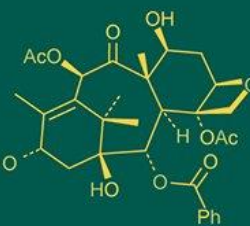
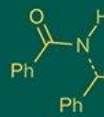
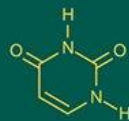


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Impact of pre-seed treatments on *Gloriosa superba* L. seeds

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Abstract

The experiment was performed at the experimental farm of Dr YS Parmar University of Horticulture and Forestry in Solan, HP, India. Since seeds are the most valuable part of this crop, the study aimed to evaluate effective pre-sowing seed treatments to enhance germination, growth, and tuber yield. The study aimed to thoroughly investigate and identify effective pre-sowing seed treatments that can enhance germination rates, promote robust plant growth, and increase tuber yield, recognising the species' ecological and medicinal significance. The experiment was conducted under a Randomised Block Design (RBD) with 6 treatments and 4 replications in raised nursery beds. The treatment details were as follows: Treatment T₁-control (whole seed), Treatment T₂- Sarcotesta removal and hot water, Treatment T₃- Arbuscular mycorrhiza, Treatment T₄-PGPR, Treatment T₅-N:P:K@120:40:60 and Treatment T₆- N:P:K@120:60:60. The observations were recorded with maximum germination initiation (31.00±0.16 days), germination duration (42.00±0.24 days), germination percentage (77.20±0.96%), seedling height (49.03±0.69 cm), number of leaves per seedlings (35.60±0.30), Arm length 1 (9.90±0.24 cm), Arm diameter 1 (11.27±0.07 mm), Arm length 2 (8.43±0.03 cm), Arm diameter 2 (12.21±0.22 mm) and Tubers weight (15.20±0.37 g).

Keywords: Pre-sowing treatments, germination, tuber weight, sarcotesta, seeds

Introduction

Gloriosa superba L., belonging to the Colchicaceae family, is an important medicinal plant widely recognized for its therapeutic properties. Its seeds and tubers serve as the primary economic parts due to their medicinal value. Owing to its extensive medicinal benefits, the plant has been extensively over-exploited from wild populations, raising concerns about its conservation. Propagation of *G. superba* is primarily achieved through its seeds and tubers, which are critical for cultivation. To satisfy the increasing demand from the pharmaceutical industry, there is a pressing need to produce high-quality planting material and to develop sustainable commercial cultivation methods, ensuring both supply and conservation (Muruganandam *et al.* 2019).

The primary method of propagating this crop has been through tubers. However, the limited availability of tubers presents a significant obstacle in satisfying the current demand for herbs, which has prompted the adoption of seed propagation techniques. Seeds often face poor germination rates due to their impermeable seed coats, making tubers the preferred choice for propagation. These tubers are characterized by their cylindrical, bifurcated shape, resembling an L or V, with two limbs that can be of equal or unequal length and end in pointed tips (Kirtikar and Basu 1975; Farooqui and Sreeramu 2004; Kurian and Sankar 2007). To overcome propagation challenges, various advanced techniques have been employed, including seed treatment, micro-propagation, tissue culture, and somatic embryogenesis, many of which have demonstrated promising results and potential for large-scale production (Ghosh *et al.* 2006; Kurian and Sankar 2007; Venudevan *et al.* 2010) [9, 6, 4, 7, 5, 10].

This study, titled "Impact of Pre-Seed Treatments on *Gloriosa superba* L. Seeds" was conducted to thoroughly investigate and identify effective pre-sowing seed treatments that can enhance germination rates, promote robust plant growth, and increase tuber yield, recognizing the species ecological and medicinal significance.

2. Materials and Methods

2.1 Site, Layout and Experiment details

The field trial was conducted at the experimental farm of Department of Forest Products, Dr YS Parmar University of Horticulture and Forestry, Solan (Himachal Pradesh). The experiment was conducted under Randomized Block Design (RBD) with 6 treatments and 4 replications in raised nursery beds. The treatment details were as follows: Treatment T₁- control (whole seed), Treatment T₂- Sarcotesta removal and hot water, Treatment T₃- Arbuscular mycorrhiza, Treatment T₄-PGPR, Treatment T₅-N:P:K@120: 40: 60 and Treatment T₆-N:P:K@120: 60: 60.

The seeds of *Gloriosa superba* have a thick sarcotesta, so to attain the best germination, the sarcotesta is removed, followed by soaking in hot water for 12 hours for all the treatments except treatment T₁ (control). The seeds were treated with Arbuscular mycorrhiza (AM) and Plant Growth Promoting Rhizobacteria (PRPR) before sowing. NPK was applied as a basal dose during nursery bed preparation for the treatments and nitrogen is applied in 3 spit doses. The seeds were treated with arbuscular mycorrhiza after removal of the sarcotesta before sowing. Similarly, the seed were dipped for a short time in plant growth promoting rhizobacteria solution before sowing in nursery beds. The observations for germination parameters, growth parameters, and yield parameters were taken during the experiment and recorded.

3. Statistical analysis

The Analysis of Variance (ANOVA) under a Randomized Block Design (RBD) was performed using R statistical tool (version 3.3.0) and python (version 3.13).

3.1 Results and Discussions: Seed treatment involves applying chemicals or other suitable substances to seeds to

boost germination, overcome dormancy, and enhance nutrient access and plant development. *Gloriosa superba* L. seeds are covered by an outer sarcotesta and a hard inner part. The sarcotesta acts as a barrier, leading to poor and inconsistent germination (Mahajan *et al.* 2023). Many studies have examined the effects of various chemicals and hot water treatments on seed germination and dormancy breaking in *Gloriosa superba* L. as well as other crops (Venudevan *et al.* 2010; Anandhi and Rajamani 2012) [8, 10, 1].

4.1 Germination Parameters

Seed germination was initiated earlier (25.67 ± 0.28 days) in seeds after removal of the sarcotesta and hot water treatment, whereas late germination (31.00 ± 0.16 days) was observed in seeds under the NPK@120:60:60 nutrient dosage. The maximum germination period (42.00 ± 0.24 days) was observed in PGPR-treated seeds, and the least (35.00 ± 0.15 days) in treatment T₆. Seeds treated with arbuscular mycorrhiza before sowing showed the maximum germination percentage of 77.20 ± 0.96 days, whereas the whole seeds (control) sown showed the least germination percentage (36.40 ± 0.68 days) among all treatments.

Similarly, the impact of hot water seed treatment of *Gloriosa superba* L. was studied by Venudevan *et al.* (2010), Anandhi *et al.* (2016), Muruganandam *et al.* (2019) and they reported higher germination percentage between 27.44 -62%. Dogra (2021) and Mahajan *et al.* (2023) also reported enhanced seed germination percentage with seed soaking in hot water and removal of sarcotesta afterwards compared to control. The present study revealed that the hot water-treated seeds along with incorporation of AM resulted in maximised germination percentage (77.00%) in *Gloriosa superba* L [10, 2, 9, 3, 8].

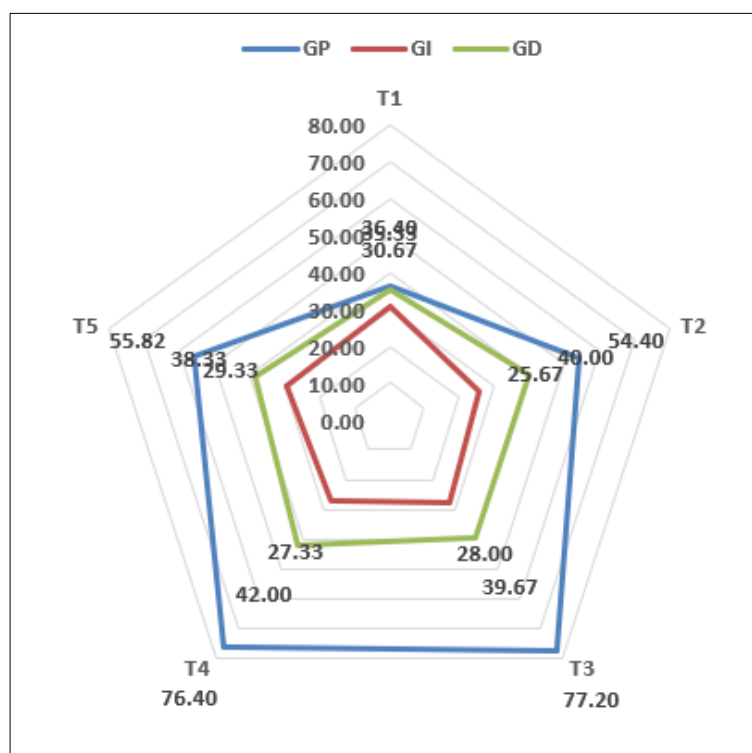


Fig 1: Effect of Germination percentage (GP), Germination initiation (GI) and Germination duration (GD) on seedlings of *Gloriosa superba* L.

4.2 Growth and Yield Parameters

The seedling height was greatest (49.03 ± 0.69 cm) in treatment T_3 compared to the control (20.50 ± 0.06 cm). The highest number of leaves per seedling (35.60 ± 0.30) was observed with NPK@120:40:60, while the control had the fewest (18.03 ± 0.03). Harvested tubers' fresh weight was measured, with the heaviest tubers (15.20 ± 0.37 g) from seeds treated with PGPR, and the lightest (7.13 ± 0.07 g) from seeds sown without treatment (T_1). The length and diameter of both arms of L or V shaped tubers were measured using a measuring tape and vernier caliper. Arm 1 length was longest (9.90 ± 0.24 cm) in tubers from PGPR treated seeds, compared to 5.17 ± 0.11 cm in controls. Arm 1 diameter was greatest (11.27 ± 0.07 mm) in T_5 , and smallest (8.10 ± 0.16 mm) in T_1 .

Similarly, arm 2 length was maximum (8.43 ± 0.03 cm) in PGPR-treated tubers versus 4.03 ± 0.06 cm in controls. Arm 2 diameter was highest (12.21 ± 0.22 mm) in T_5 and lowest (8.73 ± 0.10 mm) in T_1 . Yadav *et al.* (2013) reported 36.4 ± 1.67 leaves per seedling when treating micropropagated and *in vitro*-grown plantlets with *G. mosseae*. Dogra (2021) found the maximum number of leaves (15.70) in seedlings. Muruganandam *et al.* (2019) and Dogra (2021) observed maximum tuber weight. Similar findings by Venudevan *et al.* (2010), Anandhi *et al.* (2016) and Muruganandam *et al.* (2019) showed tubers with maximum arm length. Dogra (2021) recorded maximum arm-1 (4.92 cm) and arm-2 (3.09 cm) lengths, along with arm-1 (8.87 mm) and arm-2 (3.48 mm) diameters of microtubers [11, 3, 9, 10, 2].

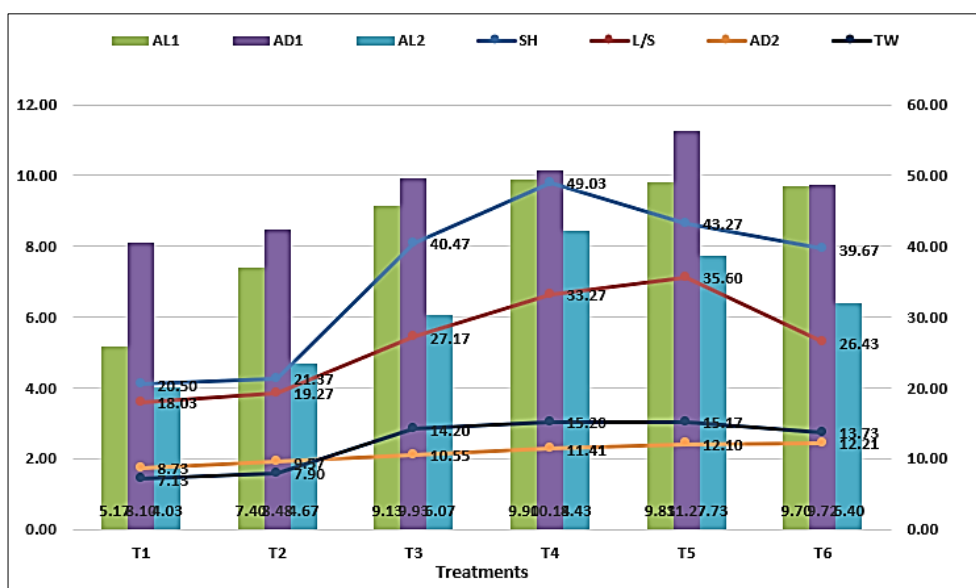


Fig 2: Effect of seed treatments on Seedling height, Leaves per seedlings, Arm length, Arm diameter and Tubers weight of *Gloriosa superba* L.

Table 1: Impact of seed treatments on Germination percentage (GP), Germination initiation (GI), Germination duration (GD), seedling height and number of leaves per seedling of *Gloriosa superba* L

Treatments	Germination Percentage (%)	Germination Initiation (days)	Germination Duration (days)	Seedling Height (cm)	Number of Leaves Seedlings ⁻¹
T ₁	36.40±0.68	30.67±0.58	35.33±0.53	20.50±0.06	18.03±0.03
T ₂	54.40±1.39	25.67±0.28	40.00±0.58	21.37±0.49	19.27±0.35
T ₃	77.20±0.96	28.00±0.49	39.67±0.95	40.47±0.40	27.17±0.51
T ₄	76.40±1.71	27.33±0.43	42.00±0.24	49.03±0.69	33.27±0.71
T ₅	55.82±1.34	29.33±0.23	38.33±0.18	43.27±0.65	35.60±0.30
T ₆	54.95±1.26	31.00±0.16	35.00±0.15	39.67±0.08	26.43±0.29
C.D.	4.02	1.24	1.69	1.52	1.12
SE(m)	1.26	0.39	0.53	0.48	0.35
SE(d)	1.78	0.55	0.75	0.68	0.50

Table 2: Effect of seed treatments on tuber dimensions and Tubers weight of seedlings of *Gloriosa superba* L

Treatments	Arm length 1 (cm)	Arm diameter 1 (mm)	Arm length 2 (cm)	Arm diameter 2 (mm)	Tubers wt. (g)
T ₁	5.17±0.11	8.10±0.16	4.03±0.06	8.73±0.10	7.13±0.07
T ₂	7.40±0.08	8.48±0.10	4.67±0.00	9.57±0.10	7.90±0.03
T ₃	9.13±0.07	9.93±0.15	6.07±0.03	10.55±0.11	14.20±0.12
T ₄	9.90±0.24	10.14±0.15	8.43±0.03	11.41±0.27	15.20±0.37
T ₅	9.83±0.01	11.27±0.07	7.73±0.19	12.10±0.29	15.17±0.21
T ₆	9.70±0.20	9.72±0.24	6.40±0.12	12.21±0.22	13.73±0.01
C.D.	0.49	0.48	0.34	0.64	0.57
SE(m)	0.16	0.15	0.11	0.20	0.18
SE(d)	0.22	0.21	0.15	0.28	0.25

Conclusion

The study demonstrates that the removal of sarcotesta and hot water treatment significantly improves the germination and growth of *Gloriosa superba* seeds. These seed treatments effectively enhance not only germination rates but also subsequent tuber yield. Overall, all tested treatments resulted in better tuber production compared to the control, indicating that adopting such treatments can be beneficial for optimizing cultivation and yield of *Gloriosa superba*.

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Disclosure statement

No potential conflict of interest was reported by the author(s)

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Ethics Approval

This study did not involve human participants or animals; therefore, ethical approval was not required.

Availability of Data and Material

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' Contributions

- Author 1: Writing - original draft, Methodology, Investigation, Formal analysis
- Author 2: Supervision, Resources, Conceptualization, Methodology
- Author 3: Review, editing
- All authors read and approved the final manuscript.

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