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Enhancing germination and seedling quality of Turkey berry (*Solanum torvum*) through seed dormancy breaking methods

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Abstract

The Turkey berry plant (Solanum torvum Sw), used as rootstock for vegetable grafting and a key medicinal species in Indian Systems of Medicine (ISM), and homeopathy from the Solanaceae family, faces challenges in commercial cultivation due to seed dormancy, which inhibits germination. To enhance the germination and seedling quality characteristics of Turkey berries, an experiment was therefore carried out in the Department of Vegetable Sciences at the Tamil Nadu Agricultural University, Coimbatore, in the year 2022-2023. In this study, effectiveness of seed dormancy-breaking treatments (12) using a Completely Randomised Block Design (CRD) with replicated three times undertaken. The seed treatment includes control, physical scarification using tap and hot water, and chemical scarification using GA_3 and KNO_3. The maximum values for early germination, number of leaves, leaf length, leaf width, shoot length, and root length were significantly recorded by GA_3 400 ppm for 24 hours among the various treatments. However, the KNO_3 3% treatment for 24 hours was superior to GA_3 400 ppm treatment for 24 hours in terms of early germination, number of leaves, leaf length, leaf width, shoot length, and root length. It also had a significant impact on the germination and survival percentage, while the control had the lowest value. The treatment T1-control had the lowest value. Therefore, it may be recommended to use GA_3 400 ppm and KNO_3 3% for 24 hours to promote germination and break dormancy in *S. torvum*.

Key words: Turkey berry, dormancy breaking, tap water treatment, hot water treatment, gibberellic acid (GA_3), potassium nitrate (KNO_3).

Introduction

The perennial Turkey berry (*Solanum torvum*), characterized by its bushy, upright, and spiny form, is a member of the Solanaceae family. It can endure partial shade and direct sunlight but not dense forest cover. Turkey berries are predominantly located along roadsides, vacant lots, overgrown pastures, recently deserted farmland, landslide areas, and riverbanks. Frugivorous birds disseminate seeds while consuming fruit. The production area remains unidentified (Ramamurthy *et al*., 2012).

The poor, irregular, and erratic germination caused by dormancy in seeds is the main barrier to the practical use of *S. torvum* as a rootstock in the commercial production of grafted aubergine plants as well as in breeding programmes (Hayati *et al*., 2005). Breaking of dormancy, a typical occurrence in wild Solanum species (Wei *et al*., 2010; Kandari *et al*., 2011; Tellier *et al*., 2011), and seed soaking, manual scarification, cold stratification, heat shocks, light irradiation, and magnetic fields are just a few examples of physical or chemical methods that can be combined to improve germination. Other methods include scarification with acidic or basic chemicals, plant growth regulators, and osmotic treatments (Bewley *et al*., 2013; Holubowicz *et al*., 2014). In addition to being widely consumed as food and used in folk medicine all over the world, it is a significant medicinal plant in tropical and subtropical regions (Yousaf *et al*., 2013). In horticulture, Turkey berry is used as an aubergine rootstock. Grafted plants are incredibly resilient and can withstand diseases that affect the root system, enabling the crop to last for an additional year (Petran and Hoover, 2014).

Nonetheless, all the seeds didn't germinate at the same time and there is little research on how to improve germination rates. The objectives of a seed program are to produce high quality seeds that will maintain their germination potential during storage. To achieve this many researchers have devised innovative methods called seed quality enhancement techniques. These techniques are developed to enhance seed quality by maximizing the seed treatment product effectiveness.

This study on Turkey berry (*S. torvum*) aims to standardize seed treatments to enhance germination, supporting its use as a rootstock and as a genetic resource in breeding programs.

Materials and methods

Site description: The field study was conducted in the College Orchard on clay loam soil in the years 2022-2023 at the Department of Vegetable Science, Horticultural College and Research Institute, TNAU, Coimbatore. The experimental orchard site at HC&RI is located in the tropical plain topography at 11 degrees north latitude, 77 degrees east longitude, and 411 meters above mean sea level (MSL). A yearly rainfall total of 830 mm was noted. The harvested, fully ripened (yellow, peach orange, or dried) berries were crushed, and the fruit's seeds were removed. The fruits' extracted seeds were sun and shade-dried for two days each, respectively.

Treatment details and characters: Dried seeds that have not been treated were regarded as the control. Normally tap water was used to soak seeds for 12, 24 and 48 h at room temperature. The soaked seeds were then removed and allowed to dry in the shade for 30 min. The seeds were soaked in the hot water for 10 seconds at 25 °C and 50 °C. Dried seeds were subjected to various treatments as viz., gibberellic acid in 100 ppm, 200 ppm, and 400 ppm seeds, immersed in solution for 24 hours at room temperature (Table 1). The soaked seeds were then removed, dried in the shade for 30 minutes, and used for germination research. One gram, two grams, and three-gram quantities of KNO_3 were dissolved in one hundred mL of distilled water to for treatment. The Turkey berry seeds were immersed in this mixture for 24 hours at room temperature. The soaked seeds were then removed, dried in the shade for 30 minutes and used for germination studies.

Table 1. The experiment comprised the following treatments

Treatment number	Treatment Details
T1	Control
T2	Tap water for 12 h
T3	Tap water for 24 h
T4	Tap water for 48 h
T5	Hot water 25 oC for 10 sec
T6	Hot water 50 oC for 10 sec
T7	GA_3 100 ppm for 24 h
T8	GA_3 200 ppm for 24 h
T9	GA_3 400 ppm for 24 h
T10	KNO_3 1 percent for 24 h
T11	KNO_3 2 percent for 24 h
T12	KNO_3 3 percent for 24 h

Observations recorded

The treatments were replicated thrice. Five plants were chosen at random from each replication, and they were all tagged for observations.

Earliness in germination (days): The number of days it took for the first seedling to emerge in each treatment was taken into account when determining how soon the germination process began. Every day starting from the sowing date and continuing for 45 days was noted.

Germination percentage (%): Three replications of 100 seeds each that were sown in portrays each underwent a germination test. Every day starting from the date of sowing and continuing for 90 days, the percentage of germination of seeds was recorded.

Number of leaves: At 90 DAS, the leaves were counted on labeled seedlings. The number of fully opened leaves produced by each seedling was recorded.

Leaf length (cm) and width (cm): Each seedling's second pair of leaves from the growing tip were measured at 90 DAS, and the mean leaf length was computed and expressed in centimeters.

Shoot length (cm) and root length (cm): At 90 DAS, the labeled seedlings' shoot length was measured. Shoot length was measured on the same seedlings that were used to measure the length of the roots. The length of the shoot was measured from the point where the seed was attached to the tip of the leaf, and the average values were given in centimeters. At 90 DAS, the length of the roots of the plants with labels was measured. Five healthy seedlings were randomly chosen from each replication at the time of the germination count in order to measure the root length of the seedlings. From the seed's attachment point to the tip of the primary root, the length of the root was measured.

Survival percentage: The seedlings were monitored for the following month after the initial 90 days of success, and in some of the successful seedlings, some seedlings died from wilt disease and other factors. The formula used to calculate the percentage of survival is as follows:

Survival percent = [(Total number of seedlings - Total number of death seedlings after germination)/ Total number of seedlings] x 100

Statistical analysis: The statistical analysis of the data was done using Completely Randomised Block Design (Panse and Sukhathme, 1985). To compare various treatment means DMRT was applied (P=0.05).

Results and discussion

The results of the current study showed that seeds did not germinate at normal room temperature under controlled conditions. The treated seeds that were planted in nursery conditions germinated.

In GA_3 400 ppm for 24 hours, the earliest germination was observed (22.08 days). Compared to all other treatments used, this was notably better. However, the treatment T12 - KNO_3 3% for 24 hours (22.83 days) was better than T9-GA_3 400 ppm for 24 hours (Fig. 1). Gibberellic acid is applied exogenously to counteract the negative effects of inhibitors (Brian and Hemming, 1958) and to increase endogenous substances that resemble gibberellin. One of the enzymes produced with the aid of GA_3 is amylase, which transforms starch into simple sugars during germination. These sugars supply the necessary energy for a number of physiological and metabolic procedures related to germination. The best GA_3 substitute has been discovered to be potassium nitrate because it can hasten water uptake, which is the first stage of germination and aids in radicle protrusion and subsequent germination. Similar results have also been reported by Sarathkumar *et al*. (2017), Cutti *et al*. (2016), Ozden *et al*. (2016), Hayati *et al*. (2005) in Turkey berry plant (*S. torvum*),

KNO_3 3% treatment showed the highest germination rate (90.07%) followed by KNO_3 2% (86.24%). The lowest germination rate (53.94%) was recorded under control (Fig. 2). According to one theory, applying KNO_3 may hasten the uptake of oxygen and water as well as improve the nutritional status of seeds by supplying them with more amino acids. Similar results have also been reported by Sarathkumar *et al*. (2017), Cutti *et al*. (2016), Ranil *et al*. (2015), Hayati *et al*. (2005) in Turkey berry plant.

Efficacy of seed treatment on leaf attributes: For 90 DAS, T9 - GA_3 400 ppm showed the greatest increase in maximum leaf number (8.54), leaf length (5.6 cm), and leaf width (3.23 cm). In contrast, for leaf length and width (4.89 cm and 2.79 cm), the treatment T12 - KNO_3, 3% was found to be the best substitute for

T9 - GA_3 400 ppm. For the number of leaves (3.92), leaf length and leaf width (1.14 and 0.76), the control yielded the lowest values (Fig. 3-5).

The fact that GA_3 and KNO_3 treatments resulted in more branches, which made it easier for the plants to harvest sunlight more effectively and produce more leaves, maybe the cause of the GA_3 and KNO_3 treatments' increased leaf production. Increased leaf length and width and leaf number. Similar results were reported by Muralidhara *et al*. (2015) in mango.

Efficacy of seed treatment on shoot and root attributes: The maximum shoot length (5.69 cm) and root length (11.66 cm), were seen in T9-GA_3 400 ppm for 24 hours 90 DAS as shown in Figs. 6 and 7. In contrast, it was discovered that the treatment T12 - KNO_3 3% for 24 hours was preferable to T9 - GA_3 400 ppm for 24 hours. The lowest values (2.11 and 5.61 cm) were obtained under control.

Younger internodes and tissues are stimulated to grow, often leading to an increase in the length of each internode while the total number of internodes remains unchanged (Ghosh and Halder, 2018). This rapid growth occurs due to two factors: an increase in the number of cells and the elongation of these cells. Given that GA_3 activates metabolic processes or counteracts the effects of growth inhibitors, the length of the shoot in seeds treated with GA_3 may be attributed to cell multiplication and elongation in the cambium tissue of the internodal region. When compared to other substances, gibberellic acid (GA_3) causes higher shoot lengths in fresh and dry weights. At GA_3 200 ppm in aonla, Chiranjeevi *et al*. (2017) reported the highest seedling stem

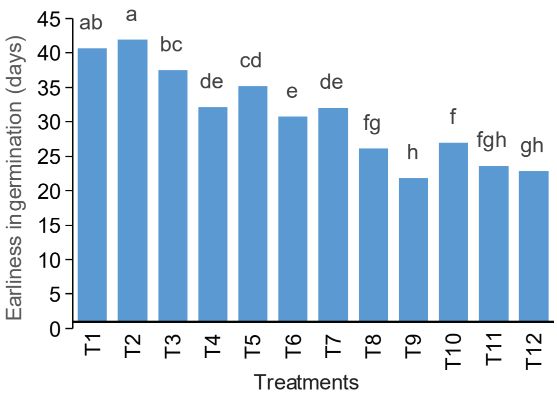

Fig. 1. Effect of seed treatment on earliness in germination in Turkey berry. Grouping is based on DMRT test. Treatments with same letters are not significantly different at *P*=0.05

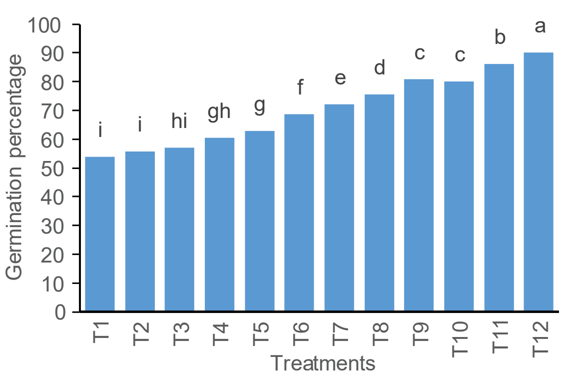

Fig. 2. Effect of seed treatment on germination percentage in Turkey berry. Grouping is based on DMRT test. Treatments with same letters are not significantly different at *P*=0.05

girth. Similar outcomes have also been reported for ashwagandha by Khanna *et al*. (2013) and basil by Uthirapandi *et al*. (2018). Gibberellic acid and potassium nitrate both have an impact on stem elongation in different ways. First, they directly affect stem elongation by causing cell wall loosening, increasing cell wall extensibility, stimulating wall synthesis, decreasing cell wall rigidity, and promoting cell division, which results in increased growth. The results of the investigation showed that seeds treated with potassium nitrate had the longest and widest roots. According to Hendricks and Taylorson (1975), this may be caused by an increase in nicotinamide adenine dinucleotide phosphate oxidation. This phenomenon may be caused by nicotinamide adenine dinucleotide phosphate reduced ($NADPH_2$) activity being

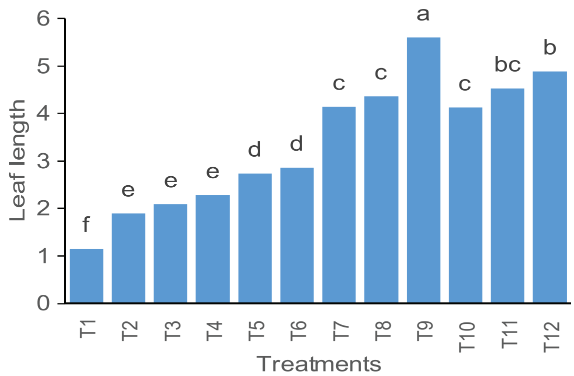

Fig. 3. Effect of seed treatment on number of leaves in Turkey berry. Grouping is based on DMRT test. Treatments with same letters are not significantly different at *P*=0.05

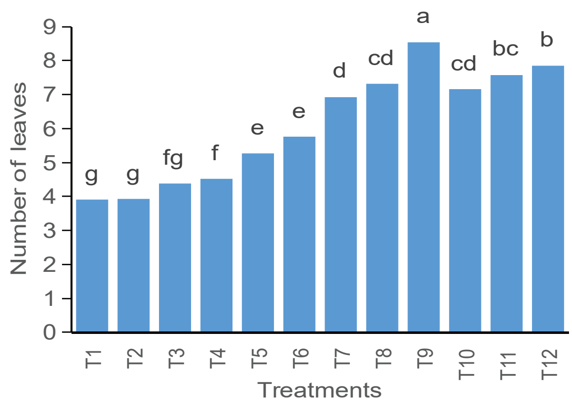

Fig. 4. Effect of seed treatment on leaf length in Turkey berry plant. Grouping is based on DMRT test. Treatments with same letters are not significantly different at *P*=0.05

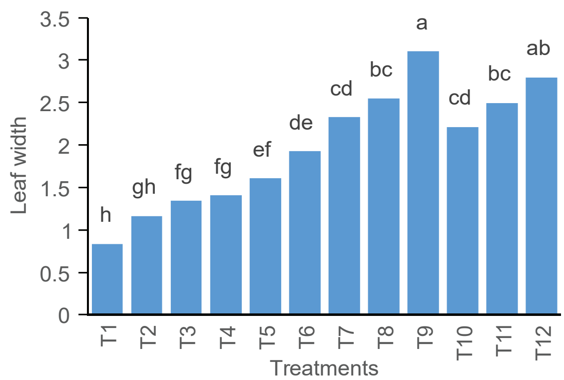

Fig. 5. Effect of seed treatment on leaf width in Turkey berry plant (*Solanum torvum* Sw). Grouping is based on DMRT test. Treatments with same letters are not significantly different at *P*=0.05

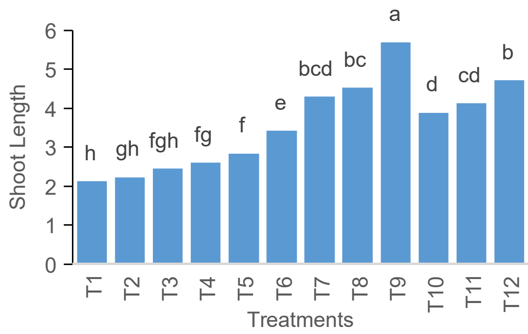

Fig. 6. Effect of seed treatment on shoot length in Turkey berry seedlings. Grouping is based on DMRT test. Treatments with same letters are not significantly different at P=0.05

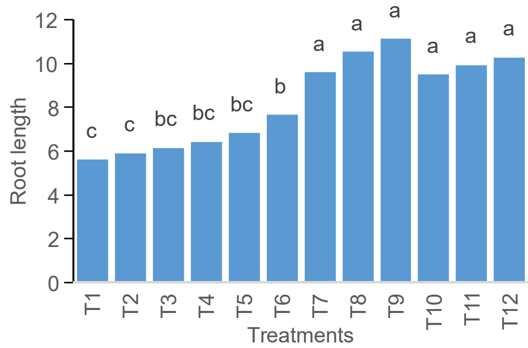

Fig. 7. Effect of seed treatment on root length in Turkey berry seedlings. Grouping is based on DMRT test. Treatments with same letters are not significantly different at P=0.05

increased by the K+ ion. (Rajamanickam *et al*., 2002).

Efficacy of seed treatment on survival percentage: The highest survival percentage (83.18%) was observed in T12- KNO_3 3% for 24 h and it was followed by T11 - KNO_3 2% for 24 h (81.13%) (Fig. 8). The treatment T1 - control recorded the lowest survival percentage (41.97%). The present result is in accordance with Geetha and Balamurugan (2011). Better root establishment of the seedling increases the crop's ability to survive. It may conclude that in order to improve seed germination and seedling vigour in the Turkey berry plant (*S. torvum*), seeds should be treated with KNO_3 3% for 24 hours.

The study focused on treating seeds with GA_3 400 ppm for 24 hours, resulting in the highest values for germination attributes (earliness), leaf attributes (number of leaves, length, and width), shoot length, and root length. Gibberellins might have induced the activation of hydrolytic enzymes favouring a proper embryo

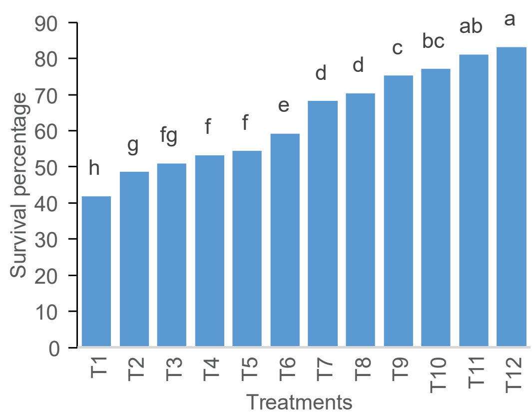

Fig. 8. Effect of seed treatment on survival percentage in Turkey berry seedlings. Grouping is based on DMRT test. Treatments with same letters are not significantly different at P=0.05

and internode elongation. Furthermore, 24h seed-coating with 3% KNO_3 was shown to be a viable option, enhancing germination and the highest survival percentages. This probably occurs because K+ ion augments $NADPH_2$ activation, thus improving nutrient status (amino acids mainly) and oxygen and water uptake as a consequence of KNO_3 application.

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