GROWTH OF *NAUCLEA ORIENTALIS* SPECIES OF YOUNG PLANTATION FOR BIG TIMBER PRODUCTION IN HOA BINH PROVINCE

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ABSTRACT

The results of the growths and development of *Nauclea orientalis* species from the experimental planting model for big timber production in Hoa Binh province showed that, *Nauclea orientalis* trees have been adapted, growth quite well on the sites at the age of 16 months in Hoa Binh province. It is worth noting that, the model of *Nauclea orientalis* plantation had a high survival rate and healthy (93.5%), growths in diameter, height and average canopy diameter were 2.67 cm, 1.09 m, and 2.2 m respectively. *Nauclea orientalis* a native species has been performed the ability to develop branches suitably towards big timber production. The branchs of plantation are initially stable, shaped and capable of good growth and development stage. The results of the growth and development assessment from this experimental planting model are very important, not only providing valuable scientific information, but also a vivid practical basis demonstrating the ability planted and develop multi-use, and economically valuable *Nauclea orientalis* species, and add new varieties into the structure of forestry plant varieties for production forests in the direction of developing big timber forests in Hoa Binh province.

Keywords: growth big timber production, native species, *Nauclea orientalis*, plantations.

1. INTRODUCTION

The great economic benefits that big timber plantations bring is one of the important motivations that motivates managers, scientists, forestry interprises and afforestation people attention and prioritize the choice of afforestation towards the development of big timber forests. Currently, big timber plantations often develop in two directions, according to which either small timber plantations with groups of acacia and eucalyptus species are transformed into big timber plantations, and or new afforestations follow the direction of big timber plantations or with a group of new varieties of *Acacia* and *Eucalyptus* species, or with native tree species of big timber plantations that grow well and have high economic value [1-3].

Nauclea orientalis is a native tree species for big timber, valuable multi-faceted, that is currently one of the indigenous tree species that many people are interested in for the development of big timber plantations. However, at present, there is not much information, data and scientific publications published on research results on concentrated planting towards the development of big timber plantations [4-6]. This causes many difficulties for big timber plantations as well as for the development of *N.orientalis* species in many localities where conditions are suitable for the ecological requirements of this species.

Therefore, assessing the growth and development of *N.orientalis* from the experimental planting model towards the development of big timber plantations is very necessary, for scientific significance and high practical value. This research result, in addition to provide information and data on the growth of *N.orientalis* species, and also creates a practical basis for managers, forestry interprises and forest growers who can consider to use this species for extending big timber production in the future.

The trial planting model of *N.orientalis* towards developing big timber plantations have been deployed and implemented from 2020 to 2022 in Luong Son district, Hoa Binh province, under a provincial level science topic with subject: "*Research and application of Biotechnology to improve the efficiency of production forests in the direction of developing big timber plantations in Hoa Binh province*", has been accepted and evaluated by the Councils of all levels with many obtained results that meet the set goals. After nearly 2 years of planting and tending, the experimental planting model of *N.orientalis* in the direction of developing big timber plantations mentioned above has a high survival rate, stable plants and good initial growth and development.

2. RESEARCH METHODOLOGY

2.1. Sites, materials and contents of research

This study was conducted in Lam Son commune, Luong Son district, Hoa Binh province. The object of the study is the experimental planting model of *N.orientalis* towards big timber plantations. The model has been conducted in an area of 5000 m^2, with bare-root cuttings and potted seedlings, planting density with 1,600 trees per ha, corresponding distances with (row x row: 2.5 x 2.5m; and tree x tree: 2.5 x 2.5m), planting hole with 60 x 60 x 60cm, tilling by mechanical method (ladder).

Planting time was in early June 2021, and data collection was undertaken by 2 times (the first time when the plants were 5 months old stage; and the second time in October 2022 when the plants were 16 months old stage. Research contents (i) Evaluation of the growth of *N.orientalis* at the age of 5 months; and (ii) Evaluation of the growth and development of *N.orientalis* at the age of 16 months.

2.2. Research Methods

Data were collected on standard plots (OTC) with an area of 100 m^2 each, total 13 OTC, Measuring growth parameters involved survival rate (TLS), stump diameter (D00), height of the top (Hvn) and canopy diameter (Dt) by the usual method.

In which, (i) The stump diameter is measured with a caliper with an accuracy of 0.01mm (measured at a position 10cm above the ground); (ii) The height of the top is measured by a meter ruler with markings, with an accuracy of 1.0 cm; (iii) The canopy diameter is measured with a metric ruler, to the nearest 1.0cm; and (iv) Survival ratio (%) is calculated according to the following formula:

$$TLS\ (\%) = \frac{N_{ht}}{N_{bd}} \times 100$$

Where are :

TLS is the survival ratio;

N_{ht} is the number of trees at the time of assessment;

N_{bd} is the number of initial crops.

Collected data are processed on computers with Excel and specialized software in agricultural and forestry research SPSS.

3. RESULTS AND DISCUSSION

3.1. Growth of *Nauclea orientalis* at the age of 5 months

** Growth to the stump diameter of the Nauclea orientalis at the age of 5 months*

In this study, growth measurement of stump diameter and height of *N.orientalis* experimented in Hoa Binh was carried out on standard plots (OTC) according to conventional plantation survey method. The results are summarized in Table 1.

Table 1. Growth of the stump diameter of the *N.orientalis* at the age of 5 months

Plots	Growth of the stump diameter, D00 (cm)				The origin of the seedlings to be planted
	$\bar{X}$	CV%	Max	Min	
1	0.87	45.3	1.6	0.3	Seedlings planted
2	1.03	49.5	2.3	0.2	
3	1.37	45.9	2.8	0.5	
4	0.77	34.3	1.1	0.4	
5	0.68	59.4	1.6	0.2	
6	1.01	47.1	2.1	0.3	
7	0.74	51.2	1.3	0.3	
8	0.91	52.6	1.8	0.4	
Average	***0.9***	***48.2***	***1.8***	***0.3***	
1	0.78	49.2	1.7	0.3	Bare root cuttings planted
2	1.23	57.0	3.0	0.5	
3	1.29	33.7	1.8	0.2	
4	1.30	42.4	2.2	0.4	
5	1.06	44.1	1.9	0.3	
Average	***1.1***	***45.3***	***2.1***	***0.3***	

Note: *Planting date: June 1, 2021; Data collection date: October 26, 2021.*

The data in Table 1 and Figure 1 show that, the average stump diameter growth ($\overline{X}$) of the group of cuttings reached a value of 1.1 cm per trees, slightly higher than that of the group of seedlings reached a value of 0.9 cm per trees. It is worth noting that the coefficient of variation (CV%) on the stump diameter of the group of seedlings reached a value of 48.2%, higher than is 1.06 times compare the group of cuttings (45.3%), the growth differentiation of the stump diameter of the group of seedlings is larger than that of the cuttings group, in other words, the group of seedlings has a faster increase in the growth rate of the stump diameter than the group of cuttings under the same conditions and planting time.

Figure 1. Experimental *Nauclea orientalis* at the age of 5 months (seedlings (left) and cuttings (right))

** Growth of the height of the top (Hvn) of N.orientalis at the age of 5 months*

The growth criteria in terms of diameter and height of plantations in the first stage after planting are very important, the basis for assessing growth, especially before the strong growth of weeds in the rainy season. Similar to the growth criteria in terms of stump diameter, growth in height of *N.orientalis* at the age of 5 months is summarized in Table 2.

Table 2. Growth of the height of *Nauclea orientalis* at the age of 5 months

Plots	Growth of the height, Hvn (cm)				The origin of the seedlings to be planted
	$\overline{X}$	CV%	Max	Min	
1	61.53	41.5	100	22	Seedlings planted
2	61.57	37.6	124	25	
3	74.42	35.6	128	33	
4	62.64	38.7	110	31	
5	53.13	36.7	99	30	
6	49.07	50.4	106	43	
7	48.00	35.6	71	31	
8	58.07	46.3	97	38	
Average	***58.6***	***40.3***	***104.4***	***31.6***	
1	48.3	48.8	106	28	Bare- root cuttings planted
2	72.3	36.3	127	52	
3	69.2	38.7	103	27	
4	71.9	31.8	106	27	
5	66.1	40.5	80	27	
Average	***65.5***	***39.2***	***104.4***	***32.2***	

The data in Table 2 and Figure 2 show that the average height growth of the group of cuttings reached a value of 65.6 cm per tree, 1.12 times larger than the group of seedlings in the same conditions and time. Thus, it is possible to make a preliminary remark that at the age of 5 months, the experimental planting model of *N.orientalis* using cuttings gives a better growth rate than using seedlings under the same conditions and time.

Figure 2. Growth of the hight of cuttings (left) and seedlings (right)

Of course, this is only a preliminary result, because the planted is only 5 months old, the time is not long enough to be able to make a firmer remarks and assessment. However, it must also be seen that, with hot weather, the temperature of June and July in the summer of 2021 temperature has 30.3 and 30.5 degree celsius, and the average temperature of the 5 months after planting the above mentioned was 29.42 degree celsius [7] although the cuttings and seedlings are newly planted, they still give good growth.

It shows that the young plants of *N.orientalis* quickly built up the adaptability to be able to settle on the new site, especially in the conditions of pure-species planting and without supporting shade trees in the early period. On the other hand, at this stage, the model plantations have not passed a cycle of changes in environmental factors, such as high temperature on long hot summer days.

3.2. Growth and development of the *Nauclea orientalis* at the age of 16 months

** Survival ratio of N.orientalis at the age of 16 months*

In this study, evaluating the survival ratio (%), the growth situation of the stump diameter and height of the top of *N.orientalis* at the age of 16 months of the experimental model was summarized in Table 3.

Table 3. Growth D00 and Hvn of *Nauclea orientalis* at the age of 16 months

N⁰	Ratio (%)		Growth factor					
	Live trees	Dead trees	D00 (cm)		Hvn (m)		Dt (m)	
			$\bar{X}$	CV%	$\bar{X}$	CV%	$\bar{X}$	CV%
Plot 1	92.83	7.17	2.49	49.11	1.03	43.48	1.90	92.48
Plot 2	92.82	7.18	2.61	43.85	1.03	36.73	2.05	97.02
Plot 3	94.83	5.17	2.93	39.42	1.23	37.95	2.72	87.84
Average	***93.5***	***6.5***	***2.67***		***1.09***		***2.22***	

Note: *Planting date: June 1, 2021; Data collection date: October 26, 2022.*

The data in Table 3 and Figure 3 show that the ratio (%) of live trees and dead trees from the *N.orientalis* trial planting model reached values of 93.5 and 6.55 respectively. Thus, although the experimental planting model of *N.orientalis* is pure-species plantations, the survival ratio is high (93.5%). This shows that the selection of tree species, seeds sources, planting techniques and especially the season, and planting time are very important in afforestation, especially the use of bare root cuttings for native trees species.

In addition, with a high survival ratio (93.5%) at the age of 16 months, it has been shown that *N.orientalis* has initially adapted quite well to the new site, which is far from the natural distribution of this native tree species. High survival ratio is one of the very important criteria, which allows to evaluate the success or failure in the early stages of a afforestation program, especially for native tree species on a new site, but the experimental planting model of *N.orientalis* in Hoa Binh province is an illustrative example for the above analysis.

On the other hand, from the initial results, it is shown that *N.orientalis* is a native tree that prefer light ratger shade species. Of course, these are only preliminary comments because the time is not long enough to draw more accurate conclusions. However, through the field practice, it is possible to believe in the ability to plant and develop this species in some localities of Hoa Binh province with similar conditions to Luong Son district.

** Growth in base diameter and height of N.orientalis at the age of 16 months*

For afforestation, a high survival ratio of live trees is very important, but it is only a necessary but not suffient condition. In other words, a high survival ratio is a necessary condition, while good growth and development is a sufficient condition to improve the productivity, quality and efficiency of plantations, especially native trees and big timber plantations.

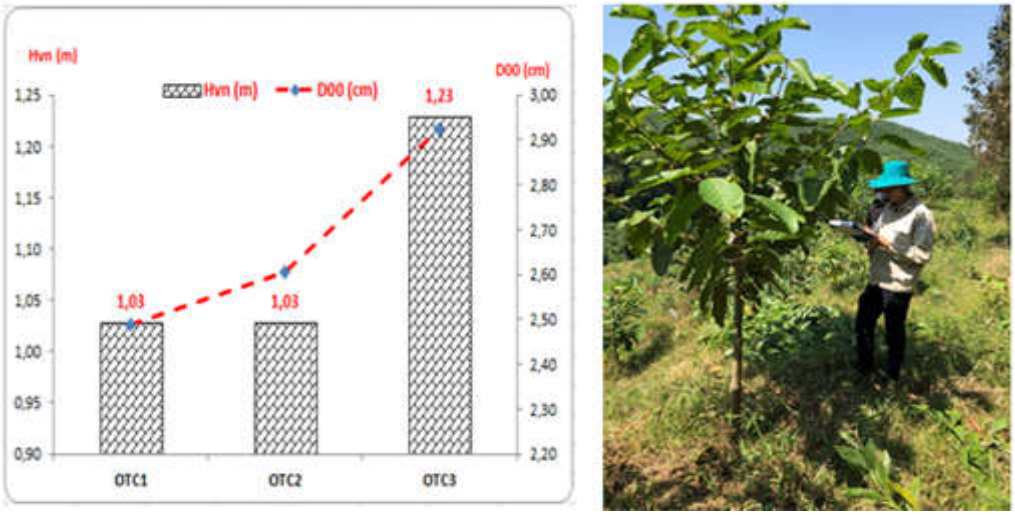

Figure 3. Growth diameter and height of *N.orientalis* at the age of 16 months

The data in Table 3 and Figure 3 show that the growth in diameter and height of the *N.orientalis* at the age of 16 months reached an average value of 2.67 cm and 1.09 m, respectively. Thus, compared with at the age of 5 months, the growth in diameter and height of the *N.orientalis* at the age of 16 months exceeded 2.6 and 1.8 times respectively.

For many species of forest trees, growth in the early stages of plantations usually has a rather slow growth rate, and some species may have to go through a "grass phase", meaning that during this time the plant growth is very slow, and has a faster rate as the plants get of year older. The results of this study show that, the experimental planting model of *N.orientalis* at the age of 16 months has a high survival ratio, grows in stump diameter and height at a good

speed, and *N.orientalis* has initially adapted and is stable determined on site conditions in Luong Son district, Hoa Binh province.

* *Development of canopy diameter of N.orientalis at the age of 16 months*

Canopy diameter is an indicator reflecting the expansion of the plant's nutrient space in order to increase access to light for growth promotion. In addition, the development of the tree's foliage reflects the growth and development of the plant, especially in the early stages of the plantation. A tree with a balanced canopy diameter, branches reaching in all directions, along with a large number of effective leaves will be a good opportunity for plants to increase photosynthesis, the basis for increasing the growth ratio of plants, especially for broadleaf, evergreen species (Figure 4).

Figure 4. Measuring branche length of *N.orientalis* at the age of 16 months

The data in Table 3 and Figure 4 show that, the average canopy diameter of the *N.orientalis* at the age of 16 months in standard plots ranges from 1.9 to 2.72 m per trees and has an overall average value of 2.2 m per trees. Thus, it may be possible to make a preliminary comment that *N.orientalis* is a native tree that has the ability to develop branches quite quickly, with a good canopy diameter right in the early stages of afforestation. This biological feature is very important, the basis for the design and adjustment of planting density to suit each site condition in each region.

With the planting density in this model, it may be necessary to have a comparative study of different planting densities to have accurate conclusions about the optimal planting density for this species when planted in Hoa Binh. However, the above results are only the first step and it takes more time to continue to monitor and update information and actual data to have more accurate conclusions, then there is enough scientific and fundamental basis for the results for optimal planting density design. In addition, it is possible to choose the right time and pruning technique to promote plant growth based on the results of experimental studies on different planting densities.

In summary, from the above research results, it can be allowed to come to a preliminary remarks that, *N.orientalis* is a native tree species, big timber, multi-use with the ability to adapt, grow and develop quite well on the land of Luong Son, Hoa Binh province. The experimental planting model of *N.orientalis* at the age of 16 months has a high survival ratio (93.5%), the tree grows well, is healthy, has the ability to develop side branches quite well, has formed, and is stable determined, and for good growth and development when the plants enter the light stage of older age.

4. CONCLUSIONS

From all the results obtained in the above sections, conclusions involved:

(1) *Nauclea orientalis* is an indigenous tree species that has the ability to adapt, grow and develop quite well in the land of Luong Son district, Hoa Binh province;

(2) Experimental planting model of *N.orientalis* for the age of 16 months has a high survival ratio (93.5%), the plants have been green and healthy; and

(3) The experimental planting model of *N.orientalis* for the age of 16 months has been an average growth of stump diameter; height of the top; and canopy diameter are 2.67 cm 1.09 m; and 2.2 m respectively.

This research result is likely important, providing information and a basis for the cultivation and development of the indigenous tree species *N.orientalis* in Luong Son area, as well as other localities of Hoa Binh province with similar conditions.

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ĐÁNH GIÁ SINH TRƯỞNG CỦA GÁO VÀNG (*Nauclea orientalis*) TỪ MÔ HÌNH TRỒNG THỬ NGHIỆM THEO HƯỚNG PHÁT TRIỂN RỪNG TRỒNG GỖ LỚN TẠI TỈNH HÒA BÌNH

Hoàng Vũ Thơ

Trường Đại học Lâm nghiệp

TÓM TẮT

Kết quả đánh giá sinh trưởng và phát triển của Gáo vàng (*Nauclea orientalis*) từ mô hình trồng thử nghiệm theo hướng phát triển rừng trồng gỗ lớn tại tỉnh Hòa Bình cho thấy, ở giai đoạn 16 tháng tuổi, cây Gáo vàng có khả năng thích ứng, sinh trưởng và phát triển khá tốt trên vùng đất tại huyện Lương Sơn, tỉnh Hòa Bình. Điều đáng chú ý là mô hình rừng trồng Gáo vàng sau 16 tháng có tỷ lệ sống đạt trị số cao (93,5%), cây sinh trưởng xanh tốt, khỏe mạnh, sinh trưởng đường kính, chiều cao và đường kính tán đat trị số trung bình là 2,67 cm; 1,09 m; và 2,2 m tương ứng. Kết quả đánh giá mô hình trồng thử nghiệm cho thấy cây Gáo vàng là loài cây bản địa có khả năng phát triển cành bên khá tốt, mô hình rừng trồng bước đầu đã ổn định và có khả năng cho sinh trưởng và phát triển tốt khi cây trồng bước sáng giai đoạn tuổi lớn hơn. Kết quả đánh giá sinh trưởng, phát triển từ mô hình trồng thử nghiệm này có ý nghĩa rất quan trọng, không chỉ cung cấp thông tin có giá trị khoa học mà còn là cơ sở thực tiễn sinh động chứng minh khả năng gây trồng và phát triển loài Gáo vàng đa dụng, có giá trị kinh tế, đồng thời bổ sung thêm giống mới vào cơ cấu giống cây trồng lâm nghiệp cho trồng rừng sản xuất theo hướng phát triển rừng gỗ lớn tỉnh Hòa Bình.

Từ khóa: Gáo vàng, loài cây bản địa, rừng trồng, sinh trưởng rừng gỗ lớn.

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