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Effects of Trellis Techniques on Growth, Development, and Yield of *Dioscorea persimilis* in Thai Nguyen, Vietnam

Nguyen Minh Tuan [a*]

[a] *Institute for Excellence in Education and Research, Thai Nguyen University (TNU), Thai Nguyen Province, Vietnam.*

Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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Abstract

Dioscorea persimilis is an important medicinal and nutritional climbing plant widely cultivated in northern Vietnam; however, limited information is available regarding suitable trellis techniques to improve its growth and productivity. The experiment was conducted to evaluate the effects of different trellis systems on the growth, yield, and economic efficiency of the medicinal plant *Dioscorea persimilis* in Dinh Hoa district, Thai Nguyen province, Vietnam, during the 2024–2025 growing seasons. The study was arranged in a Randomized Complete Block Design (RCBD) with three replications included four treatments (T1, T2, T3, and T4). Various agronomic characteristics, yield components, tuber yield, and economic indicators were recorded to determine the suitability of different trellis systems for Hoai Son cultivation. The results revealed significant differences among the treatments at the 95% confidence level. Among the treatments, T2, which using a clustered trellis system, recorded the highest values for plant height (202.3 cm), stem diameter (3.7 mm), leaf length (10.9 cm), leaf width (6.7 cm), tuber weight (0.68 kg), and tuber yield (31.6 t ha^{-1}), along with the greatest economic return compared to the other treatments at the 95% confidence level. The superior performance of the clustered trellis system may be attributed to improved vine support, better canopy

**Corresponding author: E-mail: nguyenminhtuan@tnu.edu.vn;*

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distribution, and enhanced light interception, thereby promoting vegetative growth and tuber development. In conclusion, the clustered trellis system is considered a promising cultivation technique for improving the productivity and economic efficiency of Hoai Son production in mountainous regions of northern Vietnam.

Keywords: Dioscorea persimilis; trellis techniques; economic efficiency; Thai Nguyen province.

1. Introduction

The Hoai Son plant, scientifically known as Dioscorea persimilis Prain et Burkill, belongs to the family Dioscoreaceae, order Dioscoreales, class Liliopsida, and phylum Magnoliophyta (Nguyen et al., 2019). In Vietnam, *Dioscorea persimilis* is widely distributed throughout the northern mountainous and midland provinces (Hằng et al., 2020). The species is known by various local names across different regions and ethnic communities, including Sơn Dược, Củ Mài, Khoai Mài, Mằn chèn, Mán dịn, Co mằn kép (Thai ethnic group), Mằn ôn (Nung ethnic group), Hìa dòi (Dao ethnic group), Gờ lờn (K'dong ethnic group), and Củ Lỗ (Nguyen et al., 2019).

The Hoai Son plant is considered a valuable nutritional food source, as its dried tubers contain 63.25% starch and 6.75% protein (He et al., 2002). Furthermore, the tubers are rich in essential amino acids, B-complex vitamins, and important trace elements such as Zn, Fe, and Mn, with total starch content ranging from 70–80% (Chang et al., 2013). Moreover, the Hoai Son plant is an important medicinal species widely used in traditional medicine because of its high nutritional and pharmacological value (Mignouna et al., 2003). It has spleen tonifying effects, and stabilizing the essence, and it is commonly used to treat digestive disorders, chronic diarrhea, spermatorrhea, and nocturnal urination. In addition, the tubers contain bioactive compounds such as diosgenin and saponins which exhibit antioxidant, and immune-boosting activities, and may support for treating chronic diseases (Chang et al., 2013). In recently, studies on Hoai Son (*Dioscorea persimilis*) have mainly focused on evaluating its nutritional value and medicinal properties, while the research related to cultivation techniques still limited. Besides some studies assessing the current production status and basic cultivation practices of Hoai Son (Tuan & Ung, 2025; Nguyen et al., 2025; Nguyen & Nguyen, 2025; Tuan & Hong, 2022), there is still a lack of research on agronomic techniques aimed at improving yield and tuber quality, expecially trellis construction techniques. Moreover, *Dioscorea persimilis* is a climbing plant that requires suitable support systems for optimal growth and high productivity, research on appropriate trellis techniques is therefore necessary.

The Hoai Son plant is a climbing vine with soft, smooth, light-green stems that turn reddish brown when mature or dried. The stems are cylindrical or may possess 4–6 angular edges, and the vines twine from right to left during climbing. Therefore, trellis construction is usually carried out approximately 15–20 days after planting to support proper plant growth and development (Ngan et al., 2020). However, according to Ngan et al. (2021), the cultivation of Hoai Sơn is still mostly based on traditional farming practices, with limited mechanization and low adoption of modern technologies such as soil tillers, mechanized planting systems, drip irrigation, and tuber harvesting equipment, particularly in trellis construction techniques for Hoai Sơn cultivation.

In Thai Nguyen, despite the favorable climatic conditions and substantial land resource potential for the development of medicinal plant cultivation areas, Hoai Sơn production is still mainly conducted on a small and fragmented scale, while proper planning and research on cultivation techniques suitable for local conditions are still lacking. Hence, the aim of this study was to evaluate suitable trellis systems for improving the growth, development, yield, and quality of the medicinal plant Hoai Sơn under Thai Nguyen conditions, thereby contributing to enhanced cultivation efficiency.

2. Materials and Methods

2.1 Plant Materials and Experiment Treatments

The experiment was conducted in Boc Nhiêu commune, Dinh Hoa district, Thai Nguyen province, from 2024 to 2025. The experiment was designed using a Randomized Complete Block Design (RCBD) including of four treatments with three replications. Each experimental plot covered an area of 10 m², giving a total experimental area of 150 m², excluding buffer zones. The four treatments were established as follows:

T1: A-shaped trellis system (control)
T2: Clustered trellis system
T3: String-supported trellis system
T4: Net trellis system combined with tensioned strings

Before planting, tuber cuttings approximately 5 cm long were treated for one week with a mixture of lime and wood ash at a 70:30 ratios. The planting density and spacing were 50,000 plants per hectare, with a spacing arrangement of 80 cm × 25 cm. The tuber cuttings were planted at a depth of approximately 5 cm. After planting, the cuttings were covered with soil, irrigated, and maintained under adequate moisture conditions to promote sprouting and early growth. Trellises were constructed 15-20 days after planting to support vine growth. The trellis structures needed to be build sturdy because the vigorous climbing of the plants could cause weak trellises to collapse. The basal fertilizer application consisted of 9 tons of organic microbial fertilizer, 500 kg of powdered lime, 300 kg of urea, 500 kg of superphosphate, and 150 kg of potassium chloride per hectare. Nitrogen and potassium fertilizers were with one-third of the total amount applied monthly from April to May, the remaining amount was applied in July.

2.2 Data Collection

Leaf size, including leaf length and width (cm), was measured using vernier calipers at the stage when the plants reached the trellis. Stem diameter (mm) was measured at 5 cm above the ground surface using digital vernier calipers, and average values were calculated at both the trellis-reaching stage and the harvest stage. Tuber size, including tuber length and diameter, was measured using vernier calipers. Yield for each treatment was determined by weighing the total tuber yield harvested from each plot. Tuber characteristics and yield components were evaluated at the harvest stage.

2.3 Statistical Analysis

The data were analyzed using SAS 9.1 software to evaluate treatment effects, and mean comparisons among treatments were conducted using Duncan's Multiple Range Test at a significance level of 95%.

3. Results and Discussion

3.1 Effect of Trellis System on the Morphological Characteristics of Hoai Sơn Plants

According to Aminifard et al., (2012), plant height is evaluated through the rate of height growth and is closely associated with plant yield. Increased plant height under favorable growing conditions often contributes to higher yields. Therefore, plant height is an important indicator of plant growth potential and depends on both varietal characteristics and cultivation techniques. The results presented in Table 1 show that there were revealed significant differences among treatments in plant height ($p \leq 0.05$). In contrast, T2 recorded the greatest plant height (202.3 cm), whereas the T3 and T4 showed lower plant heights, reaching 197.2 cm and 200.3 cm, respectively, both significantly lower than the control treatment at the 95% confidence level. This result indicates that T 2, in which clustered trellis formed a stable support structure, promoted plant growth by enabling the vines to attach easily and climb more effectively, thereby creating favorable conditions for stem elongation. This may be explained by the climbing characteristic of *Dioscorea persimilis*, whose stems twine from right to left around the support structure without tendrils like other climbing species (Nguyễn et al., 2020). Conversely, T3 and T4 which applying wire and mesh trellis systems, respectively provided less suitable support structures for vine attachment and climbing, resulting in shorter plant heights because these trellis types were not suitable for the climbing nature of the plants. These results are consistent with those reported by Nguyễn et al. (2020).

The results presented in Table 1 indicated that there were no significant differences among treatments in terms of stem diameter, leaf length, and leaf width at the 95% confidence level. This shows that while the form of the trellis affects the plant's ability to grow tall, it has little influence on the development of other parts such as the roots and leaves. This can be explained by the fact that the *Dioscorea persimilis* plant primarily grows its stem on the trellis to facilitate photosynthesis and nutrient accumulation for the tubers. Characteristics such as root diameter and leaf size are more dependent on nutrient levels and planting density than on the form of the trellis. It seems that the form of the trellis affects the plant's ability to grow tall, however little influence on the

development of other parts such as the roots and leaves. This may be explained that the *Dioscorea persimilis* plant grows its stem on a trellis to facilitate photosynthesis and accumulate nutrients for the tuber, whereas characteristics of this plant such as stem diameter and leaf size are generally generally influenced more by nutrient availability and planting density than by trellis type. This results are consistent with those reported by Nguyễn et al. (2020).

Table 1. Effects of trellis systems on the morphological characteristics of Hoai Son medicinal plants in Thai Nguyen*

Treatment	Plant height (cm)	Stem diameter at trellis-reaching stage (mm)[1]	Stem diameter at harvest stage (mm)[2]	Leaf length (cm)	Leaf width (cm)
T1 (control)	201.9[a]	3.69[a]	3.90[a]	10.8[a]	6.6[a]
T2	202.3[a]	3.70[a]	3.92[a]	10.9[a]	6.7[a]
T3	197.2[c]	3.62[a]	3.84[a]	10.5[a]	6.4[a]
T4	200.3[b]	3.68[a]	3.89[a]	10.6[a]	6.5[a]
P-value	≤0.05	>0.05	>0.05	>0.05	>0.05
$LSD_{0.05}$	0.68	0.10	0.09	0.44	0.62

**Means followed by different letter are significantly different within columns by Duncan's multiple range Test, $p \leq 0.05$*

3.2 Effect of Trellis System on the Yield of Hoai Sơn Plants

The data presented in Table 2 indicated that there were significant differences among treatments in tuber weight. T2 had the highest tuber weight (0.63 kg tuber^{-1}), whereas T3 and T4 produced lower tuber weights of 0.56 and 0.59 kg tuber^{-1}, respectively, both significantly lower than the control treatment (T1) at the 95% confidence level. It seems that different trellis types have different effects on on tuber biomass accumulation, with T2 producing the highest tuber weight. This can be explained the *Dioscorea persimilis* plant has a climbing stem so the clustered trellis (T2) and A-shaped trellis (T1) provided more suitable support conditions for stem and leaf development, thereby enhancing photosynthesis and nutrient accumulation in the tubers. Conversely, the trellis structures used in T3 and T4 was not suitable for the climbing nature of the plant, which may have adversely affected plant growth and photosynthetic efficiency, thus reducing tuber weight.

Table 2. Effects of trellis systems on yield and yield components of Hoai Son medicinal plants in Thai Nguyen

Treatment	Tuber weight (kg tuber^{-1})	Tuber length (cm)	Tuber diameter (cm)	yield (t ha^{-1})
T1 (control)	0.62[a]	68.77[a]	4.06[b]	31.0[a]
T2	0.63[a]	69.16[a]	4.09[a]	31.6[a]
T3	0.56[b]	62.65[b]	4.03[c]	28.1[b]
T4	0.59[c]	65.75[c]	4.05[b]	29.6[c]
P-value	≤0.05	≤0.05	≤0.05	≤0.05
$LSD_{0.05}$	0.01	1.34	0.01	0.97

**Means followed by different letter are significantly different within columns by Duncan's multiple range Test, $p \leq 0.05$*

According to the Vietnamese Pharmacopoeia V, Part 2, the tubers of *Dioscorea persimilis* have various shapes, ranging in length from 5 cm and possibly up to 1 m. The diameter of tuberfrom 1 cm to 3 cm, and up to 10 cm. The results in Table 2 indicated that there was significant difference among treatments in terms of tuber size ($p \leq 0.05$). T2 had the highest tuber length and diameter, with values of 69.16 cm and 4.09 cm, respectively. T3 had the lowest tuber size, with a length of 62.65 cm and a diameter of 4.03 cm, both significantly lower than T1 (control) at a 95% confidence level. The remaining treatments had tuber sizes lower than T1 (control) at a 95% confidence level.

3.3 Effects of Trellis Systems on the Economic Efficiency of Hoai Son Cultivation

Fig. 1 and Table 3 shows that different trellis construction techniques had varying effects on the economic efficiency of *Dioscorea persimilis*, mainly due to differences in material costs, labor requirements, and yield among the experimental treatments. Among the trellis systems, T2 using clustered trellises produced the highest

yield and the greatest profit. Therefore, compared with the other treatments, T2 was considered the most economically efficient trellis system under the experimental conditions. The application of appropriate technical measures contributed to improving the economic efficiency of Hoai Son medicinal plant production. The results of this study are in agrremetn with the findings of Tuan & Ung, (2025), who reported that the application of cultivation techniques for *Dioscorea persimilis* significantly enhanced economic efficiency compared with conventional cultivation practices without technical application.

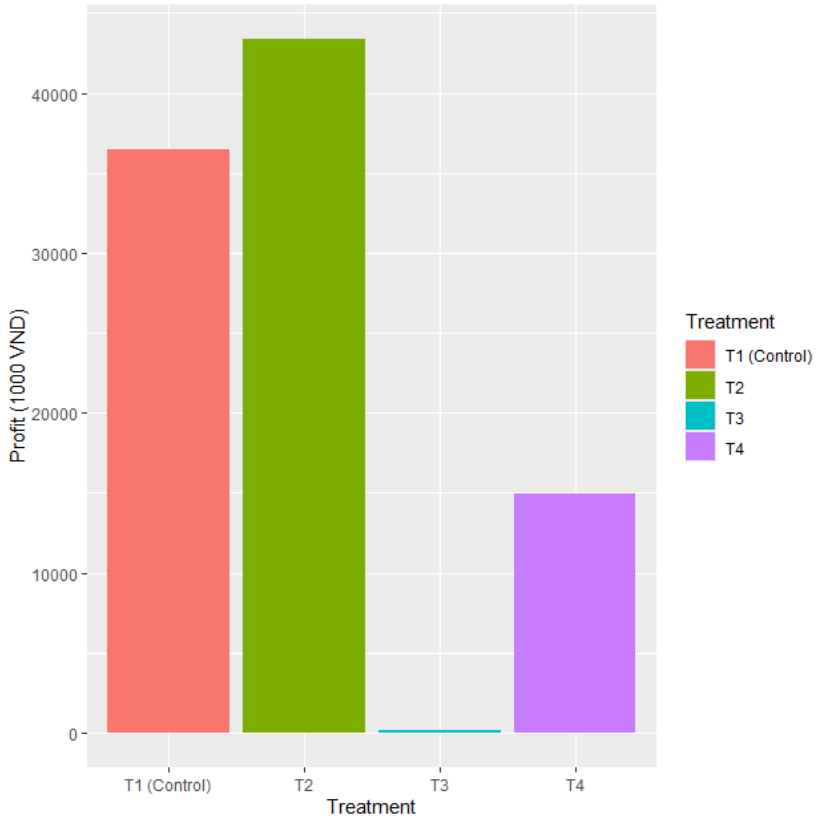

Fig. 1. Graph showing effects of trellis systems on the economic efficiency of Hoai Son cultivation

Table 3. Effect of trellis systems on the economic efficiency of Hoai Son cultivation

Treatment	Economic efficiency of Hoai Son cultivation (1000 VND)
T1 (control)	36.475
T2	43.375
T3	175
T4	14.975

4. Conclusion

In conclusion, different trellis construction techniques have varying effects on the growth, development, yield of Dioscorea persimilis. T2 using clustered trellises resulted in the best plant growth, development, tuber yield under production conditions in Thai Nguyen. Therefore, the clustered trellis system is recommended as an effective cultivation to improving the growth performance, yield, and economic efficiency of Dioscorea persimilis cultivation in Thai Nguyen province.

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Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

Competing Interests

Author has declared that no competing interests exist.

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