23
T_6	*S. violaceum* + Kashi Vishesh	7.67	18.19	64.19	28.12	82.87
T_7	*S. xanthocarpum* + Kashi Anupam	7.84	16.93	63.26	24.79	83.42
T_8	*S. xanthocarpum* + Kashi Sharad	6.64	20.26	64.93	26.45	85.80
T_9	*S. xanthocarpum* + Kashi Vishesh	8.00	23.05	63.05	23.91	86.80
T_{10}	*S. incanum* + Kashi Anupam	7.34	15.92	67.25	22.78	82.80
T_{11}	*S. incanum* + Kashi Sharad	7.77	16.92	67.92	21.78	87.80
T_{12}	*S. incanum* + Kashi Vishesh	8.14	16.75	69.08	27.61	80.80
T_{13}	Kashi Anupam (non-grafted)	0.00	0.00	0.00	15.28	91.13
T_{14}	Kashi Sharad (non-grafted)	0.00	0.00	0.00	11.61	88.33
T_{15}	Kashi Vishesh (non-grafted)	0.00	0.00	0.00	15.28	90.33
	F test	S	S	S	S	S
	SEm (±)	0.46	1.34	4.43	1.22	1.42
	CD at 5%	0.32	2.75	1.54	2.44	2.91

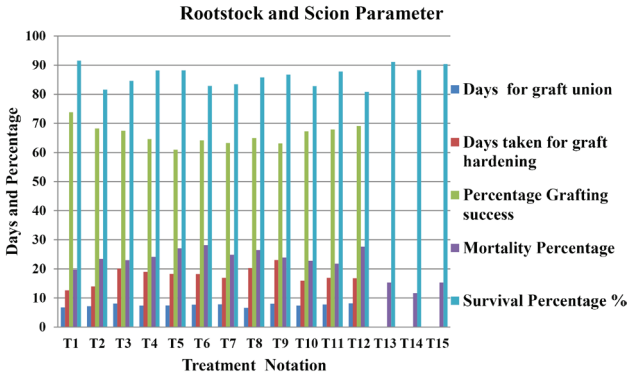

Fig. 2. Comparative analysis of growth and survival of rootstock and scion in grafted and non-grafted tomato plants.

on pooled data from the years 2022-23 and 2023-24, respectively. It is noted that all sprouted scions may not survive, leading to unsuccessful grafts. The mortality percentage recorded during the study represents the death of sprouted grafts. Out of all the rootstock and scion the treatment combinations, the maximum survival percentage was recorded as 91.54% in T_1 (*S. torvum* + Kashi Anupam), followed by 87.80% in T_{11} (*S. incanum* + Kashi Sharad) during the years 2022-23 and 2023-24, respectively (Fig. 2). Nevertheless, the lowest survival percentage was documented under T_{12} (*S. incanum* + Kashi Vishesh) at 80.80%, followed by T_2 (*S. torvum* + Kashi Sharad) at 81.62% during the same period (Table No. 3). These results are consistent with those published by Surve *et al.* (16) and Hossain *et al.* (4).

In conclusion, the grafting combination of T_1, involving *S. torvum* as the rootstock and Kashi Anupam as the scion, demonstrated remarkable success rates, with minimal mortality and the highest survival percentage. These findings underscore the significance of rootstock compatibility in ensuring the triumph of grafted plant cultivation. As we continue to explore and refine grafting techniques, understanding the pivotal role of rootstock characteristics becomes increasingly imperative for the sustainable and prosperous future of horticulture.

AUTHORS' CONTRIBUTION

Theory and calculations (LKV, VB, SET, AK), validation of analytical techniques (TT LKV), Gguidance (VB) explored and oversaw the research outcomes, shaping the final manuscript (LKV, VB, SET, AK, TT)

DECLARATION

The authors declare that they do not have any conflict of interest.

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