Journal of Plant Development Sciences
Meerut, India

RESEARCH ARTICLE

OPTIMIZING VEGETATIVE PROPAGATION OF THE ENDANGERED MEDICINAL HERB *VALERIANA JATAMANSI* JONES THROUGH NAPHTHALENE ACETIC ACID (NAA)

Aftab Ahmed, Suhail Shabir, Mubashir Ahmad Mir, Mohsin Bashir, Arzan Nazir and Amarjeet Singh*

Division of Forest Products and Utilization, Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, J&K, India
Email: amerjeetskuast@gmail.com

Received-27.03.2026, Revised-14.04.2026, Accepted-27.04.2026

Abstract: *Valeriana jatamansi* Jones, commonly known as Indian Valerian, is a critically endangered medicinal herb in the Himalayan region due to habitat loss and the overexploitation of its aromatic rhizomes for pharmaceutical use. Traditional propagation methods via seeds and rhizome division are often inefficient, characterized by poor viability and germination rates having slow growth cycle. To address this, a study was conducted at the SKUAST-K Faculty of Forestry using a hydroponic-style system with apical cuttings treated with Naphthalene Acetic Acid (NAA) at various concentrations. The methodology involved maintaining cuttings in transparent glass beakers filled with distilled water, which was changed every two days to ensure proper oxygenation and hygiene. The research findings demonstrated that a low-concentration auxin treatment of 50 ppm NAA for a 30-minute duration (T1D1) was the most effective protocol, achieving a 100% rooting success rate. This treatment produced significantly superior results across all quantitative parameters, including an average of five roots per cutting and the average root diameter of 0.271 cm. In contrast, higher concentrations of 100 ppm and 150 ppm led to physiological stress, resulting in leaf chlorosis, tissue necrosis, and a sharp decline in rooting success. This simple and reliable vegetative propagation technique offers a scalable solution for producing high-quality, uniform planting material, supporting the urgent need for the conservation and sustainable cultivation of this endangered species.

Keywords: *Valeriana jatamansi,* Stem cuttings, NAA, Rooting, Medicinal Plants, Kashmir

INTRODUCTION

Valeriana jatamansi Jones is an important herb that belongs to the family Valerianaceae, the genus consists of over 250 species, spread across the world [1] and approximately 12 species are present in India [2]. The genus is known as 'Valerian' because of its common name. Common name of Valeriana jatamansi is Mushkbala, sugandhbala in Hindi and Tagar in Sanskrit [3] [4]. Species is gynodioecious [5] and possess pubescent stem and radical leaves with several long petioled, cordate-ovate, cauline few or much smaller entire or pinnate with hairy fruits or nearly glabrous. Flowers are white tinged with pink. Root stock thick and horizontal, aromatic and modular [6] . It is distributed from Pakistan, Afghanistan south-western china, Burma and a few parts of the Indian Himalayan range and is abundantly found at an altitude of 1300-3000m from Kashmir to Bhutan, and between 1500 and 1800 metres in the hills of Khasi and Jaintia [7]. Sexual reproduction is often hindered by low seed viability and poor germination rates, making it inefficient for large-scale production. Similarly, asexual propagation through rhizome division is restricted by a long gestation period and slow growth cycles. Keeping in view these propagation problems, this study was undertaken to evaluate the effect of Naphthalene Acetic Acid (NAA) growth hormone at various concentrations on the rooting behavior of *Valeriana jatamansi* Jones.By utilizing apical cuttings in a hydroponic setup, this research seeks to optimize rooting success and produce high-quality planting material. This approach aims to overcome traditional growth delays and support the sustainable conservation of this endangered medicinal herb.

MATERIALS AND METHODS

Study Area

The study was conducted at the Benhama Campus of the Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K), situated in Ganderbal, Jammu and Kashmir. Geographically, the site is positioned at approximately 34.27latitute and 74.77longitude, nestled in the foothills of the Lar mountains at an altitudinal range of 1600 m to 1843 m above mean sea level.

*Corresponding Author

Description and Selection of Plant Material

The experimental plant, *Valeriana jatamansi* Jones (commonly known as Indian Valerian), is a high-value medicinal herb known for its aromatic roots and therapeutic compounds. Healthy and mature mother plants were identified from the medicinal plant nursery of SKUAST-K, maintained under standard agronomic practices. From these mother plants, 100 apical cuttings were harvested early in the morning to ensure optimal turgidity. Each cutting was approximately 8-10 cm in length, bearing 2–3 nodes, and freshly green in appearance. Leaves present on the lower portion of the stem were removed to avoid excessive transpiration, while upper leaves were trimmed to half of their size. The basal portion of each cutting was given a slanting cut at a 45° angle to increase the surface area for root initiation and facilitate better absorption of hormone solutions. All tools used for cutting were sterilized using 70% ethanol to prevent microbial contamination.

Preparation of Hormone Treatments

NAA solutions were freshly prepared for each treatment by first dissolving the required quantity of NAA powder in a few milliliters of ethanol (to aid dissolution) and then diluting the solution to the desired concentration with distilled water. Cuttings were divided equally into four groups corresponding to the three treatment levels. Each cutting was dipped in the respective NAA solution for a fixed duration of 30,60 and 90 minutes respectively. This treatment was chosen based on previous studies which suggested that short-term exposure to auxin at low-to-moderate concentrations promotes root initiation without causing callus formation or phytotoxicity.

Table 1. Different treatments (T1 to T9) of NAA doses (ppm) at different time durations

Treatment	NAA conc. (ppm) with durations
T1D1	50ppm+30min
T2D2	50ppm+60min
T3D3	50ppm+90min
T4D1	100ppm+30min
T5D2	100ppm+60min
T6D3	100ppm+90min
T7D1	150ppm+30min
T8D2	150ppm+60min
T9D3	150ppm+90min

Experimental Design and Setup

The experiment was laid out in a Completely Randomized Design (CRD). A total of 100 apical cuttings were utilized. These cuttings were divided into three primary hormone concentration groups (50ppm,100ppm and 150ppm)'with each concentration further subdivided into three duration intervals (30,60 and 90 minutes). Each treatment combination was replicated across multiple beakers to ensure a total count of 100 samples. Each 250 ml transparent glass beaker was filled with distilled water, serving as the rooting medium for the hydroponic-style setup. Following the respective NAA dipping treatments, the cuttings were immediately transferred into these labeled beakers.

Maintenance During the Experimental Period

The beakers were placed on an elevated surface inside the lab in shade to avoid direct sunlight and excessive heat exposure. The environmental conditions during the experiment were monitored and maintained as follows:

Temperature: Between 18°C and 25°C

Relative Humidity: 70% to 80%

Light Intensity: Diffused light under par6tial shade

Observation and Data Collection

After 30 days, each cutting was gently removed from the beaker and examined for root formation. Care was taken not to damage the fragile roots during handling.

The following quantitative parameters were recorded for each rooted cutting:

Rooting Percentage (%): The proportion of cuttings in each treatment that successfully produced roots. It was calculated using the formula:

Rooting Percentage = (Number of rooted cuttings/Total number of cuttings) ×100 Number of Roots per Cutting:

Total number of adventitious roots produced per rooted cutting. The count was taken visually for each rooted sample and averaged for each treatment.

Root Length (cm): The length of the longest root on each cutting was measured using a measuring scale. This parameter reflects the growth potential and vigor of the newly formed roots.

Root Diameter (mm): The thickness of the root was measured at the widest point of the primary root using a digital vernier calliper. This parameter gives an idea about the strength and quality of root formation.

All observations were recorded in a tabulated format, and average values were calculated for each treatment and replicate.

Statistical Analysis

The experimental data were subjected to Analysis of Variance (ANOVA) using OPSTAT software developed by CCS Haryana Agricultural University, Hisar. The statistical model followed was that of a Completely Randomized Design (CRD). Treatment means were compared using the Critical Difference (CD) at 5% level of significance ($P<0.05$) to assess whether differences among the NAA concentrations were statistically significant. If the F-test was significant, the CD values were used to separate treatment means. Tables were also generated to visually represent the variation among treatments.

RESULTS AND DISCUSSION

The present investigation on **"Optimizing Vegetative Propagation of the Endangered Medicinal Herb *Valeriana jatamansi* jones Through Naphthalene Acetic Acid (NAA)"** was carried out to assess the effect of different concentrations of Naphthalene Acetic Acid (NAA) on rooting behaviour under hydroponic conditions.

Rooting Percentage

Rooting percentage is a critical indicator of successful vegetative propagation, reflecting the ability of plant tissues to initiate root primordia in response to hormonal stimuli. Among the treatments tested, the highest rooting percentage (100%) was recorded in cuttings treated with 50 ppm NAA for 30minutes (T1D1). In contrast, a steep decline in rooting success was observed in higher concentrations—66.67% for both 100 ppm (T4) and 150 ppm (T7), and a further reduction to 33.33% and complete failure in other treatments (T8-T9) as shown in table 2. This finding strongly indicates that *Valeriana jatamansi* Jones exhibits maximum rooting efficiency at lower auxin concentrations. The success of 50 ppm NAA in inducing root formation aligns with the findings of Gautam *et al.,* (2021) [8], who reported enhanced rooting at similar auxin concentrations in *Valeriana jatamansi* Jones.

On the other hand, the reduced rooting percentage at 100 ppm and 150 ppm suggests hormonal imbalance or phytotoxicity at elevated auxin levels. This phenomenon has been previously described by Klerk *et al.,* (1999) [9] , who noted that excess auxin interferes with cellular differentiation and leads to callus formation or necrosis rather than organized root development. The results confirm the presence of a hormonal threshold, beyond which auxins shift from being stimulatory to inhibitory.

Number of Roots per Cutting

In addition to root initiation, the number of roots per cutting determines the plant's ability to establish effectively after transplantation. The study found that 50 ppm NAA for 30 minutes (T1D1) produced a significantly higher number of roots (mean = 5), while T2 (100 ppm) and T3 (150 ppm) recorded mean values of 1.11 and 1.22, respectively as mentioned in table 3. The reduced number of roots in T4 and T3 may be attributed to overstimulation of auxin receptors, leading to abnormal cell division or suppression of root primordia formation. This corroborates with Hartmann *et al.,* (2011) [10], who emphasized the principle of optimal hormonal dosage for effective root induction and proliferation. Bhatt *et al.,* (2021) [11] further confirmed that excessive NAA concentrations can lead to callus tissue rather than differentiated root structures. The findings of this study are thus in strong agreement with the broader literature, reinforcing the necessity of fine-tuning auxin levels during vegetative propagation.

Figure 1: Image showing rooting in *Valeriana jatamansi* Jones cuttings.

Root Length

Root length is a key physiological trait that reflects the plant's capacity to explore the rooting medium. While occasional longer roots were observed in T3, the overall mean root length was highest in 50ppm NAA for 30 minutes (T1D1) (0.63 cm), suggesting that lower auxin concentration led to more uniform and healthier root development as shown in table 4. In T2 and T3, root elongation was inconsistent, and roots appeared thinner and weaker, indicating stress-induced elongation rather than true physiological growth. Baskaran and Jayabalan (2005) [12] reported similar findings in medicinal plants, where optimal auxin levels led to well-developed root systems, while higher concentrations disrupted normal elongation and vascular differentiation. It is also noteworthy that high concentrations of NAA sometimes result in elongation of individual roots due to hormonal stress, but such roots often lack structural integrity and functional efficiency. T1, on the other hand, exhibited balanced development in both root length and number.

Root Diameter

Root diameter provides insight into the structural and vascular quality of the root system. Well-developed roots with higher diameters are more likely to survive transplantation, withstand desiccation, and support the shoot system. In the present study, as shown in table 5, T1 (50 ppm NAA for 30min) recorded the greatest mean root diameter (0.271 cm), indicating superior vascular development. T2 and T3 treatments showed a reduction in root diameter, with some roots appearing fragile and underdeveloped. These results support the earlier observations of [Klerk *et al.*, (1999) [9]; Baskaran and Jayabalan (2005)] [12] that emphasize the importance of balanced auxin levels for anatomical development in roots.

Table 3. Effect of NAA Concentrations on Rooting Parameters of *Valeriana jatamansi* Jones

S.No.	Treatment	Average Roots/Cutting	Average Root Length(cm)	Average Root Diameter(cm)	Rooting Percentage (%)
01	T1D1	5.00	0.630	0.271	100.00
02	T2D2	1.11	1.144	1.099	63.64
03	T3D3	1.22	1.277	0.106	63.64
04	T4D1	1.10	0.303	0.140	36.36
05	T5D2	0.00	0.077	1.110	0.00
06	T6D3	1.10	0.060	0.047	36.36
07	T7D1	1.20	0.257	0.230	36.36
08	T8D2	0.00	0.123	0.087	0.00
09	T9D3	0.00	0.00	0.00	0.00
CD (p>0.05	Factor A	0.850	0.247	0.051	
	Factor B	0.850	0.247	0.051	
	A x B	1.480	N.S	0.088	

Visual and Practical Observations

In addition to numerical parameters, visual assessments played a vital role in evaluating treatment effectiveness. The cuttings under 50 ppm NAA for 30 minutes (T1D1) appeared greener, turgid, and free from symptoms of stress throughout the 30-day observation period. In contrast, cuttings in higher concentration treatments began to show leaf chlorosis, wilting, callus formation, and tissue necrosis, especially in T3.

Role of NAA Concentration and Exposure Time

The effectiveness of 50 ppm NAA concentration is largely attributed to its ability to stimulate endogenous auxin activity without disrupting the natural hormonal balance within the plant. The 30-minute exposure time was short enough to allow absorption without over saturating the tissues. Studies have shown that excessive auxin concentrations can result in callusing instead of root formation, which was observed to a small extent in T3. Therefore, a low-concentration, short-duration exposure to NAA appears optimal for rooting in softwood cuttings of *Valeriana jatamansi* Jones.

SUMMARY AND CONCLUSION

The present study, titled "Propagation of *Valeriana jatamansi* Jones through Cuttings", was carried out at the Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, during the autumn semester of 2024. The aim was to develop an effective vegetative propagation protocol using apical cuttings of *Valeriana jatamansi* Jones, a high-value medicinal herb that is currently listed as endangered due to overexploitation and habitat degradation (Maurya *et al.*, 2017). A total of 100 cuttings were treated with three different concentrations of Naphthalene Acetic Acid (NAA): 50 ppm, 100 ppm, and 150 ppm, with each treatment replicated. The analysis was performed using OPSTAT software following a Completely Randomized Design (CRD). The cuttings were maintained in transparent glass beakers filled with distilled water (hydroponic conditions) and placed under partial shade. The water was changed every two days to maintain oxygen availability and prevent microbial growth.

Observations made after 30 days focused on four critical parameters: rooting percentage, number of roots per cutting, root length, and root diameter. The findings revealed that 50 ppm NAA for 30 minutes (T1D1) was significantly superior in promoting rooting success across all parameters. Cuttings treated with 50 ppm NAA for 30 minutes had the highest rooting percentage (100%), produced an average of five roots per cutting, and exhibited longer and thicker roots compared to higher concentrations. These results are in close agreement with Bhatt *et al*. (2021) [11], who reported improved rooting in Valeriana jatamansi under low to moderate concentrations of NAA and IBA, and with Gautam *et al*. (2021) [8], who noted that 50 ppm NAA was optimal under hydroponic conditions for this species.

The highest rooting percentage (100%) was recorded in cuttings treated with 50 ppm NAA for 30 minutes (T1D1).

The study found that 50 ppm NAA for 30 minutes (T1D1) produced a significantly higher number of roots (mean = 5), while T2 (100 ppm) and T3 (150 ppm) recorded mean values of 1.11 and 1.22

Longer roots were observed in T3, the overall mean root length was highest in T1 (0.63 cm), suggesting that lower auxin concentration led to more uniform and healthier root development.

T1D1 (50 ppm NAA for 30 minutes) recorded the greatest mean root diameter (0.271 cm), indicating superior vascular development. T2 and T3 treatments showed a reduction in root diameter, with some roots appearing fragile and underdeveloped.

In visual observation the cuttings under 50 ppm NAA for 30 minutes (T1D1) appeared greener, turgid, and free from symptoms of stress throughout the 30-day observation period. In contrast, cuttings in higher concentration treatments began to show leaf chlorosis, wilting, callus formation, and tissue necrosis, especially in T3.

A low-concentration, short-duration exposure to NAA appears optimal for rooting in softwood cuttings of *Valeriana jatamansi* Jones.

The hydroponic setup proved advantageous for this experiment, allowing clean visibility of root formation and maintaining a disease-free environment.

CONCLUSION

In conclusion, this propagation protocol offers a simple yet reliable technique for nursery managers, conservation biologists, and medicinal plant cultivators aiming to multiply genetically uniform, high-quality planting material of *Valeriana jatamansi* Jones. Given its endangered status and pharmacological value, it is recommended that this method be integrated into medicinal plant conservation programs. Further studies may be undertaken to compare the effect of other rooting hormones (like IBA or IAA) and different rooting substrates (such as cocopeat or sand) under controlled environments to optimise field-level scalability.

REFERENCES

Bhattacharjee, S.K., Jaipur: Pointer Publishers (2000). Handbook of Aromatic Plants; pp. 458–9.
Google Scholar

Prakash, V. 1-2. Jodhpur, India: Scientific Publishers (1999). Indian Valerianaceae. A Monograph on Medicinally Important Family.
Google Scholar

Raina, R. and Srivastava, L.J. (1992). Floral Polymorphism in Valeriana jatamansi Jones. Indian *Journal of Plant Genetic Resources*, **5**, 93-94.
Google Scholar

Raina, A.P. and Negi, K.S. (2015) Essential Oil Composition of Valeriana jatamansi Jones from Himalayan Regions of India. *Indian Journal of Pharmaceutical Sciences*, **77**, 218-222.
Google Scholar

Raina, R and Srivastava, R.J. (1992). *Ind.J.Plant Sci*., **5**(2): 93 – 94
Google Scholar

Hooker, J.D. Flora of British India, Vol (III) 1881; pp. 213
Google Scholar

Kirtikar, K.R. and Basu, B.D. (1975). Indian Medicinal Plants. Bishen Singh Mahendra Pal Singh, Dehra Dun, pp. 311-312.
Google Scholar

Gautam, R.D., Kumar, A., Kumar, R., Chauhan, R., Singh, S., Kumar, M., Kumar, D., Kumar, A. and Singh, S. (2021). Clonal Propagation of Valeriana jatamansi Retains the Essential Oil Profile of Mother Plants: An Approach Toward Generating Homogenous Grade of Essential Oil for Industrial Use. Front. Plant Sci. **12**:738247. doi: 10.3389/fpls.2021.738247.
Google Scholar

De Klerk, G.-J., Van Der Krieken, W. and De Jong, J. C. (1999). The formation of adventitious roots: new concepts, new possibilities. In Vitro Cellular & Developmental Biology - Plant, **35**(3), 189–199.
Google Scholar

Hartmann, H. T., Kester, D. E., Davies, F. T. and Geneve, R. L. (2011). Hartmann & Kester's Plant Propagation: Principles and Practices (8th ed.). Prentice Hall.
Google Scholar

Bhatt, R., Asopa, P. P., Jain, R. and Kachhwaha, S. (2021). Efficient plant regeneration through callus culture in Hedychium spicatum / Trachyspermum copticum / Kodo millet.
Google Scholar

Baskaran, P. and Jayabalan, N. (2005). An efficient micropropagation system for Eclipta alba—A valuable medicinal herb. In Vitro Cellular & Developmental Biology - Plant, **41**(4), 532–539.
Google Scholar