STRUCTURE, BIOMASS AND CARBON STOCKS CHARACTERISTICS OF ACACIA HYBRID FORESTS IN HAM YEN, TUYEN QUANG

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SUMMARY

Research on biomass and carbon stocks is very meaningful for managing and minimizing negative effects of climate change and global warming on people's lives. The study collected and analyzed data from plots for *Acacia hybrid* forests at two different age levels: 2 years and 6 years old in Ham Yen, Tuyen Quang. The analytical results showed that density at age 6 was lower than age 2. The diameter and height frequency distributions were well simulated by Weibull distribution. The distributions at the age 2 followed the Weibull distribution better than the age 6. Age 2, Power function is the best function, while at age 6, Cubic function is the best function to describe the correlation between diameter and height. The total amount of fresh biomass of *Acacia hybrid* is about 24.59 (ton/ha) for ages 2 and 89.92 (ton/ha) for age 6. Biomass concentrated mainly on the tree layer, then on the vegetation floor and litter layer. Dry biomass is quite similar to the fresh biomass distribution. With a forest density of 1540 plant/ha, the amount of CO_2 absorbed by age 2 was 5.13 (ton/ha). The amount of CO_2 absorbed by age 6 was 30.73 ton/ha with a forest density of 1240 tree/ha. The average amount of underground carbon at sampling point 1 was 29.51 (ton/ha), lower than the average carbon at the sampling point 2 was 30.56 (ton/ha). The amount of carbon decreases gradually from the surface layer to the 10 - 20 cm layer and finally to the 20 - 30 cm layer.

Keywords: *Acacia hybrid*, biomass, carbon stocks, structure.

1. INTRODUCTION

Carbon dioxide (CO_2) is the primary greenhouse gas in the atmosphere that leads to climate change and global warming. Only over 100 years ago, the atmospheric concentration of CO_2 has increased from 280 ppmv in 1750 to 367 ppmv in 1999 and is currently increasing at the rate of 1.5 ppmv/year or 3.3 Pg C/year (1 Pg = petagram = billion ton) (IPCC, 2001, (Lal, 2004). The World Meteorological Organization (WMO) said carbon dioxide reached new highs at 400.0 ± 0.1 ppm in the atmosphere at the end of 2015. That led to the ongoing warming of the earth at present and will cause serious consequences: the ground temperature will increase by 1.8^o -6.4^o in 2100, rainfall will increase by 5 - 10%, ice at the two poles and high mountains will increase more, the sea level will rise about 70 - 100 cm. Through photosynthesis and respiration, the forest ecosystem contributes most to the accumulation of more than 80% C on the ground and over 70% of soil organic carbon (SOC) (Niels H Batjes, 1996; Esteban G Jobbágy and Robert B Jackson, 2000).

Research on forest structure, biomass and carbon stocks is one of the important areas in forestry production and research activities. Understanding the structural and biomass characteristics as well as the amount of carbon stored in the forest, foresters can draw a complete picture of the current situation as well as production of the forest at certain times, from which owners can develop forest business plans and measures, in order to use forest resources reasonably (Bui Manh Hung, 2018).

Currently, there are many methods used to estimate and predict the carbon absorption capacity of forests. This can include the method of digging and weighing an entire sample tree, then estimating for stands, or the method based on allometric equations prepared for each species or forest status (A Inoguchi et al., 2012). Many countries now purchase carbon credits from developing countries, including Vietnam. Therefore, information on biomass and carbon stocks is really necessary and useful for this. At the same time, they are also a very important for proposing solutions to deal with global warming and climate change.

Currently, in Tuyen Quang, *Acacia hybrid* is one of the most commonly grown tree species. With outstanding features such as rapid growth, ability to fix nitrogen and improve soil fertility, *Acacia hybrid* plantations have been expanded in Ham Yen district. *Acacia hybrid* is a suitable species to cover bare soil, hills and mountains. It is a tree species that brings high economic values to planters (Tu Cuong, 2011).

However, at Ham Yen district, Tuyen Quang province, there are very few studies on biomass and carbon stock for *Acacia hybrid* forests. Therefore, this article will focus on 1) Analysis of similarities and differences in growth and structure of *Acacia hybrid* at age 2 and age 6; 2) Calculation and comparison of fresh biomass and dry biomass of *Acacia hybrid* forests at these two age levels and finally is 3) Calculation of carbon stocks for tree storey, vegetation layer, litter layer and soil of *Acacia hybrid* forests in the study area. Research results will be an important basis to manage and develop *Acacia hybrid* forests sustainably in the future.

2. RESEARCH METHODOLOGY

2.1. Data collection method

2.1.1. Plot setting up

The study has established 4 plots for 2 *Acacia hybrid* forests of 2 years old and 6 years old at different altitudes. There were 2 plots for 2-year-old forest and 2 plots for 6-year-old forest. Each plot had an area of 500 m^2 (20 x 25 m). The used sampling method was a random stratification method, which is a suitable method in forestry research (Barry D. Shiver and Bruce E. Borders, 1996).

In each plot, there were 5 sub-plots, in which 4 at corners and 1 in the center with area of 1m^2 (1 m x 1 m) to survey shrubs, vegetation and take soil and litter samples. The total number of sub-plots in the 2 studied forest states was: 6 x 5 = 30 sub-plots.

2.1.2. Measurement and sample collection method

a. Tree storey investigation

The study measured and determined the diameter at breast height ($D_{1.3}$) with calipers and the total height (H_{vn}) with Blumeleiss tool.

b. Shrub and vegetation investigation

On 5 sub-plots (1 x 1 m) in the plot, 4 sub-plots at 4 corners of the plot and 1 in the center. We cut all shrubs, vines and fresh vegetation above the ground. Then weigh at the site to get fresh weight (FW) results.

c. Litter collection

On 5 sub-plots (1 x 1 m) in the plot, 4 sub-plots at 4 corners of the plot and 1 in the center, we collected all litter objects (branches, leaves, flowers, fruits...) and weight them at the field to get the litter biomass. Then mixed all litter objects and took a 200 g sample. In the lab, the sample was dried at 105^oC in the oven until the sample weight did not change, resulting in a dry biomass.

d. Soil sample collection

In each plot, two soil profiles were excavated under representative positions of the tree storey, shrubs and vegetation floor and the litter layer. In each soil profile, soil samples were taken at random points, mixed and formed a composite sample of 3 depths: 0 – 10 cm, 10 - 20 cm and 20 - 30 cm. Aggregate soil samples at each depth were taken with a volume of 0.5 - 1 kg and then processed and analyzed. The total analyzed soil samples were 12 samples.

2.2. Analysis method

2.2.1. Sample processing method in the laboratory

a. Sample drying method to determine biomass

- Drying samples of shrubs and vegetation

The collected shrubs and vegetation samples of 5 sub-plots were chopped, took 200 g and dried in an oven at a temperature of 105^oC until the sample mass did not change, getting dry weight (DW).

- Drying litter samples

Collected litter samples at each sub-plot were cleaned up soil particles and took 200 g to dry in an oven at 105^oC until the sample

weight was unchangeable.

b. Method of soil analysis in the laboratory

Soil samples were analyzed by the following methods in table 1.

Table 1. Methods for analyzing soil samples in the laboratory

No	Index	Method
1	Soil proportion	Picnomet bottle
2	Soil density	Density ring
3	pH_{KCl}	pH-Meter
4	OM (%)	Tiurin method

2.2.2. Data analysis method

a. Forest structure and growth analysis

Basic descriptive statistics such as mean and standard deviation were calculated for diameter and height variables. Next, diameter and height frequency distributions were built and modelled using the Weibull distribution by Q-Q plot method in SPSS 24.0. The Weibull distribution is widely used to model the frequency distribution for plantations in Vietnam (Robert Ho, 2013).

Regression between diameter and height of *Acacia hybrid* was also checked by 10 common functions such as: linear, exponential, logarithm function, inverse functions... From there, analyzing differences and similarities of the correlation at the two age levels. That will be a basis for adjusting the structure and optimizing the amount of carbon stored in the stand (Nguyen Hai Tuat and Vu Tien Hinh, 2009; Robert Ho, 2013).

b. Biomass calculation

- *Tree biomass*: using the following formula:

$$Y=0.11x\ \rho\ x\ D_{1.3}{}^{2+c}$$

In which: ρ is wood density = 0.5 (g/cm^3); c = 0.62; D is the tree diameter (Jim Penman et al., 2003; Naoto Matsumura et al., 2008).

- *Shrubs and vegetation biomass (W_{SB})*

Shrubs and vegetation biomass per 1 hectare was calculated using the following formula (Jim Penman et al., 2003; Naoto Matsumura et al., 2008):

$$W_{SB} = \frac{W_{SB}/plot \times 10000}{500} \text{ (ton/ha)}$$

- *Litter biomass (W_{LB})*

Litter biomass per 1 hectare was computed using the following formula (Jim Penman et al., 2003; Naoto Matsumura et al., 2008):

$$W_{LB} = \frac{W_{LB}/plot \times 10000}{500} \text{ (ton/ha)}$$

c. Carbon stocks calculation

- *Carbon stock of trees:* C stocks in individual trees were determined by the formula:

$M_c=M_k$ x (0.5)

In which: 0.5 is the coefficient of conversion between dry biomass and carbon.

Carbon contents in dry wood were:

$$M_{CO_2} = \frac{M_c \times 44}{12} \text{ (ton).}$$

- *Carbon in the soil*

$$M_{CO_2}/ha = \frac{M_C \times 44}{12} \text{ (ton/ha)}$$

In which:

M_C: The carbon contents in the soil were calculated through the soil proportion, density, content of organic matter in the soil.

Soil carbon stocks were determined based on soil carbon contents, soil proportion, density and soil depth according to the formula:

SOC (ton/ha) = H x D x OC x 0.58 x 100

In which: SOC - Soil organic carbon (ton/ha); H - soil depth (cm); D - soil proportion (g/cm^3); OC - carbon contents in the soil (g/100g soil)

3. RESULT AND DISCUSSION

3.1. Structural characteristics of *Acacia hybrid* plantations

3.1.1. Density and descriptive statistics of Acacia hybrid

Calculation results of some descriptive statistics for diameter and height variables at different age levels were as table 2.

Table 2. Descriptive statistics for *Acacia hybrid* at age 2 and age 6

Age	Plot	Tree/ha	$D_{1.3}$ (cm)		H (m)	
			Mean	Std. Deviation	Mean	Std. Deviation
2	1	1600	4.40	0.99	4.67	0.99
	2	1480	4.77	0.76	5.16	0.89
	Average	**1540**	**4.59**	**0.88**	**4.92**	**0.94**
6	3	1280	14.84	2.57	15.35	2.96
	4	1200	15.23	3.06	17.09	3.48
	Average	**1240**	**15.04**	**2.82**	**16.22**	**3.22**

The density of *Acacia hybrid* stands in the study area is quite large but gradually decreases with the age of the stand. At the age of 2, the average density is 1540 (tree/ha), while at age 6 is 1240 (tree / ha). At age 2 due to high initial planting density and no thinning operations, so density is always higher than those at older ages. At the age of 6, the density is decreased due to adverse environmental conditions such as storms and strong winds that cause trees to die and due to the growth of the stand. At the same time, the decreasing trend is due to the competition of nutrition and light among forest trees (Bui Manh Hung, 2016). On the other hand, in order to create the best nutritional space for the tree, foresters have conducted thinning methods removing bad trees and keeping good trees.

3.1.2. Characteristics of frequency distributions and modeling using Weibull distribution

The structure of *Acacia hybrid* year 2 and 6 was assessed through the diameter and height frequency distributions. These are two indicators that clearly show the growth of plantations in the early stages.

a. Results for the diameter

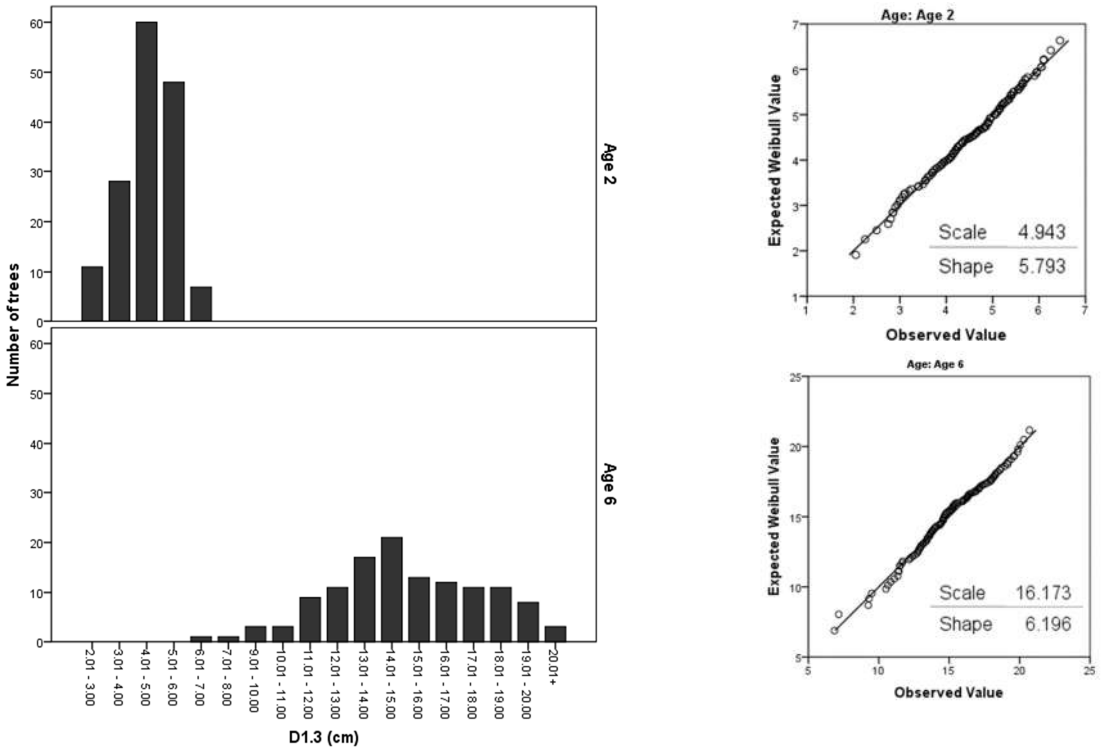

Figure 1. Diameter frequency distributions of *Acacia hybrid* plantations at age 2 and age 6 are on the left and Weibull distribution modelling results are on the right

Figure 1 shows that the diameter of the 2-year-old forest ranges from 2 to 6 cm, concentrating mainly on 4 - 5 cm size. Meanwhile, the 6-year-old forest has a larger size, ranging from 6 to 20 cm and concentrated mainly in DBH sizes from 13 to 15 cm.

The modeling results using the Weibull distribution show that both ages, the experimental distributions follow the Weibull distribution well. However, at age 2, the diameter frequency distribution tends to be more appropriate. The distribution of age 2 is more right-skewed than that of the age 6. This is consistent with plantation research results of many previous studies in Vietnam (N. V. Thang *et al.,* 2011; Vo Dai Hai, 2014; Bui Manh Hung, 2016).

b. Results for the height

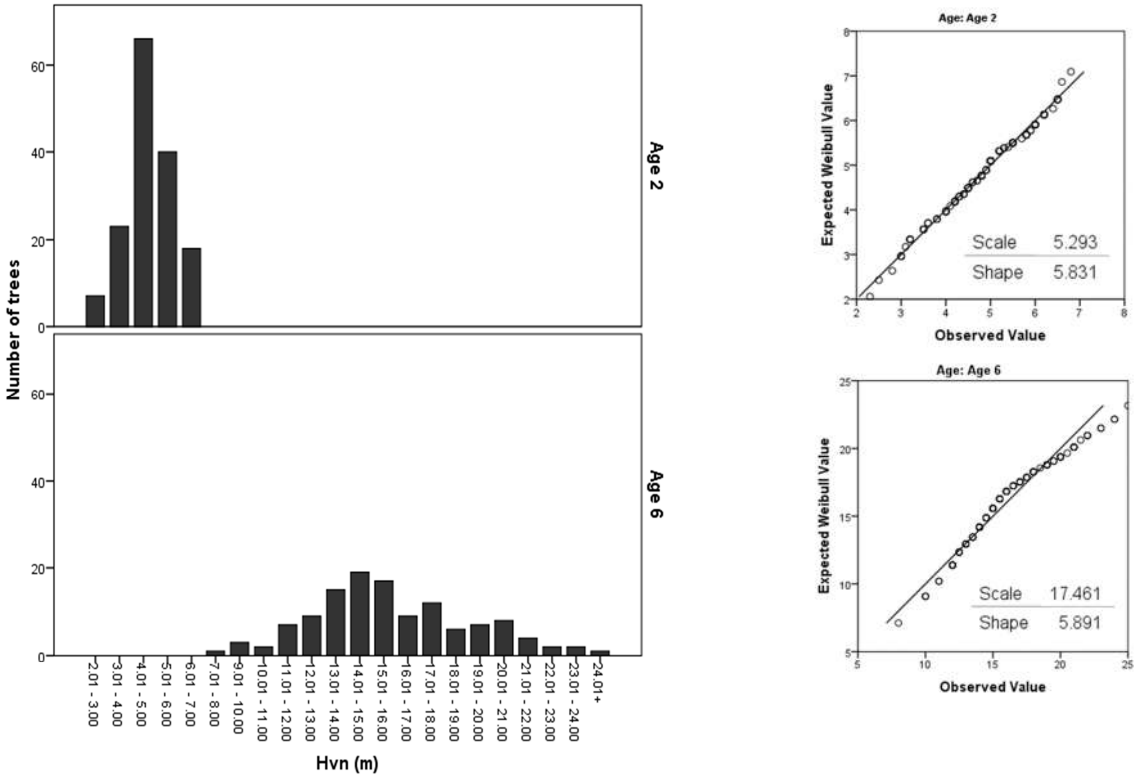

Figure 2. Height frequency distributions of *Acacia hybrid* plantations at age 2 and age 6 are on the left and Weibull distribution modelling results are on the right

Figure 2 shows that the total height of the 2-year-old forest ranges from 2 to 6 cm, concentrating mainly on 4 - 5 cm size. Meanwhile, the 6-year-old forest has a larger size, ranging from 7 to 24 cm and concentrated mainly in DBH sizes from 13 to 17 cm.

The modeling results using the Weibull distribution show that both ages, the experimental distributions follow the Weibull distribution well. However, at age 2, the diameter frequency distribution tends to be more appropriate. In both ages, the distribution is right-skewed. The skewness is not really different between the two age levels.

3.1.3. Regression between diameter and height

The results of correlation analysis using 10 functions show that the regression between diameter and height of *Acacia hybrid* is relatively strong. All functions for age 2, the correlation coefficient runs from 0.78 to 0.81. Power function is the best function to describe the relationship between diameter and height. At age 6, the correlation coefficients of functions are in the range of 0.67 to 0.84. The best function to describe correlation at this age is Cubic. Thus we see that older forests have more complex relationship between diameter and height. This is a result of a differentiation process when the forest age increases (Hans Lamprecht, 1989). This has been demonstrated

in many other studies in Vietnam as well as in other countries (Hans Lamprecht, 1989; Shadrach Olufemi Akindele and Jonathan C. Onyekwelu, 2011).

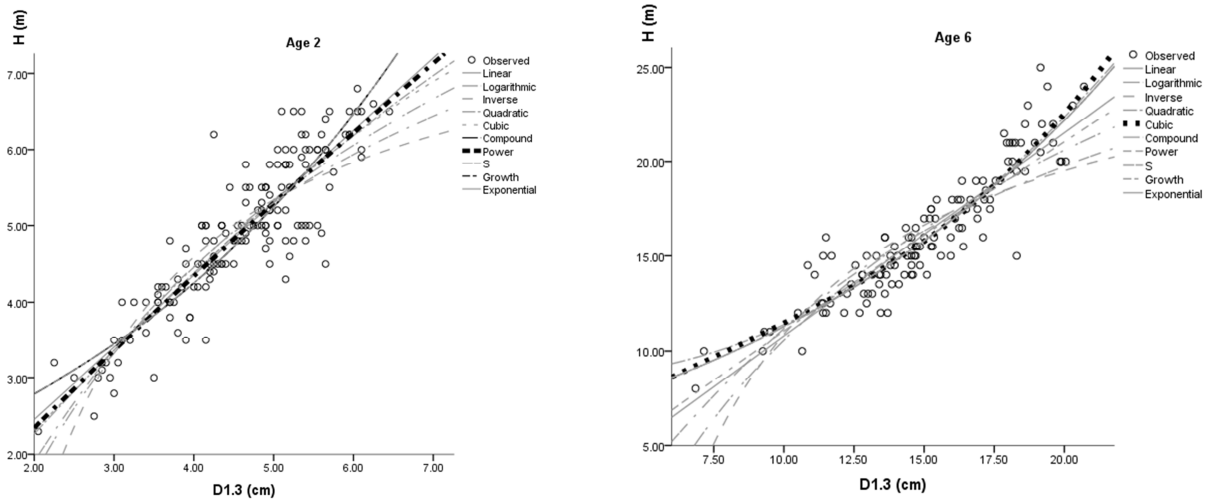

Figure 3. The regression between diameter and height of *Acacia hybrid* plantations at age 2 and age 6

3.2. Biomass of *Acacia hybrid* plantations

3.2.1. Fresh biomass of Acacia hybrid forest

The fresh biomass structure of the stand includes fresh biomass of trees, shrubs and litters. In different states and different positions of the same state, biomass structures are often different. The results of calculating biomass for stores in the forest stand are as table 3.

Table 3. Fresh biomass of *Acacia hybrid* forest

Age	Plot	Tree		Vegetation		Litter		Total (ton/ha)
		Ton/ha	%	Ton/ha	%	Ton/ha	%	
2	1	15.21	59.72	5.06	19.87	5.20	20.42	25.47
	2	16.72	70.55	4.00	16.88	2.98	12.57	23.70
	Average	**15.97**	**65.13**	**4.53**	**18.37**	**4.09**	**16.50**	**24.59**
6	1	47.81	56.77	24.40	28.98	12.00	14.25	84.21
	2	48.62	50.85	29.00	30.33	18.00	18.82	95.62
	Average	**48.22**	**53.81**	**26.70**	**29.65**	**15.00**	**16.54**	**89.92**

The fresh biomass structure of *Acacia hybrid* is concentrated mainly in the tree layer. The percentage of biomass in this layer is 40 - 70%. The average biomass of age 2 is 15.97 (ton/ha) and age 6 is 48.22 (ton/ha). This result is similar to the results of many other studies for Acacia forest in Vietnam (Trinh Xuan Thanh and Do Huu Thu, 2015).

For shrubs and vegetation layer, the biomass percentage ranges from 16 to 32% at both ages. The average biomass of the layer is 4.53 and 26.7 (ton/ha) respectively for ages 2 and 6. The amount of fresh biomass in the forest stands is less concentrated in the litter layer, ranging from 12 - 20%. The average at age 2 is 16.5% and at age 6 is 16.54%.

The total amount of fresh biomass of *Acacia hybrid* forests in the study area is quite similar to other studies. For 2-year-old forests, total biomass is 24.59 (ton/ha), while that of 6-year-old forest is 89.92 (ton/ha). The total biomass at age 6 is relatively larger than some studies for *Acacia mangium*, because the study area has a well-developed layer of shrub and vegetation, people do not conduct shrub and vegetation clearance regularly.

3.2.2. Dry biomass structure of Acacia hybrid forest

Table 4. Dry biomass structure of *Acacia hybrid* forest

Age	Plot	Tree		Vegetation		Litter		Total (ton/ha)
		Ton/ha	%	Ton/ha	%	Ton/ha	%	
2	1	2.78	37.52	1.26	16.96	3.37	45.53	7.41
	2	2.82	49.84	1.08	19.01	1.76	31.10	5.66
	TB	**2.80**	**42.85**	**1.17**	**17.87**	**2.57**	**39.28**	**6.53**
6	1	16.76	56.27	4.75	15.95	8.28	27.79	29.79
	2	16.76	47.93	5.11	14.60	13.10	37.46	34.97
	TB	**16.76**	**51.77**	**4.93**	**15.22**	**10.69**	**33.01**	**32.38**

The dry biomass structure of *Acacia hybrid* is concentrated mainly in the tree layer, ranging from 42.85 - 51.78%, an average is 50.27%. The lowest is the shrub and vegetation layer, accounting for only 15.23 - 17.87% of the total biomass of all stands (the average is 15.67%).

Dry biomass in forest stands is concentrated in litter ranges from 33.01 to 39.28% of the total biomass of the stand. The average is 34.06%.

The total amount of dry biomass of *Acacia hybrid* forests in the study area ranges from 6.53 to 32.38 ton/ha, an average is 19.45 ton/ha. Of which, the highest is at the top hill position (Plot 2 - age 6) is 34,970 ton/ha, and the lowest is at the top hill position (Plot 2 - age 2) only 5.66 ton/ha.

3.3. Amount of CO_2 absorbed by *Acacia hybrid* plantation

3.3.1. The amount of CO_2 absorbed on the ground

Trees absorb CO_2 through photosynthesis but accumulate in plants in the form of carbon compounds. Therefore, the amount of absorbed CO_2 is converted from the accumulated carbon content. The total amount of CO_2 of the tree layer depends on the forest density, diameter frequency distribution, forest volume and different site conditions (Jim Penman et al., 2003; Naoto Matsumura et al., 2008).

Table 5. The amount of CO_2 absorbed on the ground in the *Acacia hybrid* forest

Age	Plot	Tree/ha	Tree		Vegetation		Litter	
			Mc (Ton/ha)	M_{CO2} (Ton/ha)	Mc (Ton/ha)	M_{CO2} (Ton/ha)	Mc (Ton/ha)	M_{CO2} (Ton/ha)
2	1	1600	1.39	5.09	0.63	2.30	1.69	6.18
	2	1480	1.41	5.17	0.54	1.98	0.88	3.23
	TB	**1540**	**1.40**	**5.13**	**0.58**	**2.14**	**1.28**	**4.70**
6	1	1280	8.38	30.73	2.38	8.71	4.14	15.18
	2	1200	8.38	30.73	2.55	9.36	6.55	24.02
	TB	**1240**	**8.38**	**30.73**	**2.47**	**9.04**	**5.35**	**19.60**

The results in the above table show that: When the forest density is 1540 plant/ha, the amount of CO_2 absorbed by the age 2 of *Acacia hybrid* is 5.13 (ton/ha). The amount of CO_2 absorbed by age 6 is 30.73 ton/ha with a forest density of 1240 tree/ha.

The amount of CO_2 absorbed by shrubs and vegetation floor and the litter layer in the study area is quite different. In the *Acacia hybrid* forest, the CO_2 content of the litter layer ranges from 4.70 ton/ha (age 2) to 19.60 ton/ha (age 6), the average is 12.15 ton/ha. The total amount of CO_2 absorbed by shrub vegetation floor under the canopy of *Acacia hybrid* ranges from 2.14 ton/ha (age 2) to 9.04 ton/ha (age 6), the average is 5.59 ton/ha. The amount of CO_2 absorbed in the shrubs and vegetation layer and the litter layer depends on many different factors such as forest age, humidity, soil, canopy cover, slope... Especially for the litter layer, the older forests have much more litter, so the more CO_2 absorbed in them.

3.3.2. The amount of CO_2 absorbed under the ground

Although most of the carbon is absorbed by terrestrial ecosystems, some of this will be transferred to the soil through a process of organic decomposition. Results of calculation of carbon content in soil under the canopy of *Acacia hybrid* at two sampling points of each plot at a depth of 0 - 30 cm as follows.

Analysis results of carbon content in soil under canopy of *Acacia hybrid* at two sampling points of each plot at a depth of 0 - 30 cm show that the amount of carbon accumulated under the canopy of *Acacia hybrid* is very huge, fluctuating from 19.32 - 40.23 (ton/ha) (sampling point 1) and 21.91 - 38.73 (ton/ha) (Sampling point 2). The average amount of carbon at sampling point 1 is 29.51 (ton/ha) lower than the average carbon at the sampling point 2 is 30.56 (ton/ha). The amount of carbon accumulated in forest soil includes the amount of carbon available in the soil before planting and the amount of carbon generated by the assimilation process of *Acacia hybrid* plantations.

In different ages and at different locations in the same age, the amount of carbon accumulated in forest soils varies widely. This can be explained by the large amount of accumulated carbon in the soil depending on the origin of the forest soil. In addition, the amount of carbon in the soil also depends on the climate characteristics (temperature, rainfall), soil characteristics, the amount of litter converted into organic matter, density of trees, characteristics of shrubs and vegetation floor, measures to impact on forests...

The calculation results of accumulated carbon by soil depth are shown in the table 6.

Table 6. Averages and comparison results using a mixed linear model

Age	Parameter	Estimate	Std. Error	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
2	Intercept	8.638	0.414	20.869	.000	7.701	9.574
	[Depth=0-10cm]	4.708	0.585	8.042	.000	3.383	6.032
	[Depth=10-20cm]	2.685	0.585	4.587	.001	1.361	4.009
	[Depth=20-30cm]	0[c]	0				
6	Intercept	23.575	0.744	31.707	.000	21.893	25.257
	[Depth=0-10cm]	8.395	1.051	7.984	.000	6.016	10.774
	[Depth=10-20cm]	4.640	1.051	4.413	.002	2.261	7.019
	[Depth=20-30cm]	0[c]	0				

Note ([c]): The comparison results are based on the average value of 20-30 cm layer.

Calculation results show that in the 20 - 30 cm layer, for 2-year-old forest, the amount of CO_2 is 31.68 (ton/ha). CO_2 content of 6-year-old forest in this layer is 86.44 (ton/ha). The calculation and comparison results in the above table show that: CO_2 always tends to decrease when the depth increases. That means the deeper layers have less CO_2 in the soil. At age 6, the rate of CO_2 reduction is greater at age 2. At age 2, horizons 0 - 10 and 10 - 20 cm have higher CO_2 levels than the 20 - 30 cm horizon, respectively 4.71 and 2.69 (ton/ha). The difference in CO_2 in horizons is very significant, because all Sig values are less than 0.05. Similarly, at age 6, horizons 0-10 and 10-20 m have a higher CO_2 content than the 20-30 cm horizon, respectively 8.40 and 4.64 (ton/ha). The difference in CO2 content in the horizons is also significant, because the Sig value is also less than 0.05.

4. CONCLUSION

The study collected and analyzed data for *Acacia hybrid* forests at two different age levels, 2 years and 6 years old. Analysis results show that density at age 6 is lower than age 2 due to competition and thinning. The diameter and height of the 6-year-old forest are much higher than 2-year-old forests. The frequency distributions are well simulated by the Weibull distribution. The distribution at age 2 follows the Weibull distribution better than that of the 6-year-old forest. The correlation between diameter and height is relatively strong. Age 2, Power function is the best function, while at age 6, Cubic function is the best function to describe the correlation between diameter and height.

The total amount of fresh biomass of *Acacia hybrid* is about 24.59 (ton/ha) for age 2 and 89.92 (ton/ha) for age 6. Biomass concentrates mainly on the tree layer, then on the vegetation floor and the litter layer. Dry biomass is quite similar. For CO_2, the results show that when the forest density is 1540 plant/ha, the amount of CO_2 absorbed by the age 2 of *Acacia hybrid* forest is 5.13 (ton/ha). The amount of CO_2 absorbed by age 6 is 30.73 ton/ha with a forest density of 1240 tree/ha. The average amount of underground carbon at sampling point 1 is 29.51 (ton/ha), lower than the average carbon at the sampling point 2 is 30.56 (ton/ha). The amount of carbon decreases gradually from the surface layer to the 10 - 20 cm layer and finally to the 20 - 30 cm layer.

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ĐẶC ĐIỂM CẤU TRÚC, SINH KHỐI VÀ TRỮ LƯỢNG CARBON CỦA RỪNG KEO LAI TẠI HÀM YÊN, TUYÊN QUANG

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TÓM TẮT

Nghiên cứu sinh khối và trữ lượng carbon rất ý nghĩa cho quản lý và giảm thiểu những ảnh hưởng xấu của biến đổi khí hậu và nóng lên toàn cầu tới cuộc sống người dân. Nghiên cứu đã tiến hành thu thập và phân tích số liệu từ các ô tiêu chuẩn cho rừng Keo lai tại hai cấp tuổi khác nhau là 2 tuổi và 6 tuổi tại Hàm Yên, Tuyên Quang. Kết quả phân tích cho thấy mật độ ở tuổi 6 thấp hơn tuổi 2. Các phân bố tần số đều được mô phỏng tốt bằng phân bố Weibull. Các phân bố ở tuổi 2 tuân theo phân bố Weibull tốt hơn tuổi 6. Tuổi 2, hàm Power là hàm tốt nhất, trong khi đó tuổi 6 thì hàm Cubic là hàm tốt nhất để mô tả tương quan giữa đường kính và chiều cao. Tổng lượng sinh khối tươi của lâm phần keo lai là khoảng 24,59 (tấn/ha) cho tuổi 2 và 89,92 (tấn/ha) cho tuổi 6. Sinh khối tập trung chủ yếu vào tầng cây gỗ, sau đó đến thảm tươi và tiếp đó là vật rơi rụng. Sinh khối khô cũng hoàn toàn tương tự như vậy. Với mật độ rừng là 1540 cây/ha thì lượng CO2 hấp thụ của cấp tuổi 2 là 5,13 (tấn/ha). Lượng CO_2 hấp thụ của cấp tuổi 6 là 30,73 tấn/ha với mật độ rừng là 1240 cây/ha. Lượng cacbon dưới mặt đất trung bình tại điểm lấy mẫu 1 là 29,51 (tấn/ha) thấp hơn lượng cacbon trung bình ở điểm lấy mẫu 2 là 30,56 (tấn/ha). Lượng carbon giảm dần từ tầng mặt đến tầng 10 – 20 cm và cuối cùng là tầng 20 - 30 cm.

Từ khoá: Cấu trúc, Keo lai, sinh khối, trữ lượng Carbon.

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