Plus tree selection of Gao vang (*Naucleo Orientalis*) for big timber developing of indigenous plantations

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Chọn lọc cây trội Gáo vàng (*Naucleo Orientalis*) cho mục tiêu phát triển rừng trồng bản địa gỗ lớn

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ABSTRACT

The results of early growths assessment of the Gao vang experimental planting area at the stage 7 year old and the selection of plus trees for big timber plantations show that the average growths in diameter at breast height, crown diameter, total height and trunk volume of plus trees (TG) reached a value of 16.74 cm; 5.24m; 10.74m; and 118.20 dm^3 per tree, respectively, exceeding the accompanying forest tree group (ĐR) of 1.60; 1.02; 1.15; and 2.82 times, respectively, under the same comparison criteria, environmental conditions and time. The forest tree groups including, ĐR1; ĐR2; ĐR3; ĐR4; and ĐR5 had a coefficient of variation (CV%) in diameter of 19.07; 18.41; 13.45; 17.90; and 17.18%. Growth speed in diameter of plus trees including, TG4; TG3; TG2; TG5; and TG1 reached a value of 2.31; 2.40; 2.40; 2.41; and 2.43 cm per year, respectively, growth farther other forests tree group by 1.55 to 1.59 times. Exceed level (%) in diameter of plus trees including, TG1; TG2; TG3; TG4; and TG5. Forest trees groups reached a value of 31.75; 30.72; 31.97; 31.52; and 30.89%, respectively, that were better than the accompanying forest tree groups and the standards of plus trees for big timber indigenous plantating development. In total, there are over 1360 Gao vang individuals measured and evaluated, but only 5 excellent trees in growth could be selected, that had a exceed level for diameter of over 30% compared to the accompanying forest tree group, a ratio of 0.36%, and a selective intensity of 0.99. The plus trees evaluated and selected are very valuable as propagation materials, contributing to providing information, scientific basis, quality seed sources, and diversifying the structure of forestry tree varieties for the goal of developing big timber plantations with native species.

TÓM TẮT

Kết quả đánh giá sinh trưởng khu rừng trồng thử nghiệm cây Gáo vàng, ở giai đoạn 7 năm tuổi và chọn lọc cây trội lấy gỗ cho mục tiêu phát triển rừng trồng bản địa gỗ lớn cho thấy, tốc độ tăng trưởng bình quân về đường kính, đường kính tán, chiều cao và thể tích của các cây trội (TG) đạt trị số là 16,74 cm; 5,24m; 10,74m; và 118,20 dm^3/cây, vượt đám rừng đi kèm (ĐR) là 1,60; 1,02; 1,15; và 2,82 lần về cùng tiêu chí so sánh, điều kiện môi trường và thời gian. Các đám rừng gồm, ĐR1; ĐR2; ĐR3; ĐR4; và ĐR5, có hệ số biến động (CV%) về đường kính là 19,07; 18,41; 13,45; 17,90; và 17,18%, cho thấy khu rừng trồng đang bước vào giai đoạn phân hóa khá mạnh về sinh trưởng đường kính. Tốc độ tăng trưởng về đường kính của các cây trội gồm, TG4; TG3; TG2; TG5; và TG1, đạt trị số là 2,31; 2,40; 2,40; 2,41; và 2,43 cm/năm, vượt xa các đám rừng đi kèm từ 1,55 đến 1,59 lần về cùng chỉ tiêu so sánh, điều kiện môi trường và thời gian. Độ vượt (%) về đường kính của các cây trội gồm, TG1; TG2; TG3; TG4; và TG5 đạt trị số là 31,75; 30,72; 31,97; 31,52; và 30,89%, đạt tiêu chuẩn của cây trội lấy gỗ, các cây trội này rất có giá trị làm vật liệu nhân giống cho mục tiêu phát triển rừng trồng bản địa gỗ lớn. Trong tổng số trên 1360 cá thể được đo đếm và đánh giá, nhưng chỉ chọn lọc được 5 cây sinh trưởng xuất sắc, có độ vượt về đường kính trên 30% so với đám rừng đi kèm, chiếm tỷ lệ 0.36%, cường độ chọn lọc là 0,99. Các cây trội được đánh giá và tuyển chọn rất có giá trị làm vật liệu nhân giống, góp phần cung cấp thông tin, cơ sở khoa học, nguồn giống có chất lượng, đa dạng hóa cơ cấu giống cây lâm nghiệp cho mục tiêu phát triển rừng trồng bản địa gỗ lớn.

Từ khóa:
cây bản địa, cây trội, cây Gáo vàng, chọn lọc, rừng trồng gỗ lớn.

1. INTRODUCTION

Big timber plantations are of great interest to managers, scientists, forestry enterprises and forest growers because of their high economic efficiency compared to small timber plantations. High economic efficiency is the driving force promoting increased afforestation in the direction of developing big timber plantations in many localities today. However, in current practice, big timber plantations are mainly created in two forms, either (i) extending the nurturing time of existing small timber plantations, or (ii) new afforestation in the direction of the developing big timber plantations, but mainly focusing on the group of acacia species, of which hybrid acacia occupies the largest area [1, 2].

Although hybrid acacia has high yields and short harvest cycles, this is an afforestation that is continuously propagated for a very long time, with many consecutive cultivation cycles on the same area, causing plantations to lose their vitality and arising serious diseases. In addition, extending the nurturing time of plantations with the acacia species group for more than 15 years may cause the trees to easily break down due to the strunk rot fungus disease. This practice requires appropriate silvicultural solutions, such as rotating cycles with indigenous trees, economically valuable tree species to improve plantation health, stabilize productivity, efficiency and ensure sustainable development [1, 2].

The scientific name of the "Gao vang" tree is *Naucleo orientalis* L., the common English name is Yellow cheesewood, which is a big timber with a wide ecological spectrum and multi-purpose, one of the few native tree species capable of for quite quickly growth tree species on many types of sites, able to meet the requirements well for the development of big timber native plantations today. Therefore, research on selection the Gao vang plus trees with the ability to grow quickly for the goal of developing big timber native plantations is extremely necessary, has very scientific significance and has high practical value. The success of this research is one of the important contents of the Provincial level topic with the theme: "*Research and application of biotechnology to improve production forest efficiency in the direction of developing big timber plantations in Hoa Binh Province*", contributing to providing information and breeding materials of genetic quality for the goal of developing big timber native plantations from Gao vang species [3]. The article below introduces some research results on the above issues.

2. RESEARCH METHODOLOGY

2.1. Research materials

The research material is Gao vang in the experimental planting area of 0.85 hectares, including 1360 trees in Hai Duong Province, that was equal to the density of 1,600 plants per ha, forest trees at the 7-year-old stage. Among them, the Gao vang plus trees selected from the experimental planting area were named as TG1; TG2; TG3; TG4, and TG5. They were measured and evaluated from the accompanying forest tree group with at least 50 individuals each, and were named as ĐR1; ĐR2; ĐR3; ĐR4, and ĐR5, respectively. The research content includes (i) evaluating some of the growth criteria of the forest tree group and plus trees, and (ii) selecting plus trees as propagation material for the goal of developing big timber indigenous plantations at the research location.

2.2. Research methodology

Research on selecting plus trees applied statistical survey methods to plantations with heterogeneous site conditions according to the method of selecting forest tree varieties [4-6]. Growth criteria of diameter at breast height ($D_{1.3}$), crown diameter (Dt), and total height (Hvn), and canopy diameter were measured according to forest survey methods commonly used in forestry, such as measuring diameter at breast height ($D_{1.3}$) with calipers, total height (Hvn) with a Blume-leiss height ruler, crown diameter (Dt) measured with a meter ruler. Calculation of average values (TB): trunk volume (V), exceed level (%) and (σ), and selection intensity are calculated according to the following formulas (1):

$$V = \frac{\pi \times D_{1.3}^2}{4} \times H_{vn} \times f \qquad (1)$$

In there:

V is the volume of the tree trunk including bark;

$D_{1.3}$ is the diameter measured at at breast height (1.3 m) from the ground;

Hvn is the total height;

f is the taper (assumed to be 0.5).

The exceed level (%) of plus trees for timber purposes is determined based on National Standard TCVN 8755:2017, Forest tree cultivars - Plus trees [4].

In this study, the evaluation and selection of plus trees is carried out according to the above standards, accordingly the exceed level (%) and (σ) are determined according to formula 2 [5, 6] as follows:

$$T = \overline{X} + 1{,}2\ Sx \rightarrow 1{,}95\ Sx \quad (2)$$

In there,

T is the main criterion to evaluate the plus tree;

$\overline{X}$ is the average value of the forest tree groups containing plus trees;

Sx is the standard deviation of the forest tree group containing plus trees;

The selectivity intensity is calculated according to the formula 3 [5, 6] as follows:

$$I = 1 - a/N; \quad (3)$$

In there,

I is the selection intensity;

a is the number of selected trees;

N is the total number of trees surveyed.

Collected data were processed using SPSS software and according to biostatistics methods commonly used in forestry on Excel application software.

3. RESEARCH RESULTS AND DISCUSSION

3.1. Evaluation of some growth criteria of Gao vang in the experimental site

In the study of selecting forest tree varieties, assessing the growth of plantations is very important. This is the basis that allows breeders to select the best plantations and individual trees with outstanding growth as breeding material for planting and development in the next. In this study, the results of measuring some growth criteria of the Gao vang forest tree group in the experimental planting area are summarized in Table 1.

Table 1. Growth of the Gao vang forest tree groups at the research site

Forest tree groups	Growth criteria of the forest tree groups							
	$D_{1.3}$ (cm)		Dt (m)		Hvn (m)		V(dm^3)	
	$\overline{X}$	CV (%)	$\overline{X}$	CV (%)	$\overline{X}$	CV (%)	$\overline{X}$	CV (%)
ĐR1	10.50	19.07	4.53	5.52	9.39	8.07	42.68	42.80
ĐR2	10.53	18.41	4.68	7.15	9.36	8.18	42.59	40.57
ĐR3	10.96	13.45	4.70	12.30	9.42	7.70	45.57	31.08
ĐR4	10.14	17.90	4.90	8.15	9.37	7.76	39.43	40.42
ĐR5	10.70	17.18	4.92	8.13	9.43	6.69	44.06	36.77
Average	**10.57**		**4.75**		**9.39**		**42.87**	

Table 1 shows that, the average growth of the forest tree group is accompanied by the plus trees candidates of Gao vang in diameter at breast height; crown diameter; total height; and the trunk volume reached a values ranging from 10.14 to 10.96 cm; from 4.53 to 4.92 m; from 9.36 to 9.43 m; and from 39.43 to 45.57 dm^3 per tree, respectively, under the same environmental conditions.

Thus, after 7 years of experimental planting, the Gao vang had an overall average growth in $D_{1.3}$, Dt, Hvn and V reached a value of 10.57 cm; 4.75 m; 9.39 m; and 42.87 dm^3 per tree, respectively. In addition, the results of observations at the research scene also showed that, the experimental planting area of the Gao vang did not show any dead trees, traces or vacant land in the correct position of planting trees in rows, proving that the Gao vang is able to adapt and grow on experimental land.

This has scientific significance and high practical value, because the Gao vang is a native tree, a big timber species, but there is not much information, data or experimental planting results about it, especially concentrated pure species planting. Therefore, the results of this research will open up a new approach to selecting native tree species capable of pure - species afforestation, contributing to diversifying the structure of forest tree varieties towards the development of big timber native plantations.

On the other hand, the data in Table 1 also shows that there is a significant difference in average diameter at breast height between the forest tree group at the study location. For

example, the forest tree group of number 3 (ĐR3) had an average growth diameter at breast height of 10.96 cm, while the data in the forest tree group of number 4 (ĐR4) is 10.14 cm. Thus, the growth in diameter at breast height of ĐR3 exceeds ĐR4 by 1.08 times for the same comparison criteria under the same conditions and time. In addition, the coefficient of variation also fluctuates significantly between measured forest tree groups, for example, in forest tree groups of number 1 (ĐR1), the coefficient of variation in diameter reached a value of 19.07%, exceeding 1.42. times compared to forest tree groups of number 3 (ĐR3) with a value of 13.45% for the same comparison criteria.

Similar to the criteria of tree trunk volume growth - a comprehensive criteria that reflects the growth and development of individual trees in the plantations. Accordingly, in the forest tree group of number 3 (ĐR3), the average tree trunk volume growth reached a value of 45.57 dm^3 per tree, while this data for forest tree groups of number 4 (ĐR4) only reached a value of 39. 43 dm^3 per tree.

Thus, the tree trunk volume growth of forest tree group of number 3 (ĐR3) exceeds Forest tree groups of number 3 (ĐR4) is 1.16 times for the same comparison criteria, under the same conditions and time. On the other hand, the coefficient of variation in trunk volume growth also fluctuates significantly between measured forest tree group, in which forest tree group of number 1 (ĐR1) had a coefficient of variation in trunk volume of 42.80%, exceeding 1.38 times higher than the forest tree group of number 3 (ĐR3) for the same comparison criteria.

Thus, the significant fluctuations in some growth criteria show that, there is quite a strong separation between the measured forest tree groups of the Gao vang. This can be advantageous for selecting individuals with superior growth, especially diameter growth. Of course, the above results are just the beginning, because it is likely that some individuals and forests tree group with higher values of some growth criteria are planted in more favorable locations than other individuals.

Therefore, a futher study, such as the study to evaluate the genetic diversity of plus trees or the Gao vang trial forest mentioned above, may likely give more realistic results about the original seed source for planting.

However, fluctuations in some growth criteria such as diameter at breast height or trunk volume can be a good opportunity to allow the selection of plus trees according to the goal of obtaining more favorable big timber. In addition, the results of evaluating some growth criteria in Table 1 also showed that, under the same soil and climate conditions and at the same age, external environmental factors are relatively consistent. Therefore, the difference in diameter at breast height and tree trunk volume between the investigated and measured forest tree groups has shown that, individuals have differences in internal factors, or that their growth is under control and strongly influenced by genetic factors.

3.2. Plus tree selection showing the ability fast growths of Gao vang

In genetic research and forest tree breeding, large fluctuations in some growth criteria related to breeding criteria are very important, such as diameter at breast height or tree trunk volume, especially for big timber plantations. Accordingly, individuals with a big diameter or trunk volume than other individuals in that same population are the subject of priority selection.

In other words, these individuals have a phenotype for superior growth in diameter or volume compared to other individuals around them in that same population, which is the basis for selecting plus trees, especially plus trees for the purpose of obtaining timber. Because, in forest trees breeding is a key element in the improvement of productivity and timber quality plantations which were of plus-tree selection as the first important step in improvement programme of forest trees variety [7, 8]. However, in forest tree breeding, it is not necessary to select trees with superior phenotypes from large planted forest plots, but even with a smaller planted forest area, it is possible to select superior individuals of growth as propagating material for testing or new afforestation purposes.

In this study, Gao vang individuals in the experimental site had outstanding growth phenotypes such as big diameter, straight stem, narrow canopy, small branches, large branch

angles, and especially no signs of pests or diseases, and were susceptible to disease.

These trees need to be individually marked with paint and selected as propagation material according to the plus trees standards prescribed by the National Standard (TCVN 755:2017). The results the measuring some growth criteria of the plus trees and the forest tree groups are summarized in Table 2.

Table 2. Growths of the plus trees and the forest tree groups

Code		D1.3 (cm)		Dt (m)		Hvn (m)		V (dm^3)	
Plus tree	Forest tree groups	Plus tree	Forest tree groups	Plus tree	Forest tree groups	Plus tree	Forest tree groups	Plus tree	Forest tree groups
TG1	ĐR1	17.00	10.50	5.50	4.53	10.70	9.39	121.40	42.68
TG2	ĐR2	16.80	10.53	5.20	4.68	10.60	9.36	117.50	42.59
TG3	ĐR3	16.80	10.96	5.40	4.70	10.80	9.42	119.70	45.57
TG4	ĐR4	16.20	10.14	5.00	4.90	10.80	9.37	111.30	39.43
TG5	ĐR5	16.90	10.70	5.10	4.92	10.80	9.43	121.10	44.06
Average		**16.74**	**10.57**	**5.24**	**4.75**	**10.74**	**9.39**	**118.20**	**42.87**

Table 2 shows that all plus trees had growth criteria of diameter at breast height, total height, crown diameter and trunk volume better than those of the accompanying forest tree groups.

For example, the plus tree of number 1 (TG1) reached a values of diameter at breast height, crown diameter, total height, and trunk volume of 17.0 cm; 5.50 m; 10.70 m; and 121.40 dm^3 per tree, espectively, while the accompanying forest tree group (ĐR1) had an average value of 10.50 cm; 4.53 m; 9.39 m; and 42.68 dm^3 per tree, respectively, under the same comparison criteria.

Thus, the growth in diameter at breast height, crown diameter, total height and trunk volume of the plus tree (TG1) all exceed that of the accompanying forest tree group (ĐR1) by 1.62; 1.21; 1.14; and 2.84 times, respectively, under the same comparison criteria under the same conditions and time. Similarly, the plus tree of number 4 (TG4) (the smallest values) of diameter at breast height, crown diameter, total height, and trunk volume of 16.20 cm ; 5.00 m; 10.80 m; and 111.30 dm^3 per tree, respectively, but is still superior to the accompanying forest tree groups that plus tree by 1.60; 1.02; 1.15; and 2.82 times, respectively, to the same comparison criteria under the same conditions and time.

In forest tree breeding, individuals with fast growth speeds are always the priority selection as breeding materials, especially for native tree species, because they often grow slowly and take a long time to harvest wood product. In this study, determining the growth speed in diameter at breast height of the forest tree groups and plus trees is summarized in the chart Figure 1.

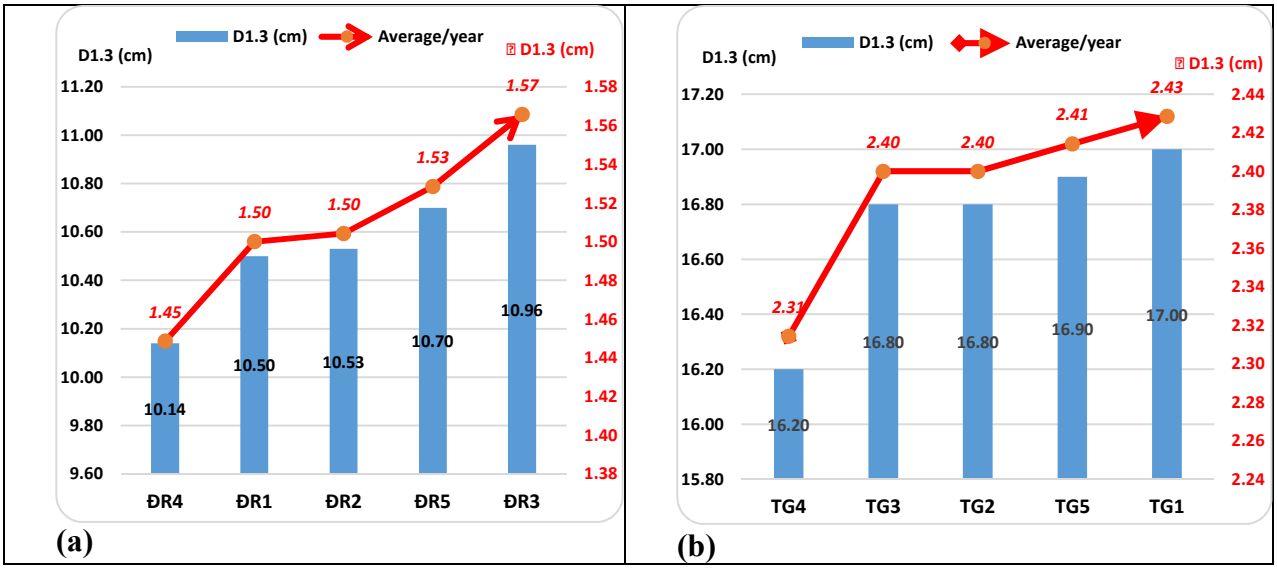

Figure 1. Average annual growth in diameter at breast height at stage 7 year old (dotted red arrow) of the forest tree groups (a) and the plus trees (b)

The values in Figure 1 and the line show that the average growth speed of diameter at breast height of the forest tree groups fluctuates and gradually increased from 1.43 cm (ĐR4) to 1.57 cm (ĐR3), while this data of the plus tree fluctuates and gradually increases from 2.31 cm (TG4) to 2.43 cm (TG1), under the same conditions and time. Clearly, the average growth speed in diameter at breast height of the plus trees is 1.55 to 1.62 times, and always higher than that of the forest tree groups for the same comparison criteria and time.

This result has high practical value in selecting of the plus trees for timber purposes, especially for groups of native tree species such as the "Gao vang" species - the research object of this article. In forestry, a certain tree species belongs to the fast-growth group if its diameter at breast height has an average growth speed greater than 2.0 cm per year. Thus, the plus trees in this study has an average growth speed in diameter ranging from 2.31 cm to 2.43 cm, belonging to the fast growth group, an important basis for selection as propagation material for the goal of in the direction of developing big timber plantations.

However, in forest tree breeding, selecting of the plus trees for the purpose of obtaining timber that have a fast-growth speed compared to the forest tree groups accompanying, it is a necessary condition, but not sufficient. Because according to the standards for evaluating and selection the plus trees (National standard: TCVN 755:2017), accordingly, the plus trees must have a exceed level for a diameter at breast height greater than 25% compared to the accompanying forest tree groups.

In this study, the results of measuring and calculating the exceed level in diameter at breast height and trunk volume of the plus trees compared to the forest trees group accompanying are summarized in Table 3.

Table 3. The exeed level of the plus trees compared to the accompanying forest tree groups

Code	Growth criteria of the plus trees				Exceed level of the plus trees			
					$D_{1.3}$ (cm)		V (dm^3)	
	$D_{1.3}$ (cm)	Dt (m)	Hvn (m)	V (dm^3)	(%)	σ	(%)	σ
TG1	18.40	5.50	11.80	156.88	31.75	4.10	87.98	56.84
TG2	18.20	5.20	12.20	158.70	30.72	3.95	85.51	54.15
TG3	17.80	5.40	12.90	160.51	31.97	4.07	91.32	57.13
TG4	18.80	5.60	12.30	170.72	31.52	3.88	90.08	52.75
TG5	18.60	5.80	12.20	165.75	30.89	3.99	90.74	57.62
Average	**18.36**	**5.50**	**12.28**	**162.51**	**31.37**	**4.00**	**89.13**	**55.70**

Data in Table 3 and Figure 2 show that the exceed level in diameter at breast height of the plus trees ranged from 30.72% of tree No.2 (TG2) to 31.97% of tree No.3 (TG3), and reached an overall average of 31.37%. While the exceed level calculated by (**σ**) in diameter at breast height of the plus trees ranges from 3.88 of tree No. 4 (TG4) to 4.10 of tree No. 1 (TG1), and reached a value an overall average of 4.00.

In selecting the plus trees for timber, diameter at breast height is one of the very important growth criteria, especially in selecting the plus trees for some indigenous species for the purpose of afforestation in the direction of developing big timber indigenous plantations.

In addition, data in Table 3 also shows that the exceed level in trunk volume ranged from 85.51% in plus tree No. 2 (TG2) to 91.32% in plus tree No. 3 (TG3), and reached the highest value. The overall average value of the plus trees was 89.13%.

Tree trunk volume is a general growth icriteria - a very important factor that constitutes the productivity of wood biomass in plantations.

The results in Table 3 show that the plus trees had an exceed level (%) of trunk volume reaching a value of over 50%, which is a very valuable practice in selecting the plus trees for timber purposes. However in reality most the plus trees have very different levels.

For example, the plus tree of No.3 (TG3) has the highest value of 31.97%, exceeding 1.04 times higher than plus tree of No.2 (TG2) under the same comparison criteria, conditions and time. Similar, the exceed level calculating acording to (**σ**) show that, all of the plus trees reached a value greater than 2 times the standard deviation, and meet the prescribed standards for the plus trees of timber (Figure 2).

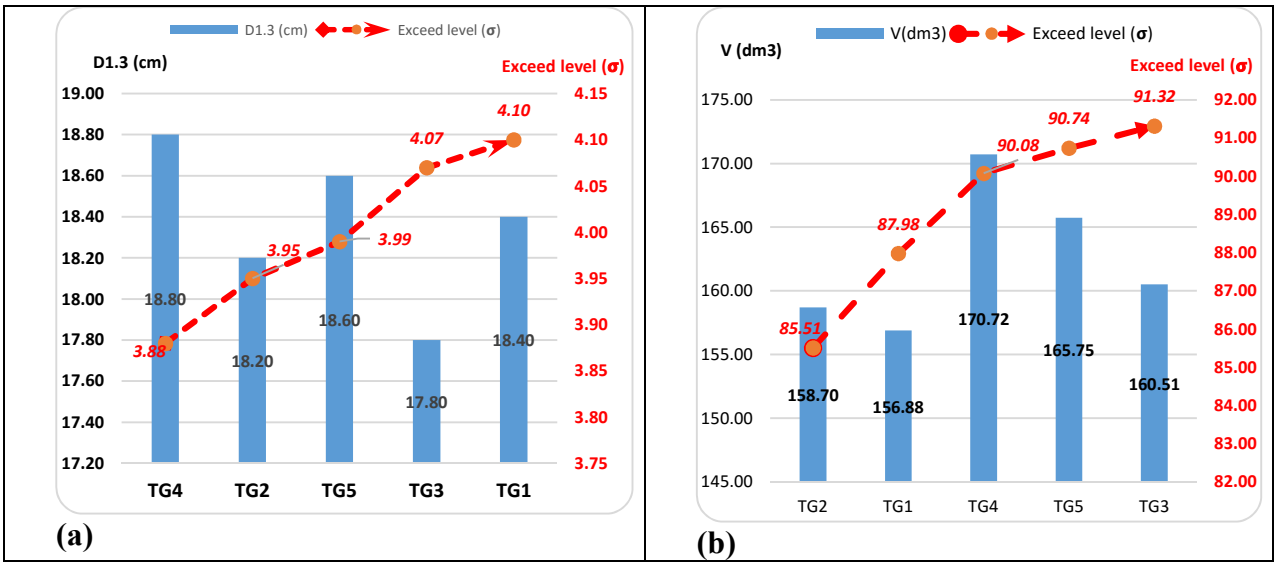

Figure 2. The exceed level (σ) of the plus trees (dotted line with red arrow) compared of the accompanying forest tree groups in terms of diameter at breast height (a) and trunk volume tree (b)

In forest tree breeding, selecting of the plus trees with high superiority in any given criterion is very difficult, but very valuable, especially for native tree species. That is the reason that in this study, from over 1360 individuals that were measured and evaluated, only 5 plus trees could be selected, including, TG1; TG2; TG3; TG4; and TG5 whose exceed level reached a value of 31.75; 30.72; 31.97; 31.52; and 30.89%, respectively, compared to the accompanying forest tree groups, a ratio of 0.36%, and a selective intensity was 0.99.

These are individuals with excellent growth from the Gao vang experimental planting area. These trees are very valuable as propagating materials for afforestating in the direction of developing big timber native plantations.

In addition, the plus trees evaluated and selected got an average growth speed of diameter at breast height of 2.31; 2.40; 2.40; 2.41; and 2.43 cm per year, they could be recognized as a group of fast-growths tree species.

Furthermore, photos (Figure 3) of the plus trees and the accompanying forest tree groups at the research scene partly shed light on what had been analyzed and commented on in the above sections.

Figure 3. Plus trees and forests trees groups of the Gao vang plantation

In summary, the results of the growth assessment of Gao vang in the experimental site and selection of the fast-growing plus trees can be preliminarily commented that the average growth in diameter at breast height, crown diameter, total height and the trunk volume of the plus trees (TG) reached a value of 16.74 cm; 5.24 m; 10.74 m; and 118.20 dm^3 per tree, respectively, and exceeded the level of accompanying forest tree groups is 1.60; 1.02; 1.15; and 2.82 times, respectively, under the same comparison criteria, conditions and time.

The coefficient of variation in diameter of the forest tree groups had a fairly values (13.45% - 19.07%), that shows forest trees were reaching a period of strong differentiation in growth, a favorable time for selection the plus trees as propagation material for planting purposes in the direction of developing big timber indigenous plantations.

The growth speed in diameter at breast height of the plus trees was quite fast and got an average value of 2.31 to 2.43 cm per year, far exceeding that of the accompanying forest tree groups (from 1.43 to 1.57 cm per year) at the time of assessment.

Notably, the exceed level (%) in diameter at breast height of the plus trees compared to the accompanying forest trees group reached values from 30.72% to 31.97%, ensuring the standard of the plus trees for timber.

The plus trees evaluated and selected cuold be valuable breeding materials, contributing to diversifying the forest tree variety structure for the goal of developing big timber indigenous plantations.

4. CONCLUSIONS

From the results of the evaluation and selection of the plus trees achieved in the above sections, can come to some conclusions as follows:

1. The average growth in diameter at breast height, crown diameter, total height and trunk volume of the plus trees (TG) at the stage 7 year-old reached 16.74 cm; 5.24 m; 10.74 m; and 118.20 dm^3 per tree, respectively, exceeding the accompanying forest tree groups (ĐR) of 1.60; 1.02; 1.15; and 2.82 times respectively;

2. At the stage 7 year old, the forest tree groups included, ĐR1; ĐR2; ĐR3; ĐR4; and ĐR5 had coefficient of variation (CV%) in diameter of 19.07; 18.41; 13.45; 17.90; and 17.18% which shows that forest trees were reaching a stage of quite strong differentiation in diameter growth;

3. Growth speed in diameter of the plus trees including, TG4; TG3; TG2; TG5; and TG1, at the stage 7 year old reached a value of 2.31; 2.40; 2.40; 2.41; and 2.43 cm per year, respectively, far exceeding that of the accompanying forest tree groups (ĐR) by 1.55 to 1.59 times;

4. Exceed level (%) in diameter of the plus trees including, TG1; TG2; TG3; TG4; and TG5 compared to the accompanying forest tree groups (ĐR) reached a value of 31.75; 30.72; 31.97; 31.52; and 30.89%, respectively, meeting the standards of the plus trees for timber, which were likely valuable goal for the developing big timber indigenous plantations;

5. In total of 1360 individuals of Gao Vang measured and evaluated, only 5 excellent trees were be selected, that had a exceed level of diameter over 30% compared to the accompanying forest tree groups, a ratio of 0.36%, and a selective intensity of 0.99.

The plus trees evaluated and selected would be valuable as propagation materials, contributing to providing information, scientific basis, quality seed sources, and diversifying the structure of forestry tree varieties for the goal of developing big timber native plantations.

REFERENCES

[1]. MARD (2022). Export of wood and forest products is expected to reach 20 billion USD by 2025 [Online]. www.mard.gov.vn.

[2]. VIFORES (2022). The wood material market will compete fiercely after Russia-Ukraine tensions [Online]. https://vietfores.org/.

[3]. Raghavamma S. T. V. & Ramarao N. (2010). In vitro evaluation of anthelmintic activity of *Nauclea orientalis* leaves. Indian J. Pharm. Sci. 72(4): 520-521.

[4]. MARD (2017). National Standard TCVN 8755:2017 on Forestry tree varieties - Plus tree [Online]. www.mard.gov.vn.

[5]. Le Dinh Kha & Duong Mong Hung (2003). Forest tree variety. Agricultural publisher. Hanoi. pp. 111, 131.

[6]. Hoang Vu Tho (2015). Research on selection of plus trees of *Pinus merkusii* with high yielding resin in Nghe An province. Journal of Agriculture and Rural Development. December (Vol. 2): 239-248.

[7]. Clark, J. & Wilson, T. (2005). The importance of plus-tree selection in the improvement of hardwoods. Quarterly Journal of Forestry. 99(1): 45-50 [Online]. https://www.researchgate.net/publication/261797286.

[8]. Lantz, C.W. (2002), "Genetic Improvement of Forest Trees", USDA Forest service, Atlanta, Georgia, USA, Chapter 2, pp.39-56 [Online]. www.fao.org