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PERFORMANCE STUDY OF GRAFTED BRINJAL (*SOLANUM MELONGENA* L.) FOR GROWTH PARAMETERS

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ABSTRACT

The present study was undertaken during the cropping seasons of 2021–22 and 2022–23 at the All India Coordinated Research Project (AICRP) on Vegetable Crops, Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, Odisha. The experiment was laid out in a Randomized Block Design (RBD) with three replications, involving eight treatments comprising ten graft combinations of brinjal. Treatments included grafts of three scions (VNR-212, Sungro-704) onto three rootstocks (*Solanum torvum*, Utkal Anushree, and Utkal Tarini), along with two non-grafted controls. The study aimed to assess the effect of grafting on various physiological, vegetative, and yield attributes. Significant differences were observed among treatments for all major parameters, including plant height, number of branches, days to flowering, plant spread and leaf area index. Notably, $\mathbf{T_2}$ (*S. torvum* × VNR-212) and $\mathbf{T_3}$ (*S. torvum* × Sungro-704) consistently outperformed others in terms of early flowering (38.05 and 40.25 days, respectively), highest plant height (73.04 and 73.49 cm respectively), number of branches (11.50 and 10.00 branches respectively) and leaf area index (5.21 and 4.38 respectively) underscoring the efficacy of *S. torvum* as a compatible and vigorous rootstock. Grafting also significantly reduced mortality and improved graft compatibility. These results validate grafting as a promising technique for enhancing brinjal productivity and resilience under Eastern Indian field conditions.

***Keywords* :** Grafting, Scion, rootstock, graft compatibility.

Introduction

Vegetable grafting is a relatively recent innovation in India, employed to develop new vegetable plants with enhanced fruit quality and yield. This technique has proven to be an effective alternative in vegetable production for combating soil-borne diseases such as fusarium wilt, bacterial wilt, and nematodes. As an eco-friendly method, vegetable grafting promotes sustainable agriculture by utilizing disease-resistant rootstocks, thereby reducing reliance on agrochemicals. The practice is particularly popular in fruit-bearing vegetables such as watermelon, cucumber, melon, tomato, and eggplant, among others (Ranjeetha *et al.,* 2023). In the field of Olericulture, vegetable grafting is a relatively recent technique, whereas in Pomology, the grafting of fruit trees has been a well-established practice for thousands of years. The use of resistant rootstocks in commercial vegetable grafting represents a significant advancement for sustainable vegetable production. This method decreases reliance on agrochemicals in organic farming (Rivard *et al.,* 2008). Aubergine, also known as brinjal, is a horticultural crop that belongs to the solanaceae family, characterized by a chromosome number of 2n=2X=24 (Choudhary, 2013). This plant is believed to have originated in India (Zeven and Zhukovsky, 1975). Brinjal is significant for human nutrition, as its fruit is rich in nutrients, containing approximately 6.4% carbohydrates, 1.3% protein, 0.3% fat, 0.02% calcium, 0.02% phosphorus, 0.0013% iron, and various other minerals. Additionally, it provides B-carotene (34 mg), riboflavin (0.05 mg), thiamine (0.05 mg), niacin (0.5 mg), and ascorbic acid (0.9 mg) per 100 grams of fruit (Choudhary, 2013). Grafted brinjal plants using *Solanum torvum* rootstocks have demonstrated significant suppression of Verticillium infections, showed only mild symptoms while increased root biomass and achieving higher yields comparable to treatments with methyl bromide sterilization (Bletsos, 2006). Research also highlighted that *S. torvum* rootstocks provide greater resistance against Verticillium pathogens than *S. sisymbriifolium* (Bletsos *et al.,* 2003). However, in Italy, while S. torvum effectively controlled root-knot nematodes, it showed limited efficacy against Verticillium after repeated cropping cycles (Garibaldi *et al.,* 2005). Evaluating the performance of brinjal for growth, yield, and quality through grafting is driven by the increasing challenges in modern agriculture, such as soilborne diseases, pest infestations, and environmental stressors. Continuous cropping practices have led to the accumulation of pathogens and nematodes, reducing soil health and crop productivity. Brinjal, a staple vegetable with high nutritional and economic significance, often faces such constraints, limiting its potential under intensive farming systems. Grafting, a proven horticultural technique, offers a sustainable solution by utilizing disease-resistant and stress-tolerant rootstocks to enhance plant vigour and resilience. It improves nutrient and water uptake, enabling plants to perform better under suboptimal conditions, such as low soil temperatures and salinity.

Material and Methods

The experiment was conducted during the 2021–22 and 2022–23 at AICRP on Vegetable crops, OUAT, Bhubaneshwar, Odisha. In the present investigation the design used for analysis of variables were Randomized Block Design (RBD) comprising 3 replications ten graft combinations. Combinations comprised of T_1 (Seedling plants of VNR-212 (Control)); T_2 (*Solanum torvum* x VNR- 212); T_3 (*Solanum torvum* x Sungro-704); T_4 (Utkal Anushree x VNR- 212); T_5 (Utkal Anushree x Sungro- 704); T_6 (Utkal Tarini x VNR-212); T_7 (Utkal Tarini x Sungro- 704) and T_8 (Seedling plants of Sungro- 704 (control)). The successful formation of a compatible graft involves three key processes: adhesion between the rootstock and scion, proliferation of callus cells at the graft junction forming a callus bridge, and vascular differentiation across the graft interface. Consequently, the rootstock and scion were systematically managed in a stepwise manner, as outlined by Mohanta *et al.* (2015). Splice grafting was the method used in experiment to join a scion (desired plant part) onto the stem of a rootstock or intact root piece. Growth parameters like mortality rate, graft compatibility (%); plant height [at 120 DAT]; number of branches per plant and days to 50% flowering were observed. Analysis of Variance was worked out using Fisher and Yates (1967).

Results and Discussion

Growth parameters

Mortality rate and graft compatibility (%)

The observations on mortality rate (%) and graft compatibility (%) for the pooled mean for cropping seasons 2021–22 and 2022–23, as shown in Table 1 revealed statistically significant differences among the grafted treatments. Among all treatments, the lowest mortality rate at 60 DAT was recorded in T_2 (*Solanum torvum* × VNR-212), with a pooled mean of 3.57%, followed closely by T_3 (*Solanum torvum* × Sungro-704) at 5.34%, and T_4 (Utkal Anushree × VNR-212) at 5.63%. Among all treatments, the lowest mortality rate at 90 DAT was recorded in T_2 (*Solanum torvum* × VNR-212), with a pooled mean of 5.15%, followed closely by T_3 (*Solanum torvum* × Sungro-704) at 5.72%, and T_6 (Utkal Tarini x VNR- 212) at 6.19%. These results underscore the effectiveness of *Solanum torvum* and Utkal Anushree rootstocks in conferring enhanced resistance against soil-borne pathogens and improving field survival. Mortality rates gradually increased in treatments T_5 through T_7, ranging from 5.92% in T_5 (Utkal Anushree × Sungro-704) to 8.03% in T_7 (Utkal Tarini × Sungro-704). In stark contrast, the highest mortality rates were observed in the control treatments: T_8 (Seedling plants of Sungro-704) exhibited the maximum mortality of 48.57%, followed by T_1 (Seedling plants of VNR-212) with 25.18%. The highest graft compatibility was recorded in T_2 (*Solanum torvum* × VNR-212), with a pooled mean of 86.40%, which was significantly superior to all other treatments. This was closely followed by T_3 (*Solanum torvum* × Sungro-704), which exhibited a graft success rate of 83.96%, thereby reinforcing the effectiveness of *S. torvum* as a highly compatible and stable rootstock across genotypes. Among the combinations involving Utkal Anushree, T_4 (Utkal Anushree × VNR-212) and T_5 (Utkal Anushree × Sungro-704) recorded nearly identical graft compatibility rates of 82.47% and

82.37%, respectively, suggesting consistent graft success in this rootstock across different scions. Similarly, Utkal Tarini-based combinations, T_6 (Utkal Tarini × VNR-212) and T_7 (Utkal Tarini × Sungro-704), recorded lower compatibility percentages of 81.11% and 78.10%, respectively, with T_7 significantly lower than T_2 and T_3 as per the CD at 5% level (1.27% for pooled data). Mortality rate and graft compatibility showed significant differences, with *S. torvum*-based combinations outperforming others. The superior performance of T_2 and T_3 in terms of low mortality and high graft compatibility underscores the effectiveness of *S. torvum* in enhancing plant survival and graft union formation, likely due to its tolerance to soil-borne pathogens and anatomical compatibility. Hence, while grafting did not markedly alter germination time, it significantly improved plant health and survival outcomes under field conditions. Petran and Hoover (2014) reported the graft compatibility of two tomato scions, 'Celebrity' and 'CLN3212A,' when grafted onto 'Maxifort,' seed-derived *Solanum torvum*, and vegetative cuttings of *Solanum torvum* rootstock.

Plant Height (cm) [120 DAT], number of branches per plant and days to 50% flowering

The data on plant height, number of branches per plant, and days to 50% flowering across 2021–22 and 2022–23 showed significant treatment differences, as indicated by the pooled CD at 5% (4.68). The pooled means demonstrated (table 1) that grafting exerted a strong influence on vegetative and reproductive traits of brinjal. For plant height, the best performer at the pooled mean was T_3 (*Solanum torvum* × Sungro-704), which recorded the tallest plants (73.49 cm), followed closely by T_2 (*Solanum torvum* × VNR-212) with 73.04 cm. Both treatments consistently outperformed others across years, reflecting the superiority of *Solanum torvum* as a rootstock. Its vigorous and deep-penetrating root system likely enhances nutrient and water uptake efficiency, resulting in stronger shoot growth. Graft combinations involving Utkal Anushree (T_4 and T_5) also exhibited good vegetative vigour (70.15–70.20 cm), though slightly inferior to *Solanum torvum*-based grafts. For number of branches per plant, the highest pooled mean was recorded in T_2 (*Solanum torvum* × VNR-212) with 11.50 branches, followed by T_3 (*Solanum torvum* × Sungro-704) with 10.00 branches. These results again highlight the capacity of *Solanum torvum* to support shoot proliferation and lateral branching. Treatments involving Utkal Anushree (T_4 and T_5: 9.50 and 9.17) performed better than Utkal Tarini and all non-grafted controls but remained inferior to the *Solanum torvum* grafts. The lowest branching occurred in the controls (T1 and T8), confirming the growth advantage conferred by grafting. For days to 50% flowering, T_2 (*Solanum torvum* × VNR-212) exhibited the earliest flowering (38.05 days), followed by T_3 (*Solanum torvum* × Sungro-704) (40.25 days). Early flowering in *Solanum torvum*-based grafts suggests improved physiological efficiency and accelerated transition to the reproductive phase. Treatments involving Utkal Anushree and Utkal Tarini showed intermediate earliness (41.61–42.88 days), while non-grafted controls exhibited the latest flowering (44.62–47.44 days). Overall, grafting significantly improved plant vigour, branching, and earliness, with T_2 and T_3 emerging as the best performers across traits at the pooled mean. The superiority of *Solanum torvum* aligns with earlier findings: Rathod (2017) reported increased plant height and branching in brinjal grafted on *Solanum torvum*, while Reshma *et al.* (2024) also observed significant improvement in growth and nutrient uptake when tomato was grafted onto wild Solanum rootstocks. These results confirm the strong potential of *Solanum torvum* as a dependable rootstock for enhancing overall plant performance.

Plant Spread (cm) and Leaf Area Index

The pooled data for plant spread in the North–South (N–S) direction across 2021–22 and 2022–23 revealed significant variation among treatments, indicating strong influence of rootstock–scion interactions on canopy expansion (table 1). The best performer at pooled mean was T_2 (*Solanum torvum* × VNR-212), which recorded the widest N–S spread (18.40 cm), significantly superior to all other grafted and non-grafted treatments. This was followed by T_3 (*Solanum torvum* × Sungro-704) at 16.51 cm, while combinations involving Utkal Anushree (T_4 and T_5) performed moderately (14.80–15.07 cm). The minimum spread occurred in non-grafted controls T_1 and T_8 (12.82 and 11.71 cm), confirming the enhanced vigour imparted by grafting. A low pooled CV (4.89%) and SE (0.41) indicated high reliability and consistency of the results. Plant spread in the East–West (E–W) direction also showed significant differences. Once again, T_2 emerged as the best performer with a pooled mean of 28.28 cm, followed by T_3 (26.38 cm). Graft combinations involving Utkal Anushree (T_4 and T_5) recorded intermediate spread (24.99–25.13 cm), while Utkal Tarini combinations (T_6 and T_7) showed moderate canopy width (23.83–24.22 cm). Similar to the N–S direction, non-grafted controls (T_1 and T_8) recorded the least spread (21.91–23.18 cm). Leaf Area Index (LAI), recorded at flowering and expressed as pooled mean, exhibited highly significant variation across treatments. T_2 (*Solanum torvum* × VNR-212) again recorded the highest LAI (5.21), representing 106.75% and 122.65% higher LAI than T_1 and T_8, respectively. T_3 (4.38) and Utkal Anushree combinations (T_4: 4.20; T_5: 3.88) also performed better than controls, while Utkal Tarini combinations (3.50–3.67) provided moderate foliage development. The lowest LAI occurred in non-grafted seedlings T_8 (2.34) and T_1 (2.52), indicating their relatively poor canopy development. Overall, the consistent superiority of T_2 across N–S spread, E–W spread, and LAI highlights the strong compatibility between *Solanum torvum* and VNR-212. The improved canopy architecture may be attributed to the robust and highly efficient root system of *Solanum torvum*, which enhances nutrient uptake, water absorption, and leaf expansion. T_3 also performed well, but the interaction of *Solanum torvum* × VNR-212 appears more synergistic. These findings align with earlier reports, where grafting onto *Solanum torvum* enhanced vegetative vigour and nutrient uptake efficiency (Reshma *et al.* 2024). Thus, grafting particularly the T_2 combination offers a promising strategy for optimizing brinjal canopy development and overall productivity.

Conclusions

Statistically significant differences were recorded for plant height, branching, and days to 50% flowering, confirming strong rootstock–scion effects. *Solanum torvum* rootstock particularly T_2 (*S. torvum* × VNR-212) and T_3 (*S. torvum* × Sungro-704) consistently outperformed all other treatments across both years. Their superiority is attributed to the vigorous, efficient, and highly compatible root system of *S. torvum*. Combinations involving Utkal Anushree and Utkal Tarini also showed moderate improvement over non-grafted controls. Overall, the findings validate grafting, especially with *S. torvum*, as an effective and sustainable strategy for enhancing brinjal growth and productivity.

Conflict of interest

The authors declare that they have no conflict of interest.

Table 1: Pooled mean performance of grafted brinjal for various graft compatibility and growth parameters.

	Treatment Details	Mortality rate (%) [60 DAT]	Mortality rate (%) [90 DAT]	Graft compatibility (%)	Plant height (cm) [120 DAT]	No of branches per plant [120 DAT]	Days to 50% flowering	Plant spread (cm) [N-S]	Plant spread (cm) [E-W]	Leaf Area Index
T_1	Seedling plants of VNR-212 (Control)	25.18	57.56	-	56.75	6.17	44.62	12.82	23.18	2.52
T_2	Solanum torvum x VNR- 212	3.57	5.15	86.40	73.04	11.50	38.05	18.40	28.28	5.21
T_3	Solanum torvum x Sungro- 704	5.34	5.72	83.96	73.49	10.00	40.25	16.51	26.38	4.38
T_4	Utkal anushree x VNR- 212	5.63	6.93	82.47	70.15	9.50	42.01	15.07	25.13	4.20
T_5	Utkal anushree x Sungro- 704	5.92	14.27	82.37	70.20	9.17	41.61	14.80	24.99	3.88
T_6	Utkal Tarini x VNR- 212	6.64	6.19	81.11	69.33	8.17	42.88	14.02	24.22	3.67
T_7	Utkal Tarini x Sungro- 704	8.03	8.71	78.10	60.51	7.33	42.57	13.80	23.83	3.50
T_8	Seedling plants of Sungro- 704 (Control)	48.57	88.71	-	59.43	5.50	47.44	11.71	21.91	2.34
	SE. m (±)	**0.40**	**0.69**	**0.40**	**1.54**	**0.32**	**0.74**	**0.41**	**0.38**	**0.10**
	CV (%)	**0.85**	**1.23**	**0.85**	**4.02**	**6.66**	**3.01**	**4.89**	**2.64**	**4.73**
	CD (5%)	**1.27**	**2.14**	**1.27**	**4.68**	**0.98**	**2.23**	**1.25**	**1.14**	**0.31**

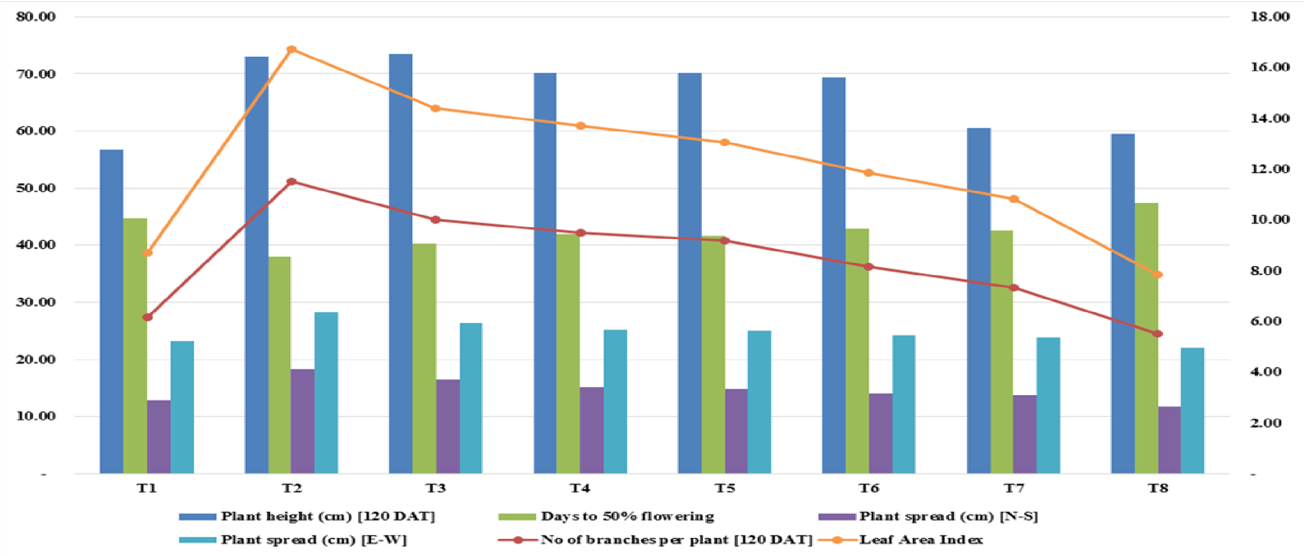

Fig. 1: Pooled mean performance of grafted brinjal for various graft compatibility and growth parameters

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