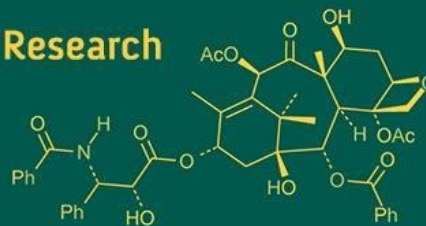


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Enhancement of germination and seedling growth of Ber (*Ziziphus mauritiana*) cv. Gola by scarification and different potting media

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Abstract

The present investigation entitled “Enhancement of germination and seedling growth of Ber (*Ziziphus mauritiana*) cv. Gola by scarification and different potting media” was conducted during September 2024-January 2025 in shade net at the departmental research farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh. The Statistical Design adopted for the experiment was Randomized Block Design (RBD) with three replication and ten treatment combinations combining different concentration of GA₃, and potting mixture (FYM, Vermicompost, Cocopeat) in different ratio. The result of present investigation shows that the treatment, T₇ application of GA₃ at @ 400 ppm, and using potting media, FYM: Vermicompost: Coco peat in ratio (1:1:1) outstands in all the aspects with significant results in germination and seedling growth. Parameters like days to germination (10.40) was minimum, seedling height (41.83 cm), seedling diameter (19.71 mm), seedling girth (61.89 mm) which was followed by T₅ application of GA₃ at @ 400 ppm, and using potting media, FYM: Vermicompost: Coco peat in ratio (1:1:2). The lowest observation was recorded in T₀ Control application of Water for scarification and Coco peat. Treatment with GA₃, FYM, vermicompost and coco peat (1:1:1) improves germination and seedling growth of Ber cv. Gola to a greater extent as compared to other treatments.

Keywords: FYM, coco peat, vermicompost, Ber, seedling, Gola

Introduction

Ziziphus mauritiana Lam., commonly known as Ber or Indian jujube, is a resilient fruit tree well-suited to the arid and semi-arid regions of South Asia. It is predominantly cultivated in Indian states like Rajasthan, Uttar Pradesh, Gujarat, and Maharashtra due to its adaptability to harsh climatic conditions, low water requirements, and poor soil fertility. Its remarkable drought tolerance and ability to grow in marginal areas make it an ideal candidate for sustainable fruit cultivation under low-input systems. Ber fruits are valued for their high nutritional content—particularly vitamin C, dietary fiber, and antioxidant compounds—contributing both to rural income and nutritional security.

Among the numerous cultivars of Ber, ‘Gola’ holds significant commercial importance due to its attractive fruit characteristics, early maturity, and consumer acceptance. Despite these advantages, its propagation through seeds remains constrained by dormancy issues. The seeds are enclosed in a tough endocarp that inhibits water and oxygen penetration, resulting in delayed or poor germination. This type of physical dormancy, while beneficial for natural survival in extreme environments, creates obstacles for uniform seedling production in nurseries. Slow and erratic germination not only reduces productivity but also affects the commercial scalability of this crop.

To address these limitations, various seed pre-treatment techniques have been explored, including mechanical scarification, hot water soaking, acid treatment, and hormone applications. Among these, gibberellic acid (GA₃) has shown considerable promise in breaking seed dormancy across many horticultural crops. GA₃ functions by enhancing enzymatic activity and softening the seed coat, thereby facilitating water uptake and stimulating early germination. Research has demonstrated its efficacy in improving germination rate, uniformity, and seedling vigour in Ber when used at optimal concentrations.

However, successful seedling establishment also requires an appropriate growing medium that supports root development, aeration, and nutrient availability. Traditionally, soil-based media were used, but modern nursery practices increasingly incorporate organic amendments such as farmyard manure (FYM), vermicompost, and cocopeat. FYM improves soil structure, water-holding capacity, and nutrient availability. Vermicompost, enriched with beneficial microbes and growth-promoting substances, enhances root growth and nutrient uptake. Cocopeat, a fibrous byproduct of coconut husk, offers excellent water retention, aeration, and a favourable root environment, especially when blended with nutrient-rich inputs.

Several studies have independently investigated the role of GA₃ in seed dormancy alleviation and the impact of different growing media on seedling growth. However, there is limited literature on their combined influence, especially in *Ziziphus mauritiana* cv. Gola. It is hypothesized that the physiological effects of GA₃ could interact positively with the physical and biological properties of the growing media, resulting in enhanced germination and seedling performance. Understanding these interactions can lead to more reliable nursery protocols for this important species.

The importance of this research is underscored by the increasing need for climate-resilient horticultural crops. Ber, being well-adapted to degraded and rainfed conditions, represents a strategic option for orchard development in vulnerable ecosystems. By refining seed pre-treatment and growing media combinations, propagation efficiency can be improved, reducing transplant shock, increasing survival, and accelerating orchard establishment. Moreover, the use of organic inputs aligns with sustainable and eco-friendly agricultural practices, contributing to reduced chemical usage and improved soil health.

This study aims to evaluate the interactive effects of GA₃ scarification and different organic growing media (FYM, vermicompost, and cocopeat) on seed germination, seedling growth, and survival percentage of *Ziziphus mauritiana* cv. Gola. The results are expected to support improved nursery techniques and promote wider adoption of this underutilized yet valuable fruit tree, thereby enhancing livelihoods in arid and semi-arid regions.

Significance and Rationale

Given the current emphasis on regenerative agriculture and the need to develop crops suitable for water-scarce regions, Ber cultivation offers both ecological and economic promise. Its hardiness, low-input requirements, and market potential make it ideal for resource-poor farmers. Yet, the major bottleneck lies in the lack of efficient and uniform propagation techniques.

The integration of biotechnological tools like GA₃ with locally available organic media provides a sustainable alternative to synthetic inputs. Such an approach not only supports plant health and productivity but also encourages circular farming systems through the utilization of farm waste and compost-based amendments. Additionally, enhancing seedling quality at the nursery level has downstream benefits in terms of orchard success, yield uniformity, and long-term plant vigour.

As more research focuses on the early stages of perennial crop establishment, it becomes crucial to explore not just isolated interventions but also the synergistic effects of

multiple inputs. This study addresses this gap by examining how seed physiology and substrate characteristics interact to influence critical growth parameters. Findings from this work may also inform propagation protocols for other fruit crops facing similar germination constraints.

Furthermore, with rising environmental concerns and policy focus on organic and low-input agriculture, this study is aligned with national priorities such as those outlined by ICAR and international organizations like the FAO. By improving the propagation efficiency of a climate-resilient crop, the research contributes to food security, livelihood development, and environmental conservation.

In conclusion, this study seeks to develop a robust, cost-effective propagation method for *Ziziphus mauritiana* cv. Gola by evaluating the combined effects of GA₃ treatment and different organic growing media. Enhancing germination and seedling vigour through such sustainable methods can contribute significantly to arid horticulture and rural resilience. The outcomes are expected to be scalable, farmer-friendly, and applicable across diverse agro-climatic conditions, thereby supporting long-term goals of sustainable fruit production.

Materials and Methods

Experimental Site

The present investigation, titled “Enhancement of germination and seedling growth of Ber (*Ziziphus mauritiana*) cv. Gola by scarification and different potting media” was carried out during the period from September 2024 to January 2025 under a shade net, at the Departmental Research Farm, Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh. All necessary facilities including labour, water supply, and management inputs were provided by the department.

Geographical Location

The experimental site is geographically located at 25.45°N latitude and 81.84°E longitude, with an elevation of 98 meters above mean sea level. It lies in the fertile alluvial basin formed by the Ganga and Yamuna rivers.

Climate and Soil

Prayagraj falls under the subtropical climatic zone characterized by hot summers and cold winters. Summer temperatures can peak at 47 °C, while winter temperatures may drop as low as 4 °C. The area receives an average annual rainfall of approximately 1013.4 mm, predominantly during the monsoon season from July to September. The soil at the experimental site is alluvial in nature, supporting diverse horticultural crops. This agro-climatic setting is considered suitable for evaluating germination and early growth responses in *Ziziphus mauritiana*.

Seed Material

The seeds of *Ziziphus mauritiana* cv. Gola were procured from the Central Institute of Arid Horticulture (CIAH), Bikaner, Rajasthan. A total of 150 seeds were sown in perforated polyethylene bags (6 × 4 inches) filled with different growing media combinations. The sowing was done on 3rd September 2024 at the Horticulture Research Farm, SHUATS.

Seed Treatment

Prior to sowing, seeds were subjected to scarification treatments involving soaking in gibberellic acid (GA₃) at concentrations of 300 ppm, 350 ppm, and 400 ppm, as well as in distilled water (control). The seeds were soaked for 40 to 45 minutes to weaken the hard endocarp and facilitate water absorption, without damaging the embryo.

Growing Media Composition

To evaluate the effect of different organic growing media on germination and seedling development of *Ziziphus mauritiana* cv. Gola, three types of substrates were used: Farmyard Manure (FYM), vermicompost, and cocopeat. These media were selected based on their known physical and biological properties that enhance seedling growth, moisture retention, nutrient availability, and microbial activity.

Farmyard Manure (FYM): Well-decomposed FYM was collected from the university's organic unit. It served as a traditional organic input rich in macro and micronutrients. FYM improves soil structure, enhances water-holding capacity, and acts as a slow-release source of essential nutrients while fostering microbial activity in the root zone.

Vermicompost: The vermicompost used in the experiment was obtained from decomposed plant-based agricultural waste processed by *Eisenia fetida* earthworms. It is known for its high cation exchange capacity and contains growth-promoting enzymes, hormones, and beneficial microbes. Vermicompost contributes significantly to root development, nutrient uptake, and seedling vigour.

Cocopeat: Commercial-grade cocopeat was procured from a certified vendor. It is a fibrous, lightweight byproduct of coconut husk processing. Cocopeat has excellent water retention capacity, high porosity, and a neutral pH, which makes it suitable for nursery substrates. It provides an aerated environment conducive to root proliferation and improves the physical structure of growing media when used alone or in mixtures.

The media were used either singly or in various combinations to assess their individual and interactive effects with GA₃ treatment on germination and early seedling performance. The growing media were filled into 6 × 4 inch polyethylene bags, and uniform quantities of each medium were maintained across replications.

Results

In terms of seed germination-

Days to Germination

Minimum days to germination (10.40) was observed in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) & it was at par with T₅ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2) with (11.53) days. Maximum days to germination (16.80) was observed in T₀ Control (Water, Coco peat).

In terms of growth parameters

Height of seedling

Maximum height of seedling at 30 DAS (21.14 cm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was at par with T₅ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2) with height of

(20.14 cm) & T₂ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2) with height of (19.33 cm). The minimum height (9.87 cm) was observed in T₀ Control (Water, Coco peat).

Maximum height of seedling at 60 DAS (28.08 cm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was at par with T₅ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2) with height of (26.83 cm) & T₂ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2) with height of (25.70 cm). The minimum height (15.23 cm) was observed in T₀ Control (Water, Coco peat).

Maximum height of seedling at 90 DAS (34.59 cm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was at par with T₅ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2) with height of (33.02 cm) & T₂ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2) with height of (32.2 cm). The minimum height (21.21 cm) was observed in T₀ Control (Water, Coco peat).

Maximum height of seedling at 120 DAS (41.83 cm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was at par with T₅ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2) with height of (39.86 cm). The minimum height (27.23 cm) was observed in T₀ Control (Water, Coco peat).

Stem diameter of seedling

Maximum diameter of seedling at 30 DAS (1.97 mm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was at par with T₅ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2) with diameter of (1.94 mm), & T₄ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:1) with diameter of (1.87 mm) & T₆ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:3) with diameter of (1.79 mm) & T₈ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:2) with diameter of (1.81 mm) & T₉ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:3) with diameter of (1.76 mm). The minimum diameter (1.51 mm) was observed in T₀ Control (Water, Coco peat).

Maximum diameter of seedling at 60 DAS (8.72 mm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was significantly superior to all other treatments. The minimum diameter (6.72 mm) was observed in T₀ Control (Water, Coco peat).

Maximum diameter of seedling at 90 DAS (14.18 mm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was significantly superior to all other treatments. The minimum diameter (10.94 mm) was observed in T₀ Control (Water, Coco peat).

Maximum diameter of seedling at 120 DAS (19.71 mm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was significantly superior to all other treatments. The minimum diameter (15.19 mm) was observed in T₀ Control (Water, Coco peat).

Stem girth of seedling

Maximum girth of seedling at 30 DAS (6.20 mm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was at par with T₅ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2) with girth of (6.10 mm), & T₄ GA₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:1) with girth of (5.86 mm) & T₆ GA₃ @

350 ppm + FYM × Vermicompost × Coco peat (1:1:3) with girth of (5.61 mm) & T₈ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:2) with girth of (5.69 mm) & T₉ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:3) with girth of (5.54 mm). The minimum girth (4.74 mm) was observed in T₀ Control (Water, Coco peat). Maximum girth of seedling at 60 DAS (27.39 mm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was significantly superior to all other treatments. The minimum girth (21.10 mm) was observed in T₀ Control (Water, Coco peat).

Maximum girth of seedling at 90 DAS (44.54 mm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was significantly superior to all other treatments. The minimum girth (34.36 mm) was observed in T₀ Control (Water, Coco peat).

Maximum girth of seedling at 120 DAS (61.89 mm) was recorded in T₇ GA₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1) and it was significantly superior to all other treatments. The minimum girth (47.69 mm) was observed in T₀ Control (Water, Coco peat).

Table 1: Effect of scarification and potting media on days to germination of Ber cv. Gola

Treatment	Treatment Details	Days to Germination
T ₀	Control (Water, Coco peat)	16.80
T ₁	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:1)	16.40
T ₂	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:2)	13.53
T ₃	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:3)	15.20
T ₄	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:1)	15.07
T ₅	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2)	11.53
T ₆	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:3)	15.73
T ₇	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1)	10.40
T ₈	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:2)	16.27
T ₉	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:3)	15.93
Test of significance		S
SEd±		1.00
CD @ 5%		2.98
CV		11.8

Table 2: Effect of scarification and potting media on seedling height of Ber cv. Gola

Treatment	Treatment details	Plant Height (cm)			
		30 DAS	60 DAS	90 DAS	120 DAS
T ₀	Control (Water, Coco peat)	9.87	15.23	21.21	27.23
T ₁	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:1)	17.29	23.25	29.53	35.83
T ₂	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:2)	19.33	25.70	32.21	38.86
T ₃	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:3)	16.29	22.43	28.58	35.06
T ₄	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:1)	16.33	22.36	28.81	35.20
T ₅	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2)	20.14	26.83	33.02	39.86
T ₆	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:3)	14.67	20.97	27.48	33.94
T ₇	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1)	21.14	28.08	34.59	41.83
T ₈	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:2)	16.29	22.53	28.97	35.48
T ₉	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:3)	15.97	22.15	28.79	35.11
Test of significance		S	S	S	S
SEd±		0.91	0.87	0.84	0.87
CD @ 5%		2.70	2.59	2.49	2.59
CV		9.4	6.6	5.0	4.2

Table 3: Effect of scarification and potting media on seedling diameter of Ber cv. Gola

Treatment	Treatment details	Seedling Diameter (mm)			
		30 DAS	60 DAS	90 DAS	120 DAS
T ₀	Control (Water, Coco peat)	1.51	6.72	10.94	15.19
T ₁	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:1)	1.64	6.73	11.16	15.72
T ₂	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:2)	1.64	7.39	12.17	17.21
T ₃	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:3)	1.55	6.90	11.43	16.01
T ₄	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:1)	1.87	7.39	11.85	16.56
T ₅	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2)	1.94	7.83	13.05	18.38
T ₆	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:3)	1.79	7.99	12.67	17.35
T ₇	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1)	1.97	8.72	14.18	19.71
T ₈	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:2)	1.81	8.18	12.71	17.31
T ₉	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:3)	1.76	7.84	12.43	17.10
Test of significance		S	S	S	S
SEd±		0.10	0.16	0.16	0.16
CD @ 5%		0.29	0.47	0.47	0.47
CV		9.3	3.6	2.2	1.6

Table 4: Effect of scarification and potting media on seedling girth of Ber cv. Gola

Treatment	Treatment details	Seedling Girth (mm)			
		30 DAS	60 DAS	90 DAS	120 DAS
T ₀	Control (Water, Coco peat)	4.74	21.10	34.36	47.69
T ₁	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:1)	5.14	21.12	35.05	49.35
T ₂	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:2)	5.15	23.21	38.22	54.03
T ₃	GA ₃ @ 300 ppm + FYM × Vermicompost × Coco peat (1:1:3)	4.86	21.68	35.90	50.28
T ₄	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:1)	5.86	23.21	37.22	52.01
T ₅	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:2)	6.10	24.57	40.97	57.72
T ₆	GA ₃ @ 350 ppm + FYM × Vermicompost × Coco peat (1:1:3)	5.61	25.09	39.77	54.47
T ₇	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:1)	6.20	27.39	44.54	61.89
T ₈	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:2)	5.69	25.68	39.91	54.36
T ₉	GA ₃ @ 400 ppm + FYM × Vermicompost × Coco peat (1:1:3)	5.54	24.62	39.04	53.70
Test of significance		S	S	S	S
SEd±		0.30	0.49	0.49	0.49
CD @ 5%		0.89	1.46	1.47	1.47
CV		9.3	3.6	2.2	1.6

Conclusion

The present study revealed that scarification using GA₃ and the use of nutrient-rich growing media significantly enhanced seed germination, seedling growth, and survival percentage in *Ziziphus mauritiana* cv. Gola. Among all treatments, T₇ (GA₃ @ 400 ppm + FYM × Vermicompost × Cocopeat in 1:1:1 ratio) consistently outperformed others in parameters like days to germination, seedling height, seedling diameter, seedling girth, number of leaves. This combination promoted early and uniform germination and improved overall plant health. The synergistic effect of GA₃ with organic amendments not only overcame seed dormancy but also created a favourable environment for root and shoot development.

Such results demonstrate that integrating appropriate hormonal treatment with biologically active media can serve as a practical, low-input approach for nursery management of Ber, especially in arid and semi-arid climates. Adoption of this protocol could improve seedling establishment, reduce transplant shock, and support sustainable horticultural practices. Therefore, this treatment can be recommended for commercial propagation and orchard establishment of Ber cv. Gola under similar agro-climatic conditions.

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