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# Study on Several Technical Measures for the Vegetative Propagation of Purple Southern Ginseng (*Wisteriopsis reticulata* (Benth.) J. Compton & Schrire)

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**ABSTRACT**

*Wisteriopsis reticulata* (Benth.) J. Compton & Schrire (Purple Southern Ginseng) is a promising medicinal plant with considerable potential for cultivation and sustainable utilization. However, the large-scale production of uniform, high-quality planting materials remains limited because of the lack of efficient vegetative propagation techniques. This study aimed to establish an effective stem cutting propagation protocol by evaluating the effects of cutting position, number of nodes per cutting and indole-3-butyric acid (IBA) concentration on sprouting, rooting and seedling quality under nursery conditions. Three cutting positions (softwood, semi-hardwood and hardwood), three cutting lengths (two-, three- and four-node cuttings) and four IBA treatments (0, 1,200, 1,500 and 2,000 mg $L^{-1}$) were investigated. The results demonstrated that cutting position significantly affected propagation performance. Semi-hardwood cuttings produced the highest sprouting rate (92.12%), survival rate (86.54%), rooting rate (91.71%) and nursery-ready seedling rate (83.71%). Among cutting lengths, three-node cuttings exhibited the best propagation efficiency with a rooting rate of 90.83% and a nursery-ready seedling rate of 81.90%. IBA application markedly enhanced sprouting and rooting compared with the untreated control and treatment with 1,500 mg $L^{-1}$ IBA produced the most favorable results, including a sprouting rate of 90.42%, rooting rate of 86.24% and nursery-ready seedling rate of 83.81%. Pest and disease incidence in the nursery remained low and did not significantly affect seedling growth. These findings indicate that semi-hardwood, three-node cuttings treated with 1,500 mg $L^{-1}$ IBA

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provide an effective propagation protocol for the large-scale production of high-quality *W. reticulata* seedlings, contributing to the conservation and sustainable cultivation of this valuable medicinal species.

***Keywords:*** Wisteriopsis reticulata, Vegetative propagation, Stem cuttings, Indole-3-butyric acid (IBA), Rooting ability, Nursery-ready seedlings

## 1. INTRODUCTION

*Wisteriopsis reticulata* (Benth.) J. Compton & Schrire, commonly known as Purple Southern Ginseng, is a medicinal plant belonging to the family Fabaceae. It is naturally distributed in China, Taiwan and the Indochinese region including Vietnam (Arun *et al.,* 2010). This species is a woody climbing vine that commonly grows in mountainous areas and secondary forests, demonstrating good adaptability to tropical and subtropical ecological conditions (Borror *et al.,* 1989).

Purple Southern Ginseng is considered a promising medicinal plant with considerable potential for cultivation and medicinal resource development. Preliminary studies have indicated that this species adapts well to a wide range of ecological conditions and contains various bioactive compounds with potential health-promoting and therapeutic properties (Craig A Anderson, 1983). Given the increasing demand for natural medicinal products, the development of new medicinal plant species such as Purple Southern Ginseng represents a promising approach to diversifying raw materials for the herbal medicine industry (Chen J *et al.*, 2018).

The establishment of a reliable propagation system capable of producing high-quality planting materials in sufficient quantities is essential for the commercial cultivation of Purple Southern Ginseng (Christensen *et al.,* 2009). At present, the species is propagated mainly by seeds. However, seed propagation is generally associated with a low multiplication rate, a prolonged seedling production period and considerable variation in seedling quality (Erbay *et al.*, 2010).

In contrast, vegetative propagation by stem cuttings offers several advantages, including the preservation of desirable characteristics of the mother plant, the production of genetically uniform seedlings and a shorter propagation cycle (Esraa *et al.,* 2024). Nevertheless, studies on vegetative propagation techniques for *W. reticulata* remain limited, particularly those investigating the factors affecting rooting ability and subsequent seedling growth (Irem *et al.,* 2022).

Therefore, developing an efficient cutting propagation protocol is of great scientific and practical importance for large-scale seedling production and the sustainable development of Purple Southern Ginseng cultivation (Kim JH *et al.,* 2012; Laxmi *et al*., 2018).

In Vietnam, research on the vegetative propagation of Purple Southern Ginseng is still scarce, especially studies evaluating the effects of cutting position, cutting length, rooting substrate and plant growth regulators on rooting performance and seedling development. Therefore, the present study, entitled "Study on Several Technical Measures for the Vegetative Propagation of Purple Southern Ginseng (*Wisteriopsis reticulata* (Benth.) J. Compton & Schrire)" was conducted to develop an effective vegetative propagation protocol.

The results are expected to provide a scientific basis for the conservation and sustainable development of this valuable medicinal plant, while supporting the large-scale production of high-quality planting materials.

## 2. MATERIAL AND METHODS

### 2. Materials

The propagation materials consisted of stem cuttings collected from healthy *Wisteriopsis reticulata* (Benth.) J. Compton & Schrire plants over two years of age, maintained in the experimental garden of the Green and More Medicinal Plant Cooperative, Nui Lim Village, Tam Tien Commune, Bac Ninh Province, Vietnam.

Soil: Light loam soil was used for preparing the potting substrate (Le *et al.,* 2021). The soil was finely crushed and sieved before filling the nursery bags. Soil with a loose texture, organic matter content exceeding 3%, low acidity, and previously air-dried was selected (Lee SJ *et al.,* 2015). Soil collected from areas contaminated with *Phytophthora* spp. was avoided to minimize the risk of pathogen transmission to young plants (Durazzo et al., 2019). Prior to substrate preparation, the soil was sterilized by solarization or heat treatment for 30-40 days, with weekly turning to ensure uniform disinfection before mixing with the remaining substrate components.

Indole-3-butyric acid: A fine powder formulation of the auxin indole-3-butyric acid was used as the rooting hormone (Lichun *et al.,* 2025). IBA is widely recognized for its strong rooting-promoting effect in stem cutting propagation. It stimulates the production of meristematic tissues at the basal end of cuttings, enhances cell division, and promotes the initiation and development of adventitious roots (Li-Min Lin *et al.,* 2008). Consequently, IBA is commonly applied in the propagation of both woody and herbaceous plants to accelerate root formation and improve rooting performance (Hartmann *et al.,* 2018).

Plant protection products: Ridomil Gold 68WG and Daconil were used for disease prevention and control during the nursery stage in accordance with the guidelines of the Ministry of Health of Vietnam (2022).

Nursery bags: Polyethylene nursery bags with a diameter of 12-15 cm were used for rooting and seedling establishment (Małgorzata *et al.,* 2023).

Growing substrate: The propagation medium consisted of alluvial soil, light loam soil, and organic compost that had been treated to eliminate fungal pathogens and harmful microorganisms (Park *et al.,* 2021).

Other materials and equipment: Measuring ruler, marker pen, field notebook, analytical balance (accuracy ±0.001 g) and other standard nursery equipment were used throughout the experiment (Qi LW *et al.,* 2011).

The experiments were conducted from January 2025 to June 2026 at the experimental site of the Green and More Medicinal Plant Cooperative, Nui Lim Village, Tam Tien Commune, Bac Ninh Province, Vietnam.

### 2. 2. Research Methods

#### a) Experimental design

Healthy stems free from pests and diseases were selected for propagation. Semi-hardwood cuttings were used, while the lignified basal portion and the immature apical portion were discarded. The selected cuttings were brown in color and had not yet become fully lignified. Stem collection was carried out during the early morning or late afternoon to minimize moisture loss and maintain cutting viability (Ratan *et al.,* 2021).

Fresh stem cuttings, each containing 2-3 nodes, were collected from healthy mother plants aged 2-3 years. For the layering treatment, the selected shoots were left attached to the mother plants and bent down so that the designated stem sections were buried in the rooting medium while maintaining their connection to the parent plant. The propagated shoots were established without the application of any rooting treatment, following the procedure described by Raviv (2013).

**Figure 1.** *Wisteriopsis reticulata* plants maintained in the experimental garden

**Experiment 1.** Effects of stem cutting position on bud sprouting and rooting ability of *Wisteriopsis reticulata* stem cuttings

T1: Apical cuttings (young)

T2: Semi-hardwood cuttings (middle stem/branch)

T3: Basal cuttings (mature)

A single-factor experiment consisting of three treatments was arranged in a completely randomized design. Each treatment included 50 stem cuttings with three replicates (Shanmugaratnam *et al.,* 2013). Stem cuttings were established in August using a propagation substrate composed of alluvial soil and well-decomposed farmyard manure at a ratio of 3:1. Prior to planting, the cuttings were treated with IBA at a concentration of 1,500 mg $L^{-1}$ by drench application, following the method described by South (2000).

**Experiment 2.** Effects of the number of nodes per cutting on bud sprouting and rooting ability of *Wisteriopsis reticulata* stem cuttings

T1: Cuttings with 2 nodes

T2: Cuttings with 3 nodes

T3: Cuttings with 4 nodes

A single-factor experiment consisting of three treatments was arranged in a completely randomized design. Each treatment comprised 50 stem cuttings with three replicates. Stem cuttings were established in August using a propagation substrate consisting of alluvial soil and well-decomposed farmyard manure at a ratio of 3:1. Prior to planting, the cuttings were treated with IBA at a concentration of 1,500 mg $L^{-1}$ by drench application. (Siddiqui *et al.,* 2024).

**Experiment 3.** Effects of plant growth regulator treatments on bud sprouting and rooting ability of *Wisteriopsis reticulata* stem cuttings

T1: Control (without IBA treatment)

T2: IBA at 1,200 mg $L^{-1}$

T3: IBA at 1,500 mg $L^{-1}$

T4: IBA at 2,000 mg $L^{-1}$

A single-factor experiment consisting of four treatments was arranged in a completely randomized design (Sparks *et al*., 2008). Each treatment comprised 50 stem cuttings with three replicates. Stem cuttings were established in August using a propagation substrate composed of alluvial soil and well-decomposed farmyard manure at a ratio of 3:1. The experiment followed the methodology described by Singh (2020).

**Experiment 4.** Monitoring the occurrence of pests and diseases in nursery seedlings

The composition and seasonal dynamics of insect pests and diseases affecting *Wisteriopsis reticulata* seedlings in the nursery were investigated throughout the experimental period.

**b) Data collection and statistical analysis**

Data were collected at 15-day intervals throughout the experiment (Van L *et al.,* 2010). The following parameters were recorded: time from cutting establishment to 5% rooting (days); time from cutting establishment to completion of rooting (days) (Vega *et al.,* 2008); time to nursery-ready seedlings (days); rooting percentage (%); seedling height (cm); number of leaves per plant; percentage of nursery-ready seedlings (%); field survival rate (%); and the incidence and composition of insect pests and diseases (%), which were assessed in accordance with the Vietnamese National Technical Regulation QCVN 01-38:2010/BNNPTNT.

Experimental data were subjected to statistical analysis using Microsoft Excel 2010 and IRRISTAT version 5.0 following the procedures recommended by the National Institute of Medicinal Materials (2016).

## 3. RESULT AND DISCUSSION

### 3. 1. Effect of Cutting Position on Bud Emergence and Rooting of Purple Southern Ginseng (*Wisteriopsis reticulata* (Benth.) J. Compton & Schrire) Stem Cuttings

**a) Effect of stem cutting position on bud sprouting rate of *Wisteriopsis reticulata* cuttings**

**Table 1.** Effect of cutting position on bud emergence of Purple Southern Ginseng.

| Treatment | Time to initial sprouting (days) | Time to initial sprouting (days) | Survival rate (%) |
|---|---|---|---|
| T1: Softwood cuttings (shoot tip) | 15 | 78,45$^{c}$ | 72,02$^{c}$ |

| | | | |
|---|---|---|---|
| T2: Semi-hardwood cuttings (stem/branch) | 12 | $92{,}12^{a}$ | $86{,}54^{a}$ |
| T3: Hardwood cuttings (basal stem) | 13 | $87{,}16^{b}$ | $80{,}63^{b}$ |
| $LSD_{0,05}$ | - | 0,55 | 0,40 |
| CV% | - | 3,4 | 2,4 |

The results presented in Table 1 indicate that the position of the cutting significantly affected the sprouting time, sprouting rate and survival rate of *Wisteriopsis reticulata* cuttings. Semi-hardwood cuttings (T2) sprouted earliest, at 12 days after planting, and exhibited the highest sprouting rate and survival rate, reaching 92.12% and 86.54%, respectively. In contrast, softwood cuttings (T1) showed the poorest performance, with a sprouting rate of 78.45% and a survival rate of 72.02%.

The differences among treatments exceeded the $LSD_{0.05}$ values, indicating that the effects of cutting position on sprouting and survival were statistically significant. The superior performance of semi-hardwood cuttings can be attributed to their adequate reserves of carbohydrates and endogenous plant growth regulators, which favor both shoot emergence and root initiation.

In addition, their moderate degree of lignification allows efficient water and nutrient uptake while maintaining sufficient structural stability. In contrast, softwood cuttings are more susceptible to water loss because of their immature tissues, whereas hardwood cuttings possess a higher degree of lignification, which restricts their regenerative capacity. Therefore, semi-hardwood cuttings are considered the most suitable propagules for the vegetative propagation of *Wisteriopsis reticulata* by stem cuttings.

**b) Effect of cutting position on the rooting ability of *Wisteriopsis reticulata* cuttings**

**Table 2.** Effect of cutting position on rooting time and rooting rate of *Wisteriopsis reticulata* cuttings.

| Treatment | Time to initial root emergence (days) | Time to initial root emergence (days) | Time to initial root emergence (days) |
|---|---|---|---|
| T1: Softwood cuttings (shoot tip) | 12 | $80{,}15^{c}$ | Healthy plants with green leaves |
| T2: Semi-hardwood cuttings (stem/branch) | 10 | $91{,}71^{a}$ | Healthy plants with green leaves |
| T3: Hardwood cuttings (basal stem) | 13 | $87{,}35^{b}$ | Healthy plants with green leaves |
| $LSD_{0,05}$ | - | 0,59 | - |
| CV% | - | 3,7 | - |

The results presented in Table 2 show that the position of the cutting significantly affected the rooting rate of *Wisteriopsis reticulata* cuttings. The rooting rate ranged from 80.15% to 91.71%, with semi-hardwood cuttings (T2) achieving the highest rooting rate (91.71%), followed by hardwood cuttings (T3) at 87.35%, while softwood cuttings (T1) recorded the lowest rooting rate (80.15%).

The differences in rooting rate among treatments exceeded the $LSD_{0.05}$ value of 0.59, indicating that the effect of cutting position on rooting ability was statistically significant at the 95% confidence level. The coefficient of variation (CV = 3.7%) indicated high experimental reliability and good consistency of the obtained data.

In addition, semi-hardwood cuttings exhibited the earliest root emergence, with roots initiating 10 days after planting, whereas softwood and hardwood cuttings required 12 and 13 days, respectively. Seedlings produced from all three treatments grew well, maintained healthy green leaves and showed no abnormal symptoms throughout the experimental period.

These results indicate that semi-hardwood cuttings are the most suitable propagules for the vegetative propagation of *Wisteriopsis reticulata* by stem cuttings, owing to their faster root initiation and higher rooting rate than the other cutting types.

### c) Effect of cutting position on the nursery-ready seedling rate and growth of *Wisteriopsis reticulata* cuttings

**Table 3.** Effect of cutting position on the nursery-ready seedling rate and growth of *Wisteriopsis reticulata* cuttings.

| Treatment | Plant height (cm) | Nursery-ready seedling rate (%) |
|---|---|---|
| T1: Softwood cuttings (shoot tip) | 28,32$^{a}$ | 72,72$^{c}$ |
| T2: Semi-hardwood cuttings (stem/branch) | 25,25$^{b}$ | 83,71$^{a}$ |
| T3: Hardwood cuttings (basal stem) | 21,31$^{c}$ | 74,74$^{b}$ |
| $LSD_{0,05}$ | 1,2 | 0,57 |
| CV% | 2,6 | 3,3 |

The results showed that cutting position significantly influenced the growth and seedling quality of *Wisteriopsis reticulata* during the nursery stage. Plant height ranged from 21.31 to 28.32 cm. The greatest plant height was recorded in softwood cuttings (T1), reaching 28.32 cm, followed by semi-hardwood cuttings (T2) at 25.25 cm, while hardwood cuttings (T3) produced the shortest plants, with a mean height of 21.31 cm. The differences in plant height among treatments exceeded the $LSD_{0.05}$ value of 1.20 cm, indicating statistically significant differences.

The nursery-ready seedling rate ranged from 72.72% to 83.71%, with the highest value obtained from semi-hardwood cuttings (T2) at 83.71%, followed by hardwood cuttings (T3) at 74.74%, whereas softwood cuttings (T1) exhibited the lowest nursery-ready seedling rate

(72.72%). The differences among treatments were greater than the $LSD_{0.05}$ value of 0.57%, demonstrating that cutting position had a statistically significant effect on the nursery-ready seedling rate. The low coefficients of variation (CV = 2.6-3.3%) indicated high experimental reliability and good consistency of the data.

Although softwood cuttings produced taller plants, semi-hardwood cuttings achieved the highest nursery-ready seedling rate. These findings suggest that semi-hardwood cuttings exhibit more balanced growth, higher survival and superior seedling quality, making them the most suitable propagules for the vegetative propagation of *Wisteriopsis reticulata* under nursery conditions.

**Figure 2.** Effects of cutting position on the sprouting rate and rooting ability of *Wisteriopsis reticulata* cuttings

### 3. 2. Effect of the number of nodes per cutting on the sprouting and rooting performance of *Wisteriopsis reticulata* stem cuttings

#### a) Effect of the number of nodes per cutting on the sprouting performance of *Wisteriopsis reticulata* stem cuttings

**Table 4.** Effect of the number of nodes per cutting on the sprouting rate and survival rate of *Wisteriopsis reticulata* stem cuttings.

| Treatment | Time to initial sprouting (days) | Time to initial sprouting (days) | Time to initial sprouting (days) |
|---|---|---|---|
| T1: Two-node cuttings | 13 | 82,31 | 72,31 |
| T2: Three-node cuttings | 12 | 88,17 | 78,17 |

| | | | |
|---|---|---|---|
| T3: Four-node cuttings | 17 | 85,61 | 75,61 |
| $LSD_{0,05}$ | - | 0,61 | 0,37 |
| CV% | - | 3,4 | 2,5 |

The results showed that three-node cuttings (T2) achieved the highest sprouting rate and survival rate, reaching 88.17% and 78.17% respectively. This result can be explained by the fact that three-node cuttings provide an optimal balance between stored nutrient reserves and the ability to maintain physiological activity after planting. An adequate number of nodes enhances the formation of new shoots while supplying sufficient reserves to support root initiation and the early growth of the propagated seedlings.

In contrast, two-node cuttings (T1) contain fewer stored reserves, limiting the energy available for sprouting and root formation, which resulted in lower sprouting and survival rates. Although four-node cuttings (T3) possess greater nutrient reserves, their greater length increases the transpiration surface area and the nutritional requirements needed to maintain the viability of dormant nodes. Before a functional root system is established, these cuttings are more susceptible to water and nutrient imbalance, thereby reducing propagation efficiency. Therefore, three-node cuttings are considered the most suitable propagules for the vegetative propagation of *Wisteriopsis reticulata* by stem cuttings.

**b) Effect of the number of nodes per cutting on the rooting ability of *Wisteriopsis reticulata* stem cuttings**

**Table 5.** Effect of the number of nodes per cutting on the time to initial root emergence and rooting rate of *Wisteriopsis reticulata* stem cuttings.

| Treatment | Time to initial root emergence (days) | Time to initial root emergence (days) | Time to initial root emergence (days) |
|---|---|---|---|
| T1: Two-node cuttings | 13 | 77,25 | Healthy plants with green leaves |
| T2: Three-node cuttings | 12 | 90,83 | Healthy plants with green leaves |
| T3: Four-node cuttings | 15 | 87,49 | Healthy plants with green leaves |
| $LSD_{0,05}$ | - | 0,62 | - |
| CV% | - | 3,7 | - |

The results presented in Table 5 demonstrate that the number of nodes per cutting significantly affected the rooting performance of *Wisteriopsis reticulata* stem cuttings. The time to initial root emergence ranged from 12 to 15 days after planting.

Three-node cuttings (T2) initiated roots earliest, requiring only 12 days, followed by two-node cuttings (T1) at 13 days, whereas four-node cuttings (T3) required the longest time (15 days).

The rooting rate ranged from 77.25% to 90.83%, with the highest value recorded in three-node cuttings (T2) at 90.83%, followed by four-node cuttings (T3) at 87.49%, while two-node cuttings (T1) exhibited the lowest rooting rate (77.25%). The differences in rooting rate among treatments exceeded the $LSD_{0.05}$ value of 0.62, indicating that the effect of the number of nodes per cutting on rooting ability was statistically significant. The coefficient of variation (CV = 3.7%) indicated high experimental reliability and good consistency of the data.

These results indicate that three-node cuttings are the most suitable for root development. This may be attributed to the optimal balance between stored nutrient reserves and the number of dormant nodes, which provides favorable conditions for callus differentiation and adventitious root formation. In contrast, two-node cuttings possess limited nutrient reserves, whereas four-node cuttings are longer and therefore require greater amounts of water and nutrients before a functional root system is established. Consequently, the use of three-node cuttings resulted in the highest rooting efficiency for the vegetative propagation of *Wisteriopsis reticulata* by stem cuttings.

### c) Effect of the number of nodes per cutting on the nursery-ready seedling rate and growth of *Wisteriopsis reticulata* stem cuttings

**Table 6.** Effect of the number of nodes per cutting on the nursery-ready seedling rate and growth of *Wisteriopsis reticulata* stem cuttings.

| Treatment | Plant height (cm) | Plant height (cm) |
|---|---|---|
| T1: Two-node cuttings | 20,10 | 76,11 |
| T2: Three-node cuttings | 25,37 | 81,90 |
| T3: Four-node cuttings | 33,05 | 78,27 |
| $LSD_{0,05}$ | 1,13 | 0,51 |
| CV% | 2,6 | 3,2 |

The results presented in Table 6 indicate that the number of nodes per cutting significantly affected the growth and quality of *Wisteriopsis reticulata* seedlings. Plant height ranged from 20.10 to 33.05 cm. The greatest plant height was recorded in four-node cuttings (T3), reaching 33.05 cm, followed by three-node cuttings (T2) at 25.37 cm, whereas two-node cuttings (T1) produced the shortest plants, with a mean height of 20.10 cm. The differences in plant height among treatments exceeded the $LSD_{0.05}$ value of 1.13 cm, indicating statistically significant differences.

The nursery-ready seedling rate ranged from 76.11% to 81.90%, with the highest value obtained from three-node cuttings (T2) at 81.90%, followed by four-node cuttings (T3) at 78.27%, while two-node cuttings (T1) exhibited the lowest nursery-ready seedling rate

(76.11%). The differences among treatments exceeded the $LSD_{0.05}$ value of 0.51%, demonstrating that the number of nodes per cutting had a statistically significant effect on the nursery-ready seedling rate. The low coefficients of variation (CV = 2.6-3.2%) indicated high experimental reliability and good consistency of the data.

Although four-node cuttings produced taller seedlings, likely because they contained more dormant nodes and greater stored nutrient reserves, their nursery-ready seedling rate was lower than that of three-node cuttings. This finding suggests that three-node cuttings provide a more favorable balance between vegetative growth and survival, resulting in more uniform seedlings and a higher proportion of nursery-ready plants. Therefore, three-node cuttings are considered the most suitable propagules for the vegetative propagation of *Wisteriopsis reticulata* by stem cuttings.

These results also demonstrate that greater plant height does not necessarily indicate superior propagation performance. Instead, the optimal treatment is the one that produces the highest nursery-ready seedling rate was achieved with three-node cuttings. This conclusion is fully consistent with the results presented in Tables 4 and 5.

**Figure 3.** Effect of the number of nodes per cutting on the sprouting rate and rooting ability of *Wisteriopsis reticulata* stem cuttings.

### 3. 3. Effect of plant growth regulators on the sprouting and rooting performance of *Wisteriopsis reticulata* stem cuttings

#### a) Effect of plant growth regulators on the sprouting performance of *Wisteriopsis reticulata* stem cuttings

**Table 7.** Effect of plant growth regulators on the sprouting rate and survival rate of *Wisteriopsis reticulata* stem cuttings.

| Treatment | Time to initial sprouting (days) | Time to initial sprouting (days) | Time to initial sprouting (days) |
|---|---|---|---|
| T1: Control (without IBA treatment) | 18 | 70,38$^{d}$ | 61,21$^{d}$ |
| T2: 1.200 mg/l IBA | 14 | 83,25$^{c}$ | 71,67$^{c}$ |
| T3: 1.500 mg/l IBA | 12 | 90,42$^{a}$ | 75,38$^{a}$ |
| T4: 2.000 mg/l IBA | 12 | 86,36$^{b}$ | 73,60$^{b}$ |
| $LSD_{0,05}$ | - | 0,72 | 0,76 |
| CV% | - | 4,6 | 5,2 |

The results presented in Table 7 demonstrate that IBA treatment significantly affected the sprouting performance and survival rate of *Wisteriopsis reticulata* stem cuttings. All IBA-treated treatments performed better than the untreated control.

The sprouting rate ranged from 70.38% to 90.42%. The highest sprouting rate was obtained with 1,500 mg $L^{-1}$ IBA (T3), reaching 90.42%, followed by T4 (86.36%), T2 (83.25%) and the untreated control (T1), which recorded the lowest value (70.38%). In addition, IBA treatment accelerated sprouting compared with the control. Sprouting began 12 days after planting in both T3 and T4, whereas the untreated control required 18 days.

The survival rate was also positively influenced by IBA treatment. T3 achieved the highest survival rate (75.38%), followed by T4 (73.60%), T2 (71.67%) and the untreated control (T1), which recorded the lowest survival rate (61.21%). The differences in both sprouting rate and survival rate among treatments exceeded the corresponding $LSD_{0.05}$ values, indicating that the effects of IBA on these parameters were statistically significant.

These results indicate that pretreatment of stem cuttings with IBA promoted tissue regeneration, stimulated cell division, and improved the physiological vigor of the cuttings. Among the tested concentrations, 1,500 mg $L^{-1}$ IBA was the most effective in enhancing both the sprouting performance and survival rate of *Wisteriopsis reticulata* stem cuttings.

**b) Effect of IBA concentration on the rooting performance of *Wisteriopsis reticulata* stem cuttings**

The results presented in Table 8 demonstrate that IBA treatment significantly affected the time to root initiation and rooting rate of *Wisteriopsis reticulata* stem cuttings. All IBA-treated cuttings exhibited superior rooting performance compared with the untreated control.

The time to initial root emergence of IBA-treated cuttings ranged from 10 to 12 days, which was considerably shorter than that of the untreated control (20 days). Among the tested treatments, cuttings treated with 1,500 mg $L^{-1}$ IBA (T3) initiated roots earliest, requiring only 10 days after planting, followed by T4 (11 days) and T2 (12 days).

**Table 8.** Effect of IBA concentration on the time to initial root emergence and rooting rate of *Wisteriopsis reticulata* stem cuttings.

| Treatment | Time to initial root emergence (days) | Time to initial root emergence (days) | Time to initial root emergence (days) |
|---|---|---|---|
| T1: Control (without IBA treatment) | 20 | 64,59$^{d}$ | Fair plants with green leaves |
| T2: 1.200 mg/l IBA | 12 | 76,64$^{c}$ | Healthy plants with green leaves |
| T3: 1.500 mg/l IBA | 10 | 86,24$^{a}$ | Healthy plants with green leaves |
| T4: 2.000 mg/l IBA | 11 | 81,42$^{b}$ | Healthy plants with green leaves |
| $LSD_{0,05}$ | - | 0,46 | - |
| CV% | - | 3,3 | - |

The rooting rate ranged from 64.59% to 86.24%. The highest rooting rate was recorded in T3 (86.24%), followed by T4 (81.42%), T2 (76.64%), while the untreated control (T1) showed the lowest rooting rate (64.59%). The differences among treatments exceeded the $LSD_{0.05}$ value (0.46), indicating that IBA concentration had a statistically significant effect on the rooting rate of the cuttings.

Regarding plant condition, all IBA-treated cuttings produced healthy plants with green leaves and vigorous growth. In contrast, plants in the untreated control exhibited poorer growth, although their leaves remained green. These findings indicate that IBA treatment promoted adventitious root formation, increased the rooting rate, and shortened the time required for root initiation in stem cuttings. Among the tested concentrations, 1,500 mg $L^{-1}$ IBA was the most effective for enhancing the rooting performance of *Wisteriopsis reticulata* stem cuttings.

### c) Effect of IBA concentration on the nursery-ready seedling rate and growth of *Wisteriopsis reticulata* stem cuttings

The results presented in Table 9 indicate that IBA concentration significantly affected the growth and nursery-ready seedling rate of *Wisteriopsis reticulata*. Plant height ranged from 18.95 to 26.44 cm among the treatments. Cuttings treated with 1,200 mg $L^{-1}$ IBA (T2) produced the tallest plants, with a mean height of 26.44 cm, followed by T3 (22.63 cm). The control treatment (T1) and T4 produced shorter plants, and no statistically significant difference was observed between these two treatments. The differences in plant height among treatments exceeded the $LSD_{0.05}$ value (1.81 cm), indicating that IBA concentration had a statistically significant effect on seedling height.

The nursery-ready seedling rate ranged from 60.35% to 83.81%. The highest nursery-ready seedling rate was obtained in T3 (1,500 mg $L^{-1}$ IBA), reaching 83.81%, followed by T4 (78.08%), T2 (76.54%), and the untreated control (T1), which recorded the lowest value

(60.35%). The differences among treatments exceeded the $LSD_{0.05}$ value (0.52%), demonstrating that IBA concentration had a statistically significant effect on the proportion of nursery-ready seedlings.

**Table 9**. Effect of IBA concentration on the nursery-ready seedling rate and growth of *Wisteriopsis reticulata* stem cuttings.

| Treatment | Plant height (cm) | Plant height (cm) |
|---|---|---|
| T1: Control (without IBA treatment) | 20,02$^{c}$ | 60,35$^{d}$ |
| T2: 1.200 mg/l IBA | 26,44$^{a}$ | 76,54$^{c}$ |
| T3: 1.500 mg/l IBA | 22,63$^{b}$ | 83,81$^{a}$ |
| T4: 2.000 mg/l IBA | 18,95$^{c}$ | 78,08$^{b}$ |
| $LSD_{0,05}$ | 1,81 | 0,52 |
| CV% | 4,8 | 3,3 |

**Figure 4.** Effect of IBA concentration on the sprouting rate and rooting performance of *Wisteriopsis reticulata* stem cuttings.

The results suggest that IBA treatment improved seedling quality by promoting root system development, enhancing plant growth and increasing the proportion of seedlings that met nursery standards. Although treatment with 1,200 mg $L^{-1}$ IBA produced the tallest plants, its nursery-ready seedling rate was lower than that of the 1,500 mg $L^{-1}$ IBA treatment. This finding indicates that plant height alone is not a sufficient indicator of seedling quality.

The 1,500 mg $L^{-1}$ IBA treatment not only achieved the highest sprouting rate, survival rate and rooting rate but also produced the highest nursery-ready seedling rate (83.81%), indicating more balanced growth and superior seedling quality. Therefore, 1,500 mg $L^{-1}$ IBA is considered the optimal concentration for the vegetative propagation of *Wisteriopsis reticulata* by stem cuttings.

### 3. 4. Monitoring of pests and diseases affecting seedlings in the nursery

**Table 10.** Monitoring of pests and diseases affecting *Wisteriopsis reticulata* seedlings in the nursery.

| No. | Pest/Disease | Incidence (%) | Severity |
|---|---|---|---|
| 1 | Leaf-feeding caterpillars | 8,5 | Mild |
| 2 | Aphids | 5,2 | Mild |
| 3 | Red spider mites | 3,8 | Mild |
| 4 | Leaf spot disease | 4,6 | Mild |
| 5 | Stem base and root rot | 2,1 | Moderate |

During the observation period in the nursery, *Wisteriopsis reticulata* seedlings were affected by several main pests and diseases including leaf-feeding caterpillars, aphids, red spider mites and leaf spot disease. Overall, the level of damage was considered mild and did not significantly affect seedling survival or growth. Stem base and root rot occurred sporadically in some nursery bags with high moisture conditions.

## 4. CONCLUSIONS

The clonal propagation study of *Wisteriopsis reticulata* (Benth.) J.Compton & Schrire using stem cuttings showed that:

The position of the cutting significantly influenced sprouting ability, rooting performance, and seedling quality. Semi-hardwood cuttings produced the best results with a sprouting rate of 92.12%, survival rate of 86.54%, rooting rate of 91.71% and nursery ready seedling rate of 83.71%. The number of nodes per cutting also had a considerable effect on propagation efficiency. Three-node cuttings achieved the highest sprouting rate (88.17%), survival rate (78.17%), rooting rate (90.83%) and nursery-ready seedling rate (81.90%).

IBA concentration markedly affected sprouting, rooting, and nursery performance of Wisteriopsis reticulata cuttings. Treatment with 1,500 mg $L^{-1}$ IBA resulted in the best performance, with a sprouting rate of 90.42%, survival rate of 75.38%, rooting rate of 86.24% and nursery-ready seedling rate of 83.81%.

Based on the obtained results, it can be recommended that semi-hardwood, three-node cuttings treated with 1,500 mg $L^{-1}$ IBA should be used for the clonal propagation of Wisteriopsis reticulata by stem cuttings under nursery conditions.

During the nursery period, Wisteriopsis reticulata seedlings were affected by several main pests and diseases including leaf-feeding caterpillars, aphids, red spider mites and leaf spot disease. However, the overall level of damage was mild and did not significantly affect seedling survival or growth.

## References


[1] Arun M, Chung L.L. Drying Technology: Trends and Applications in Postharvest Processing. *Food and Bioprocess Technology*, 2010, 3(6):843-852. DOI:10.1007/s11947-010-0353-1

[2] Borror D.J., C.A. Triplehorn and N.F. Johnson. An introduction to the study of insects. Sixth edition. Harcout College Publishers. Fort Worth Philadelphia San Diego New York Orlando Austin San Antonio Toronto Montreal London Sydney Tokyo. 1989, ISBN-10: 0-03-025397-7. pp 875.

[3] Craig A Anderson. Abstract and concrete data in the perseverance of social theories: When weak data lead to unshakeable beliefs. *Journal of Experimental Social Psychology*. Volume 19, Issue 2, March 1983, Pages 93-108

[4] Chen J, Li M, Chen L, Wang Y, Li S, Zhang Y, Zhang L, Song M, Liu C, Hua M, Sun Y. Effects of processing method on the pharmacokinetics and tissue distribution of orally administered ginseng. *J Ginseng Res*. 2018 Jan; 42(1): 27-34. doi: 10.1016/j.jgr.2016.12.008

[5] Christensen LP. Ginsenosides: chemistry, biosynthesis, analysis, and potential health effects. *Advances in Food and Nutrition Research*. 2009, 55: 1-99. DOI: 10.1016/S1043-4526(08)00401-4

[6] Durazzo, A., Lucarini, M., Souto, E.B., Cicala, C., Caiazzo, E., Izzo, A.A., Novellino, E. & Santini, A. (2019). Polyphenols: A concise overview on the chemistry, occurrence, and human health. *Phytotherapy Research*, 33(9), pp. 2221-2243. https://doi.org/10.1002/ptr.6419

[7] Erbay, Z. and Icier, F. A Review of Thin Layer Drying of Foods: Theory, Modeling, and Experimental Results. *Critical Reviews in Food Science and Nutrition*, 2010, 50, 441-464

[8] Esraa A.M, Yus A.Y, Alhussein M., Mohammad F. Investigating the Impact of Storage Conditions on Quality and Shelf Life of Full-Fat and Defatted Roasted Date Seed Powders. *Food Technology Research Journal*, 2024, 5(1): 34-51. DOI:10.21608/ftrj.2024.313841.1090

[9] Hartmann, H.T., Kester, D.E., Davies, F.T. Jr. & Geneve, R.L. (2018). Hartmann & Kester's Plant Propagation: Principles and Practices (9th ed.). Harlow, UK: Pearson Education Limited. ISBN: 9780134480893

[10] Irem Ozay-arancioglu, Hatice Bekiroglu, Ayse Karadag, Oznur Saroglu, Zeynep Hazal Tekin-cakmak, Salih Karasu. Effect of different drying methods on the bioactive, microstructural and in-vitro bioaccessibility of bioactive compounds of the pomegranate arils. *Food Science and Technology*, 2022, 42, e06221: 1-9. DOI: https://doi.org/10.1590/fst.06221

[11] Kim JH. Cardiovascular Diseases and Panax ginseng: A Review on Molecular Mechanisms and Medical Applications. *J Ginseng Res*. 2012 Jan; 36(1): 16-26. doi: 10.5142/jgr.2012.36.1.16

[12] Laxmi S, Monika D, Rakesh K.V, Santosh V.V. Kumar, Shashank, K. Yadav, Suchitra Pushkar, SitaRam K, Arpan B, Viswanathan C. Auxin protects spikelet fertility and grain yield under drought and heat stresses in rice. *Environmental and Experimental Botany*. Volume 150, June 2018, Pages 9-24. https://doi.org/10.1016/j.envexpbot.2018.02.013

[13] Le, K., Chu, D., Mai, K., Nguyen, H., Phan, T., Ngo, L., Nguyen, C., Tran, L., & Ton That, Q. Chemical constituents of Ngoc Linh ginseng leaves (Panax vietnamensis Ha et Grushv.). *VNUHCM Journal of Advanced Research in Natural Sciences*, 2021, 5(4), 1627-1632. https://doi.org/https://doi.org/10.32508/stdjns.v5i4.1076

[14] Lee SJ, Kim Y, Kim MG. Changes in the ginsenoside content during the fermentation process using microbial strains. *J Ginseng Res*. 2015 Oct; 39(4): 392-7. doi: 10.1016/j.jgr.2015.05.005

[15] Lichun Z, Xinyu J, Hao Y, Xinze C, Wenchao W, Mengke L, Jiapin L, Qian Z, Xuhai Y, Zhihua G. Heat Pump Technology in the Field of Fruit and Vegetable Drying: A Review. *Foods* 2025, 14(15), 2569; https://doi.org/10.3390/foods14152569

[16] Li-Min Lin , Jen-Her Wu , Wen-Shen Shen , Robert A. Greenes. Testing the technology acceptance model for evaluating healthcare professionals' intention to use an adverse event reporting system. *International Journal for Quality in Health Care*, Volume 20, Issue 2, April 2008, Pages 123-129. doi.org/10.1093/intqhc/mzm074

[17] Małgorzata N, Magdalena D, Urszula T. Drying Technologies in Food Processing. *Appl. Sci*. 2023, 13(19), 10597. https://doi.org/10.3390/app131910597

[18] Park SK, Hyun SH, In G, Park CK, Kwak YS, Jang YJ, Kim B, Kim JH, Han CK. The antioxidant activities of Korean Red Ginseng (Panax ginseng) and ginsenosides: A systemic review through in vivo and clinical trials. *J Ginseng Res*. 2021 Jan; 45(1): 41-47. doi: 10.1016/j.jgr.2020.09.006

[19] Qi LW, Wang CZ, Yuan CS. Isolation and analysis of ginseng: advances and challenges. *Nat Prod Rep*. 2011 Mar; 28(3): 467-95. doi: 10.1039/c0np00057d

[20] Ratan ZA, Youn SH, Kwak YS, Han CK, Haidere MF, Kim JK, Min H, Jung YJ, Hosseinzadeh H, Hyun SH, Cho JY. Adaptogenic effects of Panax ginseng on

modulation of immune functions. *J Ginseng Res*. 2021 Jan; 45(1): 32-40. doi: 10.1016/j.jgr.2020.09.004

[21] Raviv, M. (2013). Composts in growing media: What's new and what's next? *Acta Horticulturae*, 982, 39-52. https://doi.org/10.17660/ActaHortic.2013.982.3

[22] Shanmugaratnam, S., Mikunthan, G., & Thurairatnam, S. Potential of Withania somnifera Dunal cultivation as a medicinal crop in Jaffna district. *American-Eurasian Journal of Agriculture and Environmental Science*, 2013, 13(3), 357-361

[23] Siddiqui, S. A., Ucak, İ., Jain, S., Elsheikh, W., Ali Redha, A., Kurt, A., & Toker, O. S. Impact of drying on techno-functional and nutritional properties of food proteins and carbohydrates - A comprehensive review. *Drying Technology*, 2024, 42(4), 592-611. https://doi.org/10.1080/07373937.2024.2303580

[24] Singh, A.; Sharma, J.; Paichha, M.; Chakrabarti, R. Achyranthes aspera (prickly chaff flower) leaves- and seeds-supplemented diets regulate growth, innate immunity, and oxidative stress in Aeromonas hydrophila-challenged Labeo rohita. *J. Appl. Aquacult*. 2020, 32 (3): 250-267. doi.org/10.1080/10454438.2019.1615594

[25] South, D.B. (2000). Planting Morphologically Improved Pine Seedlings. Auburn, Alabama, USA: Auburn University, School of Forestry and Wildlife Sciences.

[26] Sparks, T., et al. Leaf Degradation, Macroinvertebrate Shredders and Energy Flow in Stream. *The American Biology Teacher*, 2008, 70, 90-94. doi.org/10.1662/0002-7685

[27] Van L, T., Vontas, J., Tsagkarakou, A., Dermauw, W., & Tirry, L. (2010). Acaricide resistance mechanisms in the two-spotted spider mite Tetranychus urticae and other important Acari: a review. *Insect Biochemistry and Molecular Biology*, 40(8), 563-572. doi.org/10.1016/j.ibmb.2010.05.008

[28] Vega G.A, Lemus M.R, Bilbao S.C, Fito P, Andrés A. Effect of air drying temperature on the quality of rehydrated dried red bell pepper (var. Lamuyo). *Journal of Food Engineering*, 2008, 85(1):42-50. DOI: 10.1016/j.jfoodeng.2007.06.032