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Studies on germination of Turkey berry rootstock and performance of grafted brinjal in Tamil Nadu, India

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Abstract

Eggplant (brinjal) is commonly affected by fungal and bacterial wilt, as well as shoot and fruit borer infestations, leading to significant yield losses. This study aimed to investigate the production of brinjal grafts using wilt-resistant rootstock, specifically Turkey berry (*Solanum torvum* Sw.), and to evaluate the field performance of the grafted plants. The success of grafting largely depends on the quality and compatibility of the Turkey berry rootstock. To produce Turkey berry rootstock, seeds were soaked in water for 12, 24, and 36 hours before being sown in protrays filled with cocopeat and in raised beds during May and October. The highest germination rate was observed in seeds soaked for 36 hours and sown in protrays, followed closely by those sown in raised beds. Brinjal scions, 30-35 days old, were grafted onto 55-60 day old Turkey berry rootstocks and placed in a polytunnel under a shade net. These grafted plants were then transplanted into the field alongside non-grafted plants (seedlings) to compare their performance. Results showed that grafted brinjal plants had significantly greater plant height (142.54 cm), more branches per plant (21.17), and a higher number of fruits per plant (135.31) compared to non-grafted plants. The fruit yield was also notably higher in grafted plants, with 9.11 kg per plant and 61.65 t/ha, compared to 4.82 kg per plant and 30.45 t/ha in non-grafted plants. Grafted brinjal plants exhibited an extended growing period, higher net income, and a benefit-cost ratio (BCR) of 2.36. No instances of wilt were observed in grafted plants, and they also had lower incidences of shoot borer (15.31%) and fruit borer (11.74%) infestations compared to non-grafted plants. This grafting technique has the potential to enhance brinjal yield and productivity, promoting organic farming by reducing the need for pesticides.

Key words : Grafted brinjal, Turkey berry, rootstock, germination, wilt, yield

Introduction

Brinjal, *Solanum melongena* L. is one of the commonly cultivated vegetables in India. It is also known as "Eggplant" and "Aubergine" and belongs to the Solanaceae family. It was originated in India. In India, it is cultivated in 7.36 lakh hectares and production of 12.78 million tonnes (Anonymous 2020). The tender fruits comprise iron, calcium, potassium, magnesium, dietary fibre, and phenolic compounds and hold an important place in Indian diets. The dietary fibre present in the fruits helps in managing cholesterol levels in the blood. The bioactive compound glycoalkaloids (solasonine, solasodine and solamargine) present in the fruits are promising antiproliferative agents with potential anticancer effects against liver cancer cells (Fekry *et al.*, 2019) and lung cancer cells (Shen *et al.*, 2017). The cultivated brinjal is susceptible to shoot borer, fruit borer, sucking pests and wilt. Wilt and shoot and fruit borer, *Leucinodes orbonalis* Guenee (Jat and Pareek, 2003), are serious diseases and pests that cause heavy yield loss in brinjal. To manage these pests and diseases, farmers use high doses of pesticides and fungicides, which increase the cost of cultivation, pesticide residues in harvested produce, and the destruction of beneficial insects (Dadmal *et al.*, 2004). The integrated pest management strategies were used to manage shoot and fruit borer in eggplant (Pandey *et al.*, 2016). The selection of suitable technologies needs to be identified and followed to mitigate the adverse effects of diseases, pests, temperature and water stress (Pandita and Singh, 1992; Yadav *et al.*, 2012). For imparting disease resistance (King *et al.*, 2008) and environmental stresses such as water stress, thermal stress and organic pollutants (Schwarz *et al.*, 2010), grafting is the best technology, which involves the union of two plant parts *viz*, rootstock and scion.

Production of new xylem and phloem permits the vascular connection between the rootstock and scion. Translocation of auxin from the scion to the rootstock is responsible for the development of graft union (Aloni *et al.*, 2010). Upon successful graft union, water, nutrients, photosynthates, and growth substances are transferred from rootstock to scion. Grafting of brinjal was started by using wild *Solanum* species as rootstocks in the 1950s (Lee and Oda, 2003). Grafting of high-yielding cultivars on drought-tolerant, pest and disease-resistant rootstocks can provide added vigour, fruit quality (Kumbar *et al.*, 2021), tolerance to abiotic stress such as drought, resistance to pathogens and pests (Louws *et al.*, 2010). Grafting reduces the usage of pesticides to manage *Verticillium* wilt (Bletsos *et al.*, 2003), bacterial wilt, root rot and nematodes. Grafting enhances the uptake of nutrients (Santa-Cruz *et al.*, 2002), duration of harvesting and fruit quality (Colla *et al.*, 2006; Kumar *et al.*, 2017). For brinjal grafting, it is essential to use suitable rootstocks derived from Solanum species. The choice of rootstock significantly influences factors such as plant growth, vigor, yield, fruit quality, as well as the plant's tolerance to low temperatures, salinity, and soil moisture conditions (King *et al*., 2010). Turkey berry, *Solanum torvum* Sw. is a bushy, erect, spiny perennial plant with vigorous root system, vegetative growth, resistant to bacterial wilt (Rahman *et al.*, 2002) caused by *Ralstonia solanacearum,* fungal wilt caused by *Verticillium dahliae* Kieb. and tolerant to excess moisture from drought (Kumar *et al.*, 2016). It is also used

as rootstock (Bletsos *et al.*, 2003; Kumar *et al.*, 2017) for grafting brinjal. Since it is resistant to wilt pathogens and tolerant to drought, it is selected as a rootstock for grafting with brinjal. However, the germination of seeds is not uniform and requires treatments to improve germination percentage. Keeping this in view, germination studies on *S. torvum* Sw. for grafting with brinjal and technology demonstration of grafted brinjal were conducted in the farmer's field in Villupuram, Tamil Nadu.

Materials and methods

The present experiment was conducted at ICAR - Krishi Vigyan Kendra, Tamil Nadu Agricultural University, Tindivanam, Villupuram district, Tamil Nadu, India, from 2020 to 21. The experiment was conducted with eight treatments and three replications in a Completely Randomized Design.

Seeds of Turkey berry were soaked in water for 12, 24 and 36 hours and sown in raised beds and 98 cavity protrays containing well-decomposed cocopeat during May and October. Seeds without water soaking treatment were also sown in protrays and raised beds (control). Watering was done daily using a rose can. Germination of Turkey berry seeds was observed form 15 days and continued for up to 30 days (Fig. 1). After attaining 2 - 3 leaf stage, Turkey berry seedlings were transplanted in the 50 cavity protrays containing well-decomposed cocopeat. After 30 days of Turkey berry sowing, brinjal seeds were sown in 98 cavity protrays. On attaining similar stem thickness of rootstock and scion, grafting was done. The scion from 30 - 35 days old brinjal cultivar Dhruva was grafted by cleft method on 55 - 60 days old Turkey berry rootstock using grafting clips and kept in polytunnels under shade net. The data on germination was recorded and subjected to statistical analysis. On the successful union, healing and hardening, the brinjal grafts cultivar Dhruva were distributed to the farmers to study the productivity of the grafts at the field level.

The demonstration on the cultivation of grafted brinjal was conducted at Agoor village, Tindivanam Taluk, Villupuram district, Tamil Nadu, India, from 2020 to 2021. The grafts were transplanted at a spacing of 0.9 x 0.9 m in 15 replications in a Randomized Block Design. Along with grafted brinjal, the non-grafted plants (seedlings) were planted as control. All packages of practices were followed uniformly as per recommendations of brinjal cultivation. The data on growth, yield characteristics, and pest and disease incidence in grafted and non-grafted brinjal was recorded and subjected to statistical analysis (Panse and Sukhatme, 1985). After completing harvesting from the main crop, pruning was done after 7 months for the ratoon crop. The crop duration, gross cost, gross income and net income were estimated for grafted and non-grafted brinjal.

Results and discussion

The germination percentage of Turkey berry seeds in raised beds and protrays is presented in Table 1. The germination of Turkey berry seeds was uniform in protrays compared to seeds sown in raised beds. Since germination was not recorded in Turkey berry seeds sown during May, germination of Turkey berry seeds sown during October was continued for this study. May month sowing was not found suitable for producing Turkey berry rootstocks, which might be due to the prevalence of high temperatures and low relative humidity. The germination of Turkey berry seeds sown during October started from 15 days and continued up to 30 days (Fig. 1). The germination of Turkey berry seeds was significantly higher (89.98%) in seeds soaked for 36 hours and sown in protrays followed by seeds soaked for 36 hours and sown in raised beds (67.45%). The higher germination recorded in seeds soaked in water for 36 hours might be due to the leaching of germination inhibitors during water soaking treatment and rainy season, the prevalence of cool climate and high relative humidity.

Once grafting of brinjal cultivar Dhruva was done onto 55-60 days old Turkey berry rootstock, grafted plants were ready for planting in 22-25 days (Fig. 1). The survival rate of grafted brinjal on Turkey berry was good (75.5%) due to better rootstock-scion union, interaction, compatibility and hormonal influence on the growth. The successful healing of the graft union is influenced by factors such as temperature, relative humidity, light intensity, and air movement. Rahman *et al*. (2002) and Petran and Hoover (2014) reported on the compatibility and survival rates of brinjal grafted onto Turkey berry rootstocks.

It was found that the plant morphology, plant vigour, height, number of branches, leaves, deep tap rooted system, length, weight and number of primary and secondary roots, number of fruits and fruit yield were recorded better in grafted brinjal (Fig. 1) compared to non-grafted plants. The height, yield, duration and wilt incidence were significantly influenced by grafting. The plant height (142.54 cm) and number of branches/plant (21.17) were significantly higher in grafted brinjal than in non-grafted plants (Table 2). The grafted brinjal developed using Turkey berry rootstock was found to be superior in terms of plant growth and yield-attributing characteristics (Kumar *et al.*, 2017). The vigorous growth of grafted brinjal might be due to a vigorous root system (Gisbert *et al.*, 2011), nutrient uptake (Santa-Cruz *et al.*, 2002) and higher concentration of cytokinin (Aloni *et al.*,

Fig. 1 Left: Turkey berry seedlings soaked for 36 hours and sown in protrays. Middle: Brinjal grafted on Turkey berry rootstock. Right: Grafted plants in fruiting

Table 1. Germination percentage of Turkey berry seeds sown during October in raised beds and protrays

Treatments	Germination (%)
Turkey berry seeds sown in raised beds	-
Turkey berry seeds soaked in water for 12 hours and then sown in raised beds	2.12
Turkey berry seeds soaked in water for 24 hours and then sown in raised beds	34.67
Turkey berry seeds soaked in water for 36 hours and then sown in raised beds	67.45
Turkey berry seeds sown in protrays	-
Turkey berry seeds soaked in water for 12 hours and then sown in protrays	4.55
Turkey berry seeds soaked in water for 24 hours and then sown in protrays	51.45
Turkey berry seeds soaked in water for 36 hours and then sown in protrays	89.98
Mean	41.70
CD (*P*=0.05)	3.11

2010). The better rooting characteristics might be due to good interaction between rootstock and scion. The root dry weight was higher in grafted plants than in non-grafted watermelon plants (Alan *et al.*, 2007).

The grafted brinjal produced flowers from 59.37 days, whereas flowering was observed from 48.12 days in non-grafted plants. The delayed flowering in grafted brinjal was reported by Suthar *et al.* (2005). The period from fruit set to horticultural maturity was recorded as 15.65 days, which is lower than that of non-grafted plants (17.28 days). The number of fruits/plant (135.31) and individual fruit weight (68.92 g) were significantly higher in grafted brinjal than in non-grafted plants. The fruit yield was significantly higher in grafted brinjal (9.11 kg/plant and 61.65 t / ha) compared to non-grafted plants (4.82 kg/plant and 30.45 t / ha). The results are also in line with the study reported in grafted plants by Rahman *et al.* (2002); Aloni *et al.* (2010); Musa *et al.* (2020) who recorded higher fruit yield. The increase in fruit yield varies with fertility level (Suthar *et al.*, 2005) and nutrient uptake by grafted plants (Santa-Cruz *et al.*, 2002). The double yield was recorded in grafted brinjal compared to non-grafted plants (Sudesh *et al.*, 2021).

Table 2. Growth and yield parameters of grafted Brinjal in Villupuram district

Practices	Plant height (cm)	No. of branches/ plant	No. of fruits/ plant	Individual fruit weight (g)	Yield/ plant (kg)	Yield (t/ha)
Demonstration Grafted brinjal cv. Dhruva	142.54	21.17	135.31	68.92	9.11	61.65
Farmer practices (Non-grafted Brinjal cv. Dhruva)	69.87	13.28	73.25	66.76	4.82	30.45
CD (0.05)	1.08	2.35	3.14	2.67	1.02	5.23

The infestation of shoot borer (*Leucinodes orbonalis* Guenee) was lesser (15.31%) and easily manageable in grafted brinjal compared to non-grafted plants (Table 3). The fruit borer infestation was lesser in grafted brinjal (11.74%) than in non-grafted plants (19.56%). There was no wilt incidence in the grafted brinjal plants compared to non-grafted plants (21.3%). The resistance might be due to the use of *Verticillium* wilt resistant (Alconero *et al.*, 1998) and bacterial wilt resistant (Ramesh *et al.*, 2016; Praveenkumar *et al.*, 2023) Turkey berry rootstock and positive scion - rootstock interaction. The usage of plant protection chemicals was greatly reduced due to the resistant nature of brinjal grafts and the lower incidence of shoot and fruit borer, which is a serious pest in brinjal. The results are also in line with the study reported by Pandy and Rai (2003).

Table 3. Shoot borer, fruit borer and wilt of grafted brinjal in Villupuram district

Treatments	Shoot borer infestation (%)	Fruit borer infestation (%)	Wilt incidence (%)
Grafted brinjal cv. Dhruva	15.31	11.74	-
Farmer practices (Non-grafted Brinjal cv. Dhruva)	23.78	19.56	21.3
Mean	19.545	15.65	21.3
SEd	0.25	0.11	-
CD (0.05)	0.52	0.23	-

It was reported that the crop duration was significantly extended up to 12 months in grafted brinjal compared to non-grafted plants (Table 4). The duration was extended as a biennial eggplant by using grafted plants (Curuk *et al.*, 2005). The gross cost was higher for grafted brinjal (Rs.4,04,200/-) than non-grafted plants (Rs.2,86,330/-) due to the high cost of brinjal grafts and cost of cultivation for maintaining the crop for 12 months. The gross income was significantly higher in grafted brinjal (Rs.9,56,000/-) than in non-grafted plants (Rs.4,21,000/-). A higher net income of Rs.5,51,800 was recorded in grafted brinjal with BCR of 2.36 compared to non-grafted plants with BCR of 1.47. The higher net income could be obtained due to high fruit yield, no wilt incidence, low infestation of shoot and fruit borer and less usage of plant protection chemicals in the cultivation of grafted brinjal. The freshness and shelf life were better in tender fruits harvested from grafted plants compared to fruits from non-grafted plants. Fallik and Ilic (2014) reported an impact of rootstock and scion on the postharvest quality in brinjal.

Table 4. Crop duration and economics of grafted Brinjal in Villupuram district

Practices	Demonstration grafted brinjal cv. Dhruva	Farmer practices (Non-grafted brinjal cv. Dhruva)
Duration (Months)	12	7.5
Gross cost (Rs./ha)	4,04,200	2,86,330
Gross income (Rs./ha)	9,56,000	4,21,000
Net income (Rs./ha)	5,51,800	1,34,670
BCR	2.36	1.47

The production of wilt-resistant rootstocks of Turkey berry is an important step in producing wilt-resistant grafted brinjal plants. The germination of Turkey berry seeds was significantly higher and uniform in seeds soaked for 36 hours and sown in protrays during October. At field-level cultivation, the grafted brinjal performed significantly better in terms of plant height, number of branches, number of fruits and fruit weight compared to non-grafted plants. The yield was significantly higher in grafted brinjal (9.11 kg/ plant and 61.65 t / ha) compared to non-grafted plants (4.82 kg/ plant and 30.45 t / ha). The two-fold increase in yield in grafted brinjal over yield from non-grafted plants with extended crop duration makes the brinjal grafting technology advantageous. A higher net income of Rs.5,51,800 was recorded in grafted brinjal.

The infestation of shoot borer and fruit borer was lower in grafted brinjal compared to non-grafted plants and there was no wilt incidence in grafted brinjal. It is concluded that grafted brinjal is a successful technology that doubles the yield, thereby increasing the net income of farmers and reducing the indiscriminate use of pesticides and fungicides. In the changing climate scenario, more research is needed to focus on developing climate-resilient technology in brinjal through grafting for moisture stress and flooding conditions and imparting resistance to shoot and fruit borer.

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