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Research Article
Effects of Additional Bio-fertilizer on the Growth and Yield of *Angelica dahurica*

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Abstract

Background and Objective: *Angelica dahurica* is a medicinal plant and an essential constituent in Vietnamese traditional medicine. Currently, overusing chemical fertilizer and growth-promoting substances cause reducing the quality of the products. The purpose of this study is to find out the impact of bio-fertilizer on yield and quality of *Angelica dahurica*. **Materials and Methods:** Seedlings of *Angelica dahurica* (Benth. Et Hook. F) were processed using 3 treatments (a controlled treatment and 2 treatments applying 2 types of bio-fertilizer). **Results:** The research also showed that adding bio-fertilizer could help *Angelica dahurica* to archive the highest yield, stood at 7330.9 kg ha^{-1} and up to77.3% of the tuber was ranked as 1st class. **Conclusion:** The results showed that the supply of bio-fertilizer could efficiently promote the development and yield capacity of *Angelica dahurica*. It could assist *Angelica dahurica* in its development and generate high quality of medical content.

Key words: *Angelica dahurica*, bio-fertilizer, controlled treatment, seedlings, Benth. Et Hook. F

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Angelica dahurica is an important medicinal plant in the list of essential medicinal plants of Vietnamese traditional medicine. Plants adapt to cool and humid climate, fertile soil, deep soil layer, especially alluvial soil along the river. According to Võ[1], the main component of *Angelica dahurica* root and tuber are coumarin derivatives and the essential oils have many good effects: analgesic, anti-inflammatory. They are used to treat many diseases such as fever, headache, toothache, menopause, myalgia.

Currently, the use of large quantities of chemical fertilizers with growth-promoting substances has increased the risk of high nitrate residues in the product and the quality of *Angelica dahurica* tubers is declining. Vietnam is a member of the World Trade Organization (WTO), therefore, the goods must compete fiercely with similar products of other countries in the world. In order to gain a competitive advantage and stand firm in the market, it is necessary to create products with high productivity, good quality and to ensure product hygiene and safety. Therefore, the inevitable trend is to follow the direction of safe production, reduce the use of chemical fertilizers, increase organic fertilizer and bio-fertilizer to increase productivity and quality of medicinal herbs.

Systematically applying organic fertilizer will improve the physical and chemical properties as well as biology, water regime, soil heat regime[2]. Well-structured soils are well ventilated, thus helping the roots to grow and exchange gas better[3], while reducing the density and soil resistance[4]. In contrast, a decrease in soil organic matter leads to a reduction in soil porosity and an increase in soil density[5]. This study was aimed to investigate the effect of additional bio-fertilizer in growth and yield of *Angelica dahurica*.

MATERIALS AND METHODS

Materials: Seedlings of *Angelica dahurica* (Benth. Et Hook. F) was collected from National Institute of Medicinal Materials, Quang Trung, Hoan Kiem, Hanoi. Two types of bio-fertilizer was applied: (1) Que Lam 03bio-fertilizer (from Que Lam Group): Humidity: 30%, Organic 23%, N-$P_2O_{5(hh)}$-K_2O: 1-3-1, Useful microorganisms: *Aspergillus* sp.: 1×10^6 CFU g^{-1}, *Azotobacter*: 1×10^6 CFU g^{-1}, *Bacillus*: 1×10^6 CFU g^{-1}, (2) Song Gianh bio-fertilizer (Song Gianh Corporation): Humidity: 30%, Organic: 15%, P_2O_{5hh}: 1.5%, Humic acid: 2.5%, Intermediate: Ca: 1.0%, Mg: 0.5%, S: 0.3%, Useful microorganisms: *Aspergillus* sp: 1×10^6 CFU g^{-1}, *Azotobacter*: 1×10^6 CFU g^{-1}.

Methods: This study was conducted for 12 months at Botanic garden, Hung Vuong University, Viet Tri, Phu Tho, with an area of 10 m^2, a total area of 90 m^2 excluding the protection strip. The experiments were arranged in a fully randomized block model (RCB), consisting of 3 treatments, each treatment had 3 replicates, planting density of 25 plants/m^2 (20×20 cm distance):

- **T1:** Foundation = 180 N+160 P_2O_5+100 K_2O ha^{-1} (Controlled)
- **T2:** Foundation+2000 kg of Que Lam bio-fertilizer ha^{-1}
- **T3:** Foundation+2000 kg of Song Gianh bio-fertilizer ha^{-1}

The following indicators were monitored: dynamics of plant height growth, leaf growth dynamics, leaf area index (m^2 of leaf m^{-2} of land) at time of 60, 90, 120, 150, 180, 210 days after planting, real fresh tuber yield (t ha^{-1}), the rate of fresh/dry (g/plant), tubers:

- Type 1: Diameter = 2 cm, length = 15-20 cm
- Type 2: Diameter <2 cm, length <15 cm)

The survey of disease composition was conducted according to "National technical regulation on Surveillance method of plant pests" (QCVN 01-38:2010/BNNPTNT). Data were processed in accordance with IRRISTART 4.0 and Excel software.

RESULTS AND DISCUSSION

Effect of bio-fertilizer on the growth and development of *Angelica dahurica*

Effect of bio-fertilizer on the growth dynamics of plants height: After planting 60-90 days, plant height using 3 treatments was not different (Fig. 1). However, at 120 days after sowing, the height of plants using the bio-fertilizer treatments was much higher than the controlled treatment without bio-fertilizer. At 150 days after sowing, the plant height of the controlled treatment T1 was only above 80 cm, while the 2 complementary treatments for plant height were over 100 cm (both height of T2 and T3 are relatively similar). This shows that the addition of bio-fertilizer has the effect of stimulating the growth of plant height, which is beneficial for the development of leaf stems and tuber formation of *Angelica dahurica*.

Effect of bio-fertilizer on leaf dynamics: The leaf dynamics is the vital factor that decides the productivity of plants in general and *Angelica dahurica* in particular. The number of

leaves per plant is an important indicator in the production of *Angelica dahurica* productivity. Results showed that there was a difference in the number of leaves per plant from sowing to reaching 150 days of age (Fig. 2). 150 days after sowing, the number of leaves per plant in T2 and T3 reached over 20 leaves/plant, while the controlledT1 reached only 15.4 leaves/plant. The highest leaf dynamics was in the T3 (21.6 leaves/plant). This is beneficial for photosynthesis that produces and accumulates content on tubers for *Angelica dahurica*.

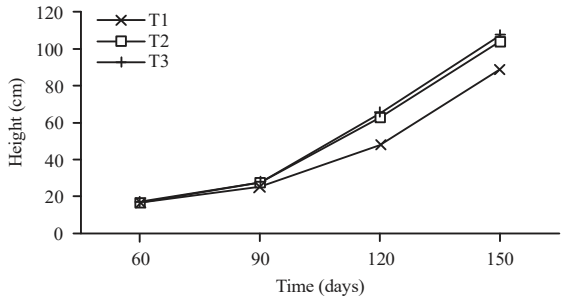

Fig. 1: Growth dynamics of height of *Angelica dahurica* applying 3 treatments

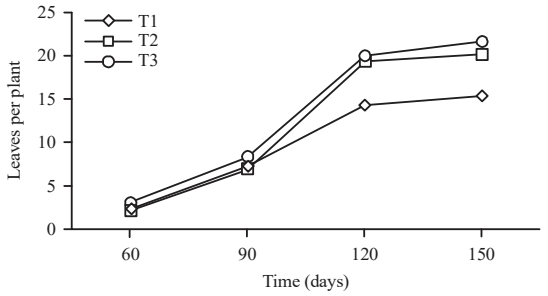

Fig. 2: Leaf per plant growth dynamics of *Angelica dahurica* applying 3 treatments

Effect of bio-fertilizer on leaf area index (LAI): It can be seen that the LAI increases gradually during growth from germination, the highest increase is from 120-180 days after planting, then tends to decrease gradually until harvest (Table 1). In which, LAI was the highest with T3, followed by the T2 and the lowest was the T1.

Thus, the addition of bio-fertilizer affects the LAI. This is entirely reasonable because the addition of bio-fertilizer increases the water permeability and drainage, the air permeability and reduces soil resistance and surface scum[6,7]. In addition, the organic matter is decomposed and releases highly useful nitrogen for plants[8,9].

Influence of bio-fertilizer on productivity and quality of *Angelica dahurica*: Organic fertilizer plays an important role in restoring and improving the fertility of degraded soil, the greater the amount of organic fertilizer buried in the soil, the faster the fertility will recover[10]. Mixing organic matter into the soil increases the stability of the soil texture, helping to soften the soil due to soil microbial activity and creating a surface covering of the soil. The results indicate that the yield of fresh tubers in the treatment with additional bio-fertilizer is much higher than the controlled treatment, ranging from 5804.5-7330.9 kg ha^{-1}. T2 has a higher yield (7330.9 kg ha^{-1}) comparing to T3 at (6713.7 kg ha^{-1}) as presented in Table 2). The fresh/dry ratio had a clear difference in which the T2 and T3 were all higher than the T1, ranging from 5.8 to 6.1%. In addition, the ratio of Type 1 tubers in the three treatments also varied widely from 39.5-77.3%, the highest was T2 (77.3%) and the lowest is T1. This proves that the addition of bio-fertilizer has a good effect on the production of *Angelica dahurica.*

Table 1: Leaf area index applying different treatments U (m^2 leaf/m^2 land)

	Time after sowing (days)					
Treatments	60	90	120	150	180	210
T1 (Controlled)	0.11	1.21	3.16	4.81	5.77	5.58
T2	0.25	1.32	4.78	6.63	7.10	6.73
T3	0.31	1.39	5.26	6.98	7.84	7.51
CV%			8.90		9.00	11.2
LSD_{05}			0.23		0.08	0.17

Table 2: Product quality of *Angelica dahurica* applying three treatments

Treatments	Fresh tuber yield (kg ha^{-1})	Fresh/dry ratio (%)	Type 1 tube (%)
T1 (Controlled)	5804.5	4.4	39.5
T2	7330.9	6.1	77.3
T3	6713.7	5.8	55.7
CV%	7.4		
LSD_{05}	295.8		

Fig. 3: Planting and production of *Angelica dahurica*

Table 3: Influence of bio-fertilizer on pest and disease composition of *Angelica dahurica*

Treatments	Scientific names	Popularity
T1 (Controlled)	*Agrotis ypsilon*	++
	Anomis flava Fabr	+
	Spodoptera litura	+
	Pieris rapae Linn	+
	Atractomorpha sinensis	+
	Oxya chinunsis Thunb.	-
	Aphis sp.	++
	Achatina fulica	++
T2	*Agrotis ypsilon*	+
	Anomis flava Fabr	+
	Spodoptera litura	+
	Pieris rapae Linn	+
	Atractomorpha sinensis	+
	Oxya chinunsis Thunb.	+
	Aphis sp.	++
	Achatina fulica	++
T3	*Agrotis ypsilon*	+
	Anomis flava Fabr	+
	Spodoptera litura	+
	Pieris rapae Linn	+
	Atractomorpha sinensis	+
	Oxya chinunsis Thunb.	-
	Aphis sp.	++
	Achatina fulica	++

+: Frequency of occurance<10%, ++: Frequency of occurrence 11-25%

Influence of bio-fertilizer on pest and disease composition of *Angelica dahurica*: Results showed that *Angelica dahurica* has many species of pests and insects from the time the plant starts to sprout until harvest. Through the survey, a total of 10 species of pests was collected belonging to 5 orders and 7 different families (Table 3). It is worth noting that the first phase when the *Angelica dahurica* germinate until 3 complete leaves, there is the appearance of cavities and

large snails. They eat young plants, bite off young stems to kill plants, thereby reducing crop density in the field. However, the addition of bio-fertilizer did not affect the composition of the pests in *Angelica dahurica*.

When the plant entered the leaf spreading stage, there are some other pests (e.g., green caterpillars, aphids, grasshoppers). However, they do not significantly affect the growth of *Angelica dahurica*.

Some planting and production for obtaining medicinal plant *Angelica Dahurica* of good quality for the sustainable production has been presented in Fig. 3.

CONCLUSION

The results showed that the supply of bio-fertilizer could efficiently promote the development and yield capacity of *Angelica dahurica*. It could assist *Angelica dahurica* in its development and generate high quality of medical content.

SIGNIFICANCE STATEMENT

The present research is a first technical guidance on obtaining medicinal plant materials of good quality for the sustainable production of *Angelica dahurica* (GACP-WHO).

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