MINISTRY OF EDUCATION AND TRAINING
THAI NGUYEN UNIVERSITY

LE VAN PHUC

RESEARCH ON SCIENTIFIC BASES AND PROPOSE SOME CONSERVATION MEASURES FOR *PSEUDOTSUGA BREVIFOLIA* W.C. CHENG & L. K. FU, 1975 IN HA GIANG PROVINCE

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INTRODUCTION

1. Statement of the problem

There are 75 species of *Pseudotsuga* in around the world. At present, in Vietnam, there is only one specie has been detected *Pseudotsuga chinensis* Dode or *Pseudotsuga chinensis* var. brevifolia (W. C. Cheng & L. K. Fu) Farjon&Silba according to Nguyen Tien Hiep. *Pseudotsuga brevifolia* is one of 33 national level endangered pine species in Vietnam. According to the Red book of Vietnam (2007), *Pseudotsuga brevifolia* only grows on the limestone mountain with the altitude more than 1000 meters above sea level, and under threaten by over exploitation and natural habitat dilapidation. However, the scientific data for conservation of this species has not been adequately studied for instance: classification; distribution; biological, ecology characteristics; and regeneration, propagation of *Pseudotsuga brevifolia* in Ha Giang province has many limitation. Thus, it is necessary to have an advanced study on the morphological, ecological and phenological characteristics of this species to be the constructing the measures for conservation and development of this rare species. In this context, it is necessary to have "*Research on scientific bases and propose some conservation measures for Pseudotsuga brevifolia W. C Cheng & L. K. Fu, 1975 in Ha Giang province*" is essential for the purpose of providing leading scientific data as a basis for proposing solutions to forest restoration and conservation of rare genes.

2. *Objectives*

2.1. General objectives

Supplement the biological and ecological characteristics of *Pseudotsuga brevifolia* W. C Cheng & L.K. Fu to the scientific bases for development and convervation of this specie in Vietnam.

2.2. Specific objectives

- Identify the biological, ecological and silvicultural characteristics of *Pseudotsuga brevifolia* in the plant communities of the research area.

- Test the capability of propagating by using the cutting technique as well as identify the factors that affect the growth and development of *Pseudotsuga brevifolia* in the nature to be the basis to propose some solutions for conservation and development of this specie.

3. Research distributions

This is the first systematically study on the biological, ecological, anatomical structure characteristics of *Pseudotsuga brevifolia*, a threatening specie in Vietnam.

The first time the cutting technique has been tested to propagating the *Pseudotsuga brevifolia* specie. And initially conclude that this species can be propagated by using cutting technique.

Chapter 1
LITERATURE REVIEW

1.1. International researches

1.1.1. Researches on *Pinophita*

Pine (*Pinophita*) as known as gymnosperm (*Gymnospermae)*, including large and medium size hardwood species, with high growth rate with complicated reproduction organs for adaptation. There are 6-8 families with 65-70 branches included 600-650 species. There have been studies on ecological, biological, reproduction characteristics and the factors that influence the growth and development of these species. Typically, The Flora of China (1989), Encyclopedia of Agriculture of China (1989), Tran Huu Dan (2008), Farjon (2001)...

1.1.2. Researches on Pinaceae and members of this

Pinaceae includes evergreen woody and branched shrubs trees. As the biggest Family of *Pinophita*, there are 11 branches with species worldwide. There have been studies on ecological, biological, reproduction characteristics and the factors that influence the growth and development of this family, such as abberley DJ (1997), DM Richardson (ed.) (2000), Farjon A. and Page Sun (1999), FAO (1995), Singh SP (2006), Trieu Thanh Cong, Doan Tu Tu, Hong Si Kiem (2013) ...

According to these researches, Pine is a concerned research object which is mainly threatened by human activities such as unsustainable exploitation.

1.1.3. **Researches on *Pseudotsuga***

There are many limitations in the research on the *Pseudotsuga*. Until now, the taxonomists characteristics of this branch only mentioned in the "Flora of China".

1.1.4. **Researches on *Pseudotsuga brevifolia***

The researches on *Pseudotsuga brevifolia* are very limited, mostly in the field plant systematics. For instance Nguyen Tien Hiep et al (2004), Ying et al. (2004), Wu & Raven (1999), the Flora of China, IUCN Red List (2014), ...

1.2. Researches in Vietnam

1.2.1. **Researches on *Pinophyta***

There are several studies on biological characteristics as: Le Tran Chan et al (1999), Tran Co (2002), Nguyen Duc Luu and Thomas (2004), Nguyen Tien Hiep et al (2005), Le Thi Dien et al (2007), Tran Ngoc Hai (2011), Phan Ke Loc et al (2002)... ; species distribution: Phung Tien Huy et al (1996), Nguyen Tien Hiep et al (1998), Le Thi Dien et al (2007), Leonid V. Averyanov et al (2005), Do Van Ngoc (2015) ... ; regenerate characteristics: Nguyen Huy Son et al (2002), Nguyen Van Born (2009), Tran Ngoc Hai (2012)... ; propagation: Nguyen Hoang Nghia et al (2002), Nguyen Duc Luu et al (2012), Le Dinh Kha et al (2003), Van Thao et al (2003), Tran Minh Tuan (2002)...; and Nguyen Hoang Nghia et al (2002), Nguyen Duc Luu et al (2012), Le Dinh Kha et al (2003), Van Thao et al (2003), Tran Minh Tuan (2002)...

1.2.2. Researches on Pinaceae and its members

There are some typical studies such as: Le Thi Huyen et al (2004); Nguyen Tien Hiep et al (2005), "Pine of Vietnam-a research on conservation status"; Viet Nam Plant Data Center; Nguyen Duc Luu et al (2012), Nguyen Thanh Men (2012), Hoang Van Sam (2012), Nguyen Hoang Nghia (1996, 1997)

1.2.3. **Researches on *Pseudotsuga***

There are some scientific documents which briefly wrote on *Pseudotsuga brevifolia* "Plants list of Vietnam" (Vollume I); Nguyen Duc Luu et al (2004); "Vietnam Coniferous"; Nguyen Hoang Nghia (2006); Nguyen Tien Hiep et al (2005), Nguyen Sinh Khang et al (2009); Le Tran Chan et al (2006)...

1.2.4. Research on *Pseudotsuga brevifolia* in Vietnam

There are several studies on descriptions of *Pseudotsuga brevifolia* such as: Viet Nam Plant Data Center; Nguyen Hoang Nghia (2006); Nguyen Tien Hiep et al (2005); Vietnam Red Book (2007)...

According to these studies, there is no conservation plan for *Pseudotsuga brevifolia*; also the biological, ecological, propagation characteristics of this specie have not been studied properly. Therefore, it is necessary to have a research on the distribution and population status of this specie to develop a conservation plan.

Chapter 2
NATURAL CONDITION AND SOCIOECONOMIC OF STUDY AREA

2.1. Natural condition

Ha Giang is a high mountainous province, over three forth of area are hills and moutains, but the forest cover is relatively large. The total natural area is 791,488.92 ha, including: 718,827.09 ha of agricultural land (obtained 90.82% of total area), 28,431.63 ha of non-agriculture land (3.59%) and 44,230.20ha of unused land. Ha Giang has a population of spectacular moutains, harsh terrain, the average elevation range from 800 to 1200 m above sea level.

The climate of Ha Giang has the characteristics of Northern Moutainous region - Hoang Lien Son, however the weather in here is colder than Northeast region and wamer than Northwest region,… The annual precipitation is high, on annually about 2,300 to 2,400 mm and the annual humidity is average 78%.

2.2. Socioeconomic conditions

The population is 778,958 and over 22 ethinic groups. The rate of poverty on average of entire province is 26.95% in which the highest is

Dong Van District with 51.09%, just under this rate is 45.53% of Meo Vac and the lowest is 0.79% in Ha Giang city.

The GDP per person is reatively low, the urban is 1,892.75 VND/month while this is only 649.23 VND/month in the rural area.

General evaluation: the agroforestry is still obtained the vital portion in economic structure, the acceleration of agriculture is not very fast. The infrastructure is poor, the GDP per person is low, the lives of people are mostly in poverty and hungering condition. The rate of population is highly increased, the labor sources is crowed but the intellecture, culture and professional standards are limited. People lives are still a lot of difficulties, the livelihoods rely much on forest therefore this has significantly effected to forestry management and protection.

Chapter 3
CONTENT AND METHOLODOGY

3.1. Object and Scope

3.1.1. Object

The object of the research is *Pseudotsuga brevifolia* specices (*Pseudotsuga brevifolia* W. C Cheng & L. K.Fu) which is naturally distributed in Ha Giang province.

3.1.2. Scope

The dissertation is concentrated on researching the morphologic feature, the structure of leaf anatomy, regeneration of *Pseudotsuga brevifolia* specices, the reproduction ability cuttings culture method and other factors in the study area.

3.1.3. Research location

The research was implemented in 2 districts of Ha Giang including: Dong Van district and Quan Ba district, both are the essential distribution of *Pseudotsuga brevifolia* specices.

3.2. Reseach content

- The biological features of *Pseudotsuga brevifolia*
- The morphologic features of *Pseudotsuga brevifolia*
- The regeneration features of *Pseudotsuga brevifolia*
- The abiligy of reproduction of *Pseudotsuga brevifolia*

- Other factors influence on the survivals, growth of *Pseudotsuga brevifolia* specices

- Proposing some solution for conservation and growth of *Pseudotsuga brevifolia* specices

2.3. Research methodologies

- Secondary data collection: filtering inheritability such as available data and documents in relation with research in the study area.

- Field survey method:

+ Set up the survey transects and sample plots (SP): 10 transects with 60 sample plots (30 in middle and 30 in the top of the mountain) where the *Pseudotsuga brevifolia* is distributed, with the sample plot area are 400m^2. On the investigated transects, when the *Pseudotsuga brevifolia* specices was detected, the detail description and measurement of morphologic features were implemented is to form the base for recognition and classification. The observation of *Pseudotsuga brevifolia* samples (5 standard samples) which were the representative for this species in the study area revealed that trees are growing well, trunk is straight without twisted and diseases, on each trees, three sample stems are marked in three positons of the shade: top, middle and under. Observe, describe morphologic features and identify the size of each components, the variation of these (stems, shoot, flower, strobile) of species. The data collection on SP as silviculture investigated method to determine the woody tree layers, regeneration tree, and shrub layers.

+ Researching the distribution features of *Pseudotsuga brevifolia* specices according to the research of Nguyen Nghia Thin 1997, 2007; phenology research Nguyen Nghia Thin (2007), Le Mong Chan (2000), Nguyen Duc To Luu et al. (2004).

+ Soil survey: taking soil samples in different places ambient root and near root of *Pseudotsuga brevifolia* specices and analyzing nessessary norms in Institute of Life Science - Thai Nguyen University of Agriculture and Forestry..

+ Surveying the ecology relations of *Pseudotsuga brevifolia* specices with other species within the biome by setting up 30 plots with area of $100m^2$.

+ Setting up 80 plots with $25m^2$/each to identify the natural regeneration around the root of mother trees. And setting a semi-positioning sample plot has an area of $2000m^2$, remarks 30 regeneration trees to identity the growth of regeneration tree

+ Growth research by analytical method of 6 sample trees in middle and top of mountain.

+ Identifying the factors influencing to growth of the species based on survey results, interviews and field survey.

+ Propagation by cuttings: using 3 kinds of root stimulant including IAA, IBA and NAA with the concentrations of 250ppm, 500ppm,750ppm and 1000ppm to experiement cutting culture for *Pseudotsuga brevifolia* specices in three different repeatations and two different places.

- Data processing method: data will be processed by SPSS 13.0 software and Excel 7.0.

+ Identifying woody layer composition according to Nguyen Hai Tuat (2011).

+ Calculating the biodiversity indexes: Shannon coefficient - Wiener (H'), diversity index Simpson (Cd) according to Nguyen Hai Tuat et al. (2011).

+ Identifying the relation of *Pseudotsuga brevifolia* specices compared to other species composition according to Nguyen Hai Tuat et al. (2011).

+ Species distribution mapping: using GPS device to allocate the transects, sample plots which *Pseudotsuga brevifolia* specices presents. GIS is the main tool to build the distribution map of *Pseudotsuga brevifolia* specices and print the map.

- Using SPSS software 13.0 to analyze the equivalence between growth norms, check the distribution of regeneration trees in horizontal surface and calculate the variance of a component in experiment equations of propagation according to Nguyen Hai Tuat (2005).

Chapter 4
RESULT AND DISCUSSION

4.1. Biological characteristics of *Pseudotsuga brevifolia* specices

4.1.1. Morphological characteristics of Pseudotsuga brevifolia specices

Scientific name: *Pseudotsuga brevifolia* W. C. Cheng & L. K. Fu Medium woody tree, upright growth, vertical trunk, wide shade. Outside bark usually has verticle deep rift, scaly and flaky, darkish gray and brownish gray. New stems has a flat brown bark in the period of 2-3 first years. Resin has a light pink color and scent. The root grows strongly, in particular the mature trees, the tap-root plunges into the limestone mountain to uptake nutrients, the fasciculate roots spread out the thin layer of humus. Mature leaves: simple leaf, alternated, twisting, and two sides arrangement. Lamina is ribbon, spiral and two sides arrangement. On surface of lamina, there is a middle vein, and there are two stomata lines in the overlamina, sprial at the bottom of lamina.

The length of leaf is from 1.5 to 2cm, and this of petiole is about 1mm. The young leaves usually have a bigger size compared to that of mature stems. Facial leaf has the light green color, the under side has veins in the middle, white line on two side, also on the edge of leaf. The shoots is in oval shape, brown or red with many thin layers of scaly in outer covering. Unisexed cones are on the same root, female cone grows lonly on the sided shoots, ganging down, oval shape, reaching the length at 6cm and the diameter at 5cm; scaly converts into wood, wide and round; old female cone which is still stick on the stems is always directed down. The seed is three-sided oval shape, the seeds in the 2 ending points are talings, has the reddish brown wings with crescent shape, when coning fruit saparates, the wind can scatter them further as wings. Male cone has an oval shape, reddish brown color, forming cluster from 8-15 cones or more, it grows on the top of the stems or just elbow of leaf.

4.1.2. The phenology characteristic of Pseudotsuga brevifolia specices

Pseudotsuga brevifolia specices is evergreen, non-falling-leaf season. Shoots grow strongly in the Spring, and start to erupt at the late of February and first week of March, and continue to growsing in April. After 2 months, the buds grow well reaching the length of 10 -

22 cm, young leaves are fold to surface. After young stems beginning, strobile appear, and fruits ripe at thr late of November. *Pseudotsuga brevifolia* specices has the cycle of full fruit (cycle phenomenon), the ability for flower and fruit is inhomogeneity in years. in details, the research from 2013 - 2015 revealed that trees flowered but not strobile.

4.1.3. The structure characteristic of leaf anatomy of Pseudotsuga brevifolia specices

The leaf analysis result revealed: epidermis of *Pseudotsuga brevifolia* leaves contains cells with thick membrane, the surface covers by cutin layers 6.24/5.19µm thickness, colorless, and transparent. The above epidermis of leaves contains equal rows of cells, thick wall, the epidermis has large size17.02µm, hence the trees can be better in drought toleration. Hypodemis turns hard, the size of above hypodemis is 17.02µm and the under one is 20.79µm, the epidermis and hypodemis increase the hardness of leaves, the protection capacity, and reduce the water evaporation.

Erectile tissue is in the form of stone, thick film, wooden. Membranes are long lozenge dead cells, sharp at top and bottom, and closed arangerment. Shel wall is thick leading cell compartment small like a hole. There is no endoplasm in the cells. Proportion of palisade parenchyma to sclerenchymais is 1.026. This figure shows that, this specie is light specie.

4.1.4. Growth characteristics about diameter and height of Pseudotsuga brevifolia species

- Growth in diameter (D): *Pseudotsuga brevifolia* species has a slow growth speed in diameter, from the first year to sixteenth year the average growth amount ($\triangle d$) is slow, $\triangle d < 0.5$. From eighteenth year to twenty-second year, the average growth amount reaches 0.51 - 0.53, then there is a fall trend. Coutinuous growth amount (Zd) is increased as ages rise and reach the peak at Zd = 0.71cm in the period of 18 to 20 years old then on a gradual decrease.

- Height growth (H): *Pseudotsuga brevifolia* species grow height slowly from 1 - 12 years, the average growth amount is slow $\triangle h$ from 0.23 - 0.26 (m). the average growth amount reaches the peak at $\triangle h$ = 0.5 (m) at 20 years old.

4.2. Ecology characteristics of *Pseudotsuga brevifolia species*

4.2.1. Topography features

The result of field survey on 60 sample plots reveals: *Pseudotsuga brevifolia* species is mostly distributed on middle and top of limestone mountain, at the average elevation of 1300m above sea level; In the case of Can Ly, Lung Tam communes in Quan ba district, this species commonly presents at 1100m - 1400m, in Dong Van district (Sa Phin and Thai Phin Tung communes), it is popular at elevation of under 1500m.

4.2.2. Soil characteristics

The analyzing results of some physiochemical norms of soil shows that about the exchange acidity (pHkcl), it is 6.49-6.98 in the soil with the presence of *Pseudotsuga brevifolia*. This means the soil in *Pseudotsuga brevifolia* appreance is neutral. The content of humus in soil in the study area is high (33.28-34.75%). Nitrogen content is 2.158-2.327%, the N content of easy absorptive is 4.567 mg/100g. Phosphorus content (P_20_5) in soil is on an average level <0.1 (0.071-0.073%), the content of easy absortive P is 2.401-2.417 mg/100g.

4.2.3. Climatic characteristics

Located in the mountainous region, the climate is tropical monsoon, colder than lower land and midland. The average temperature is from 22.7^0C to 23.3^0C. The raining season in here is vary but unstable, the highest rainfall is in July (862.5mm in 2012; 1,066.9mm in 2013 and in 2014 only 570.6mm). The humidity is high and maintain in all seasons in year, there is phenomenon of drizzles, fogs, white frosts, continuous rains and long lasts, and the weather is cool and cold.

Due to climatic characteristics, it is a good condition of growing trees, especially the species are predominant in Pinaceae family, hence this is the vital ecological factor which affects the ability of growth and survival of species in Pinaceae family. In the location of *Pseudotsuga brevifolia* species distribution, the elevation is over 1100m above the sea level, on the top and middle of limestone mountain, and harsh weather. *Pseudotsuga brevifolia* poplation still survives with other species in Pinaceae family, this reveals that the climatic condition, topography, and soil of this region is appropriate to the growth of Pinaceae family species.

4.2.4.The characteristics of vegetation composition.

The class composition: On the flank site of the limestone mountain, the forest composition contains 2 woody tree layers, a shrub layer and groundlayer: The canopy has the average height 10-11m including mostly *Pseudotsuga brevifolia* species. Canopy is about 0.6 which is significantly created by main forest layer A_2 and the layer under forest shade A_3. Forest cover is 40%. On the top, the forest has a simple structure with a woody tree layer, an understory layer, and a low forest floor layer. Canopy of the forest reaches at 0.5 formed by the essential forest layer. The woody tree layer predominantly includes *Pseudotsuga brevifolia* species and *Calocedrus macrolepis* at height of 9-10m, the understory cover level is 30%.

Dense structure: the result of density was analyzed with some sample plots of the forest on limestone mountain as summmry in

Table 4.1. Dense structure of forest in *Pseudotsuga brevifolia* distribution

Site	SP	No. of sp. /SP	Density (tree/ha)		The percentage of *Pseudotsuga brevifolia*
			stand /entire plot	*Pseudotsuga brevifolia*	
Flank	1	12	390	170	43.59
	2	12	470	140	29.79
	3	10	370	80	21.62
	4	9	290	70	24.14
	5	9	320	100	31.25
	6	4	470	260	55.32
	AVG	**9**	**385**	**137**	**34.28**
Top	1	10	450	270	60.00
	2	12	510	270	52.94
	3	10	600	200	33.33
	4	8	530	150	28.30
	5	12	550	230	41.82
	6	6	420	200	47.62
	AVG	**10**	**510**	**220**	**44.00**

The table 4.1 presents that the forest density on flank site where *Pseudotsuga brevifolia* appears is 385 trees/ha. The density in the flank site ranges 70-260 trees/ha, on average 137 trees/ha. On the other hand, on the top site, the average density of stand is 510 trees/ha, and this of *Pseudotsuga brevifolia* varies from 150 - 270 trees/ha, and on average 220 trees/ha. The *Pseudotsuga brevifolia* is predominant in the forest with density from 34.28% on flank site to 44% on the top. Species composition structure: the result of species composition at the place of *Pseudotsuga brevifolia* on the limestone mountain is summarized in the Table 4.2:

Table 4.2. The structure species composition on the limestone mountain in the place of *Pseudotsuga brevifolia*.

Site	Plot	Species composition	IVI *Pseudotsuga brevifolia* (%)
Flank	1	**47.75Pse** + 13.81Too + 8.83Pilg + 6.12Cast + 6.03Nhc + 17.47Other (7 species)	47.75
	2	26.53Macr + **24.74Pse** + 11.64Mun + 7.77 Bv +7.62Pm + 5.69Fleu + 16.01Other (6 species)	24.74
	3	**31.6Pse** + 19.14Macr + 13.96Fagr + 7.90Mun + 7.38 Pilg + 6.34Fleu + 6.10So + 7.57Other (3 species)	31.60
	4	**27.32Pse** + 23.65 Macr + 12.54 Taxus + 10.91Mun + 9.29 Mang + 6.87Cast + 5.14Fagr + 4.29 Other (2 species)	27.32
	5	34.53Ngh + **28.69Pse** + 7.60 Fleu + 6.93Macr + 5.77Mun + 5.60Cast + 5.43St + 5.46Other (2 species)	28.69
	6	**58.89Pse** + 28.53Macr + 9.36Fleu - 3.2Other (1 species)	58.89
Top	1	**64.35Pse** + 13.42 Pilg + 5.95Taxus + 16.28Other (7 species)	64.35
	2	**56.7Pse** + 12.61Pilg + 30.69 Other (10 species)	56.70
	3	**38.06Pse** + 24.71Macr + 9.87Fagr + 7.09Mun + 5.95Taxus + 9.07Other (4 species)	38.06
	4	33.82Macr + **33.79Pse** + 13.45Fagr + 8.47Fleu + 10.47Other (4 specie)	33.79
	5	**42.32Pse** + 21.15Macr + 12.05Exc + 7.42Fleu + 17.07Other (8 species)	42.32
	6	**44.06Pse** + 25.85Macr + 24.28Java + 5.82Other (3 species)	44.06

The table 4.2 illustrates that natural forest species composition in the distribution site of *Pseudotsuga brevifolia* is uncomplicated. On the flank site, the number of predominant trees in the species composition equation fluctuates between 3 and 7 species and from 2 to 5 on the top site. Index IVI% of *Pseudotsuga brevifolia* varies 36.51% - 46.55%. The species present with *Pseudotsuga brevifolia* are *Calocedrus macrolepis, Podocarpus pilgeri, Toona sinensis, Podocarpus fleuryi, Burretiodendron tonkinense, Garcinia fagracoides, Diospyros mun, Castanopsis chinensis, Xanthoxyparis vietnamensis, Bischofia javanica), Fokienia hodginsii, Taxus chinensis*. In addition, other species obtain a minor proportion in forest species composition which have created a suitable sub-forest for Gymnospermae to live in including *Pseudotsuga brevifolia*.

Biodiversity index: the result of analysis reveals that coefficient Shannon - Wiener (H') is relatively low, fluctuating from 1.08 to 2.34; H' index on the flanksite (1.9) is higher than that on the top (1.65), and this has significantly varied between sample plots. The results presents that Cd index in sample plots have a significant fluctuation, from 0.14 to 0.4. The average of Cd index on the top site (0.28) is higher than that on the flanksite (0.21). It has proven that the biodiversity on the flanksite is

more than on the topsite. From this findings, it is seen that the species diversity on limestone mountain in the distribution site of *Pseudotsuga brevifolia* is very low.

- The ecological relationship of *Pseudotsuga brevifolia* with other species in biome: the study carried out the test about ecological relationship for each predominant species according to the standard ρ and χ^2: the result presents that *Pseudotsuga brevifolia* has a random relationship with species: *Calocedrus macrolepis, Podocarpus fleuryi, Podocarpus pilgeri, Garcinia fagracoides, Diospyros mun, Taxus chinensis, Bischofia javanica, Toona sinensis... Pseudotsuga brevifolia* has symbiosis relationship with species such as *Toona sinensis* and *Castanopsis chinensis*. Based on this relationship, it is applied to select species for mix-plantation with *Pseudotsuga brevifolia*.

- The relationship between parameter norms:

+ The relationship between diameter 1.3m and height of top trees ($D_{1.3}$ và H_{vn}). The study used four common equations to determine the correlation of these parameters on SPSS software 13.0, however the correlative equation $H_{vn}/D_{1.3}$ with function Parabol is incompatible so the general result of correlative equation between height and diameter was sum up by three following equations:

Table 4.3. Correlative equations between height and diameter of *Pseudotsuga brevifolia*.

Equations	Statistics indice				
	R^2	Std.E	Sig.f	a	b
(1). $H_{vn} = 3.516 + 0.3965.D_{1.3}$	0.688	0.0265	0.000	3.516	0.3965
(2). $H_{vn} = -7.248 + 6.312.Ln(D_{1.3})$	0.735	0.3975	0.000	-7.248	6.312
(3). $H_{vn} = 1.522.(D_{1.3})^{0.676}$	0.739	0.04	0.000	1.522	0.676

The Table 4.3 shows that three correlative equations have a coefficent of determination R^2 fluctuated between 0.688 to 0.739 ; The equation (3) has a greater coefficient of determinant with R^2 = 0.739, the minimal error and parameters are existed in overall. Therefore the equation (3) is the most suitable one to research the correlative law of $H_{vn}/D_{1.3}$ for *Pseudotsuga brevifolia.*

+ The relationship between canopy diameter and diameter 1.3m (D_t and $D_{1.3}$ m): using two types of equations to describe the relationship, the results is shown in the Table 4.4:

Table 4.4. Types of correlative equations of $D_t/D_{1.3}$ of *Pseudotsuga brevifolia*

No.	Types of equation	Statistic indice			
		R^2	Std.E	a	b
1	$D_t = a + b \times D_{1.3}$	0.610	0.070	1.367	0.124
2	$D_t = a + b \times Ln(D_{1.3})$	0.615	0.166	-2.873	2.388

The Table 4.4 reveals that there are 2 correlative equations which have the coefficient of determinant R^2 varies in range of 0.610 - 0.615 ; equation (2) has a greater coefficient of determinant with $R^2 = 0.615$, but error is also greater and all parameters present in overall. Thus, equation (1) is the most compatible one to research the correlative law of $D_t/D_{1.3}$ of *Pseudotsuga brevifolia*. So, based on the correlation between H_{vn} and $D_{1.3}$, D_t and $D_{1.3}$, it saves much time-consuming, costs and efforts when the application is in the practice to determine hard-counted factors.

4.3. The characteristic of regeration tree layer and *Pseudotsuga brevifolia*

4.3.1. The characteristic of species composition structure of regeneration trees

The analyzing result about the characteristics of natural regeneration on sample plots Ha Giang is reported in Table 4.5:

The Table 4.5 shows that the number of regeneration species presents in sample plots on the flanksite is 22, five predominat species of which with species composition rate over 5% are: *Diospyros mun*, *Pseudotsuga brevifolia*, *Podocarpus fleuryi*, *Calocedrus macrolepis*, *Podocarpus pilgeri*. The *Diospyros mun* obtains the highest proportion of to thanh at 30.7%, *Pseudotsuga brevifolia* is just under this species in the list with 27.09%. On the top site, the number of regeneration species is 24 species in which there are four species participated in species composition equation: *Diospyros mun, Pseudotsuga brevifolia, Podocarpus fleuryi, Calocedrus macrolepis*. *Diospyros mun* still has the highest species composition rate at 33.8% then *Pseudotsuga brevifolia* is the the second with 26.76%. Compared with the species composition of woody plant in the high layer, it is revealed that most of trees in high layer presents in the regeneration tree layer which means the trees in woody layer can seed at the present site. This is an advantage characteristic for the process of utilizing natural regeneration

Table 4.5. The regeneration tree species composition on limestone mountain in Ha Giang

TT	Flanksite		Top site	
	Species	**N (%)**	**Species**	**N (%)**
1	*Diospyros mun*	30.77	*Diospyros mun*	33.80
2	*Pseudotsuga brevifolia*	27.09	*Pseudotsuga brevifolia*	26.76
3	*Podocarpus fleuryi*	10.03	*Podocarpus fleuryi*	8.22
4	*Calocedrus macrolepis*	10.03	*Calocedrus macrolepis*	5.63
5	*Podocarpus pilgeri*	6.02	*20 other species*	*25.59*
	17 other species	*16.06*	24 species	100
	22 species	100		

4.3.2.The characteristic of density structure and the rate of potential regeneration trees

The results of density and rate of potential trees are reported in the Table 4.6:

Table 4.6. Density regeneration and rate of potential regeneration trees in Ha Giang forest

Site	General density (tree/ha)	General potential density (tree/ha)	% potential tree	Species density *Pse* (tree/ha)	Density *Pse* (tree/ha)	% *Pse*
Flank	997	540	54.18	270	160	59.26
Top	1420	673	47.39	380	240	63.16

The result in Table 4.6 shows that the density of regeneration trees of forest is low and fluctuated in range 997 - 1420 tree/ha. *Pseudotsuga brevifolia* has a fluctuated density from 270 - 380 tree/ha. The rate of potential trees in forest is relatively high at ranging 47.39 - 54.18%. In which, *Pseudotsuga brevifolia* has a rate of high potential tree from 59.26 - 63.16%. The density of regeneration tree, potential regeneration tree on the top site of *Pseudotsuga brevifolia* are higher than on the flank site, it is proven that *Pseudotsuga brevifolia* is more adaptive on the top than on the flank.

4.3.3. The quality and origin of regeneration trees

The collecting result and the processing one about the quality and origin of regeneration tree in the study area are illustrated in the Table 4.7:

Table 4.7. Quality and origin of regeneration tree in Ha Giang

Site	Species	Density	Qualitative rate (%)			Origin			
		(tree/ha)	Good	Avg	Bad	Seed	%	shoot	%
Flank	*Pse*	270	43.21	38.27	18.52	253	93.70	17	6.30
	Entire plot	997	36.79	46.49	16.72	643	64.55	353	35.45
Top	*Pse*	380	36.84	43.86	19.30	353	92.89	27	7.11
	Entire plot	1420	39.20	44.60	16.20	1083	76.27	337	23.73

The Table 4.7 shows that regeneration ability of *Pseudotsuga brevifolia* is low. The regeneration rate of high qualitative trees in the forest only obtains from 36.79 - 39.20%; medium qualitative tree is in the range of 44.60 - 46.49% and 16.20 - 16.72%. The regeneration trees have the origin from seed of entire plot on the fluctuation between 64.55% and 76.27% and this rate of *Pseudotsuga brevifolia* is mostly laid in the range of 92.89% - 93.7%. It is claimed that the regeneration trees in here is significantly from seed, only a small amount of regeneration are original from shoots. This is the advantage of forest succession in the future, because trees grow from

seed which have a better ability of growth and toleration with unexpected weather condition than from shoots.

4.3.4. The distribution of Pseudotsuga brevifolia regeneration as height level

The result about regeneration characteristic as height level in Ha Giang is reported in the Table 4.8:

Table 4.8. Report of regeneration density of *Pseudotsuga brevifolia* in different height level in Ha Giang

Site	Species density (tree/ha)	*Pseudotsuga brevifolia* density as height level (tree/ha)		
		<50cm	50 - 100cm	>100cm
Flank	270	17	93	160
Top	380	30	110	240

The result in Table 4.8 presents that the density of regeneration *Pseudotsuga brevifolia* mainly distributed at height level >1m with fluctuation from 160 - 240 trees/ha, then next height level is from 0.5-1m varying in the range of 93-110 trees/ha, and the density of regeneration is the lowest at height <0.5m with only 17-30 trees/ha.

4.3.5. The distribution of regeneration Pseudotsuga brevifolia sp. in horizontal surface

In order to research the form distribution of regeneration trees, the study applies Poisson distribution. the result is shown in the Table 4.9:

Table 4.9. Distribution of regenerative trees of *Pseudotsuga brevifolia* in horizontal surface

Topography site	Average	Std.D	Sig	Z	Distribution type
Flank	3.682	2.570	0.99	0.436	Random
Top	4.583	4.095	0.65	0.736	Random

The result indicates that both sites have Z<1.96 and probability of Z>0.05; in details, on the flank site, Z=0.436 has the two variables probability at 0.99 >0.05. With this probability, the assumption of Poisson distribution law in observed transects is acceptable, it means that the distribution on the forest floor is randomly. On the top of mountain, Z=0.736 has its two variables probability at 0.65>0.05. With this probability, the assumption of Poisson distribution law in observed transects is acceptable, it means that the distribution on the forest floor is randomly. So, the distribution of regenerative tree of *Pseudotsuga brevifolia* in Ha Giang is incidental on the forest floor, this will lead the empty spaces without regenerative trees.

4.3.6. Natural regeneration of Pseudotsuga brevifolia around parental trees

The result is shown as the following:

Table 4.10. The frequency of natural regeneration of *Pseudotsuga brevifolia* around parental root trees

Site of sample plots	Plots	Frequency of appearance		Total number of trees		Distance of parental trees (m)	$\overline{Hvn}$ (cm)
		No. of plots with *Pseudotsuga brevifolia*	Rate %	No. of trees	Rate %		
Beneath shade of tree	40	9	22.5	11	40.74	3	65
Outside shade of tree	40	14	35.0	16	59.26	8	100
Total	**80**	**23**	**28.75**	**27**	**100**		

The tables indicates that in the total of 80 formed plots, the number of regenerative trees of *Pseudotsuga brevifolia* is 27 trees, they distributes randomly. In which, regenerative trees are mostly ouside the shade of parental trees with 35% frequency of appearance and beneath shade of tree is 22.5% frequency of appearance. The number of regenerative trees outside of shade is 16 trees obtaining 59.26% and this beneath the shade is 11 trees occupying 40.74%.

4.3.7. Growth progress of natural regenerative trees of Pseudotsuga brevifolia in Ha Giang

The result in following growth progess of regenerative trees in 3 years on the semi-positioning sample plots has indicated that the growth rate of average height per year of *Pseudotsuga brevifolia*. fluctuates from 3.73cm - 10.07cm, the growth rate of stump varies 0.08cm - 0.13cm. To conclude, *Pseudotsuga brevifolia* grows on limestone mountain, the growth rate is relatively low. In the period of 3 years, the height increased 13.8cm; that of stump was 0.21cm.

4.3.8. Some Influent factors to natural regenernation of Pseudotsuga brevifolia in Ha Giang

4.3.8.1. The influence of shrub, vegetation layer to natural regenernation

The result illustrates that shrub layer in here mostly are *Sasa japonica, Indosasa amabilis, Maesa perlarius, Alchornea tiliaefolia, Psychotria rubra, Actinodaphne pilosa, Melastoma sanguineum, Blastus borneensis, Alchornea rugosa, Ardisia quinquegona, Dracaena cambodiana,...* with average height of 0.7-1m. The fresh floor layer are mainly *Miccostegium ciliatum, Imperata cylindrica, Centosteca latifolia, Selaginella sp, Lemmaphyllum microphyllum, Drynaria bonii, Thysanolaena maxima, Cymbidium hybrid, Cyclosorus parasiticus, Dicranopteris linearis, Miccostegium ciliatum, Cyperuss gracilispica,…* Some vines species are *Gynostemma pentapyllum, Zehneria indica, Pueraria montana, Mucuna pruriens, Caesalpinia minax,...* and the forest cover is up to 40%.

This reveals that canopy cover of shrub layer, vegetation layer strongly influent to the density and the rate of potential regenerative trees.

4.3.8.2. the impact of topography to natural regeneration and the quality of regenerative trees.

The result synthesized some of regenerative species, regenerative density of forest on the top site is higher than on the flank site of the mountain. This density of *Pseudotsuga brevifolia* on the top site (380 trees/ha) is greater than on the flank site (270 trees/ha), the density of potential regeneration tree on the top is also higher than that on the flank site. However, the topography has unclearly affected to the quality of regenerative tres.

4.3.8.3. Human impacts

The impact of human has been shown through customs of slash-and-burn and logging for people's needs near the forest. This has significantly influented to the density of regeneration trees, in the location without human impacts, most of the top site which the terrain is harsh has the regenerative desity of 520 trees/ha and the potential tree density of 280 trees/ha. In locations with less human impact, the density of *Pseudotsuga brevifolia* is 350 trees/ha, the potential regeneration of the *Pseudotsuga brevifolia* is 150 trees/ha, the number of regenerative species in here is the highest with 22 species. And the area with a huge impact of human has the lowest density of regenerative trees and potential regenerative trees. Density of mature *Pseudotsuga brevifolia* trees is 150 trees/ha, the number of regenerative species is 17 species.

4.4. The reproductive oppotunity of propagation of cuttings of *Pseudotsuga brevifolia*

The propagation of cuttings result of *Pseudotsuga brevifolia* sp. were repeated three times, the details are in below:

4.4.1. The propagation of cuttings ***result of the first replication: At the Institute of Forestry Research and Development - Thai Nguyen University of Agriculture and Forestry.***

Propagation conducted from 15/02/2014, after 90 days, there is no survival. The cause is due to a too high temperature (35 - 36^0C), the peak of temperature at 37-38^0C.

4.4.2. The propagation of cuttings result of the second replication: At the Institute of Forestry Research and Development - Thai Nguyen University of Agriculture and Forestry

4.4.2.1. The result about the survival rate of cuttings in diffirent experimental formulas

The result about the survival rate of cuttings in diffirent

experimental formulas reveals that at the end of experiment (after 180 days) the survival rate remains at 7.43%. The formulas used root stimulants which had a higher rate of survival compared to that of control. The result of experimantal formulas at different concentrations showed that root stimulant IAA gave the best chance of survival compared to that of other substances such as IBA, NAA with 21.90% at 500ppm. The control formula presented no survival at the 180h day.

4.4.2.2. Result of root growth in research experiment

The result observed the time and the rate of root growth (%) of cuttings *Pseudotsuga brevifolia* in experimental formulas which indicated that the rate of root growth of *Pseudotsuga brevifolia* cuttings is relative low and time-consuming. In which, only three formulas grew roots, IAA formulas 500ppm is 3.8% then next is NAA 500ppm with 2.85% and the lowest is IBA 500ppm with 1,9%; the formulas with the concentration of 750ppm and 1000ppm and control formula had seen no roots. The average number of roots on cuttings is low, each cutting had only one root. With the same concentration, IBA stimulant resulted the length of root on average 1.33cm; IAA is 1.56cm and NAA is 1.16cm.

4.4.3. The result of the third replication: at Center of Pine tree Conservation at Can Ty commune, Quan Ba district, Ha Giang province

4.4.3.1. The result of survival cutting in experimental pormulas

The result of survival cutting in formulas of the third experiment is shown in the Table 4.11:

Table 4.11. Result in survival cuttings of *Pseudotsuga brevifolia*.

Experimental Formulas	No. of cutting	Observation Schedule (day)							
		90		120		150		180	
		Survival cutting	Rate (%)	Survival cutting	Rate (%)	Survival cutting	Rate (%)	Survival cutting	Rate (%)
CT1A	90	84	93.33	84	93.33	72	80.00	36	40.00
CT1B	90	78	86.67	75	83.33	57	63.33	48	53.33
CT1C	90	75	83.33	60	66.67	54	60.00	27	30.00
CT1D	90	81	90.00	66	73.33	57	63.33	18	20.00
CT2A	90	84	93.33	72	80.00	51	56.67	45	50.00
CT2B	90	87	96.67	81	90.00	72	80.00	36	40.00
CT2C	90	84	93.33	75	83.33	51	56.67	21	23.33
CT2D	90	75	83.33	63	70.00	42	46.67	15	16.67
CT3A	90	81	90.00	75	83.33	66	73.33	15	16.67
CT3B	90	84	93.33	72	80.00	60	66.67	24	26.67
CT3C	90	72	80.00	69	76.67	63	70.00	30	33.33
CT3D	90	75	83.33	63	70.00	60	66.67	33	36.67
CT4	90	39	43.33	26	28.89	10	11.11	2	2.22
Total/AVG	**1170**	**999**	**85.38**	**881**	**75.3**	**715**	**61.11**	**350**	**29.91**

The Table 4.11 shows: the survival rate of cuttings in formulas is on the gradual decrease time by time, after 90 observed days in formulas with the use of root stimulants, the survival rate is roundly 90%, the control formulas has the survival cutting at 43.33%. The NAA stimulant 500ppm has the highest survival rate (53.33%) compared to that of other formulas, then IBA 250ppm is the next with the rate of 50%. The control formula only remains 2 survival cuttings (2.22%).

4.4.3.2. The results about rate of growth root and parameters of growth roots

The observation result about time and the rate of growth root (%) of *Pseudotsuga brevifolia* cutting in formulas in the third experiment is shown in the Table 4.12 as below:

Table 4.12. the rate of growth root of *Pseudotsuga brevifolia* cutting after experiment

Experimental formulas	No. of cutting	No. of taking root	Rate (%)	AVG No. of root/ cutting (piece)	AVG length of root (cm)	Growth root index
CT1A: NAA 250ppm	90	1	3.33	2.3	2.8	6.44
CT1B: NAA 500ppm	90	7	23.33	1.43	8.5	12.16
CT1C: NAA 750ppm	90	2	6.67	1.83	2.5	4.58
CT1D: NAA 1000ppm	90	0	0.00	0	0	0
CT2A: IBA 250ppm	90	2	6.67	1.5	3.5	5.25
CT2B: IBA 500ppm	90	6	20.00	1.39	6.5	9.04
CT2C: IBA 750ppm	90	0	0.00	0	0	0
CT2D: IBA 1000ppm	90	0	0.00	0	0	0
CT3A: IAA 250ppm	90	1	3.33	1.33	5.5	7.32
CT3B: IAA 500ppm	90	6	20.00	6.7	7.5	50.25
CT3C: IAA 750ppm	90	1	3.33	3	1.2	3.6
CT3D: IAA 1000ppm	90	0	0.00	0	0	0
CT4: control	90	0	0.00	0	0	0

The table 4.12 reveals that the rate of growth root of *Pseudotsuga brevifolia* cutting is low and time-consuming, the result of experimental observation indicates that after 150 days *Pseudotsuga brevifolia* cutting starts growing root. After 180 days, there are 8 formulas which grow root, in which NAA formula 500ppm has the highest rate of taking root (obtained 23.33%), then next in the list are IBA 500ppm and IAA 500ppm in order, both have the equal rate of taking root with 20%. The lowest rate found in NAA 250ppm; IAA 250ppm and IAA 750ppm which only had one cutting growing root, occupying 3.33%. The three formulas has the highest rate of taking root at concentration of 500ppm, other formulas at 1000ppm haven't seen roots, especially the control formulas CT4 do not use root stimulants, the cuttings' roots cannot grow and survire.

The result of variance analysis of some factors by SPSS software presents that the probability of F about growing root rate of *Pseudotsuga brevifolia* cutting is less than 0.05, this shows that the rate of cutting's root growth in experimental formulas has a significant difference. Using Duncan standard to check the difference among average samples aims at finding the highest rate formula. The result indicates that NAA formula 500ppm is the most predominant, has the highest numeric value at 7.0. It is proven that NAA 500ppm stimulant affects more strongly than other formulas to the rate of *Pseudotsuga brevifolia* cutting's growth root

4.5. Influence factors to survival, growth of *Pseudotsuga brevifolia*

The influence factors to survival, growth of *Pseudotsuga brevifolia* can list two essentials which are nature and human. And, human plays a significant role. To assess the human impact level, it is based on the interview result of 60 households and 15 officers, the below Table has summarized some human's impacts to the survival of *Pseudotsuga brevifolia*.

Table 4.13. Summary of interview result about human impacts to *Pseudotsuga brevifolia*.

No.	Cause	Officers		household	
		No. Of Sheet	Rate (%)	No. Of Sheet	Rate (%)
1	Wood logging for use	15	100	48	80.00
2	Wood logging for sale	8	53.33	40	66.67
3	Wood for heat energy	7	46.67	37	61.67
4	Forest fire	2	13.33	12	20.00
5	Cultivation expand	12	80.00	51	85.00
6	Limited awareness of species diversity role	15	100	56	93.33
7	Flowering cycle and cone formation has year frequence	12	80.00	45	75.00
8	Ineffetive management	11	73.33	42	70.00
9	High unemployment and poverty rate	15	100	60	100

The Table 4.13 indicates that a group of causes has the strongest impact to the survival of species is the logging exploitation for local demand and a limited awareness about the role of species and the umemployment and poverty rate are at 100%, then nest is the expansion of agriculture and cultivation area which is devided the population and the 80% of flowering cycle and coning formation has the year frequency. 100% interviewed household said that unemployment and poverty are the main cause, then the wareness is the next with 93.33% and the exploitation is last obtained only 80%. In total of 60 sample plots, there are 24 sample plots with the deforestation symptom (occupied 40%). Each sample plots found that 1-2

trees with diameter >40m is cut down. Furthermore, *Pseudotsuga brevifolia* is also cut down and some other species such as *Calocedrus macrolepis, Podocarpus pilgeri,...*

4.6. Recommendation of solutions for conservation and development of *Pseudotsuga brevifolia*

- Put the ***Pseudotsuga brevifolia*** down to the list of rare and endangerous plants and animals species, in IA group of the Decree 32/2006/NĐ-CP and list of rare and endangerous plants and animals species, prior to protect follow Decree 160/2013/NĐ-CP on November 12th 2013 of the Government.

- A need to carry out the observation of phenology characteristic of *Pseudotsuga brevifolia* sp. to see the flowering cycle, coning formation of this species to plan for the seed harvest.

- Selecting some healthy trees, potential of fruit to convert into predominant trees produces seeds.

- The conservation of species has the correlative relationship with *Pseudotsuga brevifolia* such as *Podocarpus fleuryi, Diospyros mun...*

- As growing mix-forest, it is suggested to select correlative relationship species with *Pseudotsuga brevifolia*.

- The application of localizing methods forster regeneration and grows endermic species of limestone mountain which is presented in the species composition formula.

- Protecting *Pseudotsuga brevifolia* individuals has average growth ability onward, only remove bad individuals, or low valuable species to create a nutrious space for this species.

- Removing vines, shrubs, vegetation, low valuable trees before drought season to avoid forest fire.

- Adjusting the canopy to foster regenerative trees to grow and develop, regulating the species composition of regenerative trees through increasing regeneration, nurture targeted species, remove low valuable trees, bad quality.

- The plantation of *Pseudotsuga brevifolia* in Ha Giang should be on the flank site and top site of limestone mountain at the elevation over 1000 m above sea level.

- Applying cutting propagation for *Pseudotsuga brevifolia* in winter, in the suitable climate region with three root simultants IAA 500ppm, IBA 500ppm, NAA 500ppm.

- Increasning awareness of local about sustainable exploitation and use of forest resources, conserve biodiversity, especially the rare species in Pinaceae family.

CONCLUSION AND RECOMMENDATION

1. Conclusion

Biological characteristic of *Pseudotsuga brevifolia*: medium woody trees, vertical growth, straight trunk, wide shade of tree. The outer bark usually has a deep vertical rift with the scaly shape and flaky formation, darkish gray or brownish gray. The leaf is simple, alterniphyllous, twisted at the bottom, two-sided. The cone is unisexed the same as roots, female cone grows lonely on the short sided shoots, hang down, has oval shape, and scaly turns wood, wide and round. The seed is in triangle oval shape, flat 2 sides, seeds has reddish brown and crescent shape. The root system of *Pseudotsuga brevifolia* grow strongly, especialy mature trees. There is no clear falling-leaf seasons, shoots grow well in Spring, and has a full-fruit cycle, the flowering capacity is inhomogeneous among years.

Morphological characteristic: *Pseudotsuga brevifolia* usually scatters on the flank and the top of mountain, they distribute at the elevation from 1100m onward. The soil type is essentially Feralit humus on mountain, darkish brown. The pH of soil is neutral with high humus rate, porous soil, and the content of N, P, K is average. The climate is characterized of monsoon tropical, much colder than lowland and midland. The precipitation is high, long raining season and humidity is high too. *Pseudotsuga brevifolia* is the predominat species in the crown canopy layer of forest, there usually has 1-2 woody trees, shrub layer and fresh floor layer, in which the woody layer has the low height, including endermic species of limestone mountain with canopy of forest from 0,5-0,6; the cover level of shrub layer and fresh floor layer is 30-40%. The density of stand fluctuates from 385 - 510 tree/ha. The density of *Pseudotsuga brevifolia* is on the fluctuation between 2-7 species, in which *Pseudotsuga brevifolia* obtains a high rate in the species composition. The research of ecological relationship between *Pseudotsuga brevifolia* and other species reveals that they have the random relations with 9 species, correlative relation with 2 species. The power equation is the most compatible one to research the correlative law among $H_{vn}/D_{1.3}$ for *Pseudotsuga brevifolia* while the linear equation is the most compatible one to research the correlative laws among $H_{vn}/D_{1.3}$ of *Pseudotsuga brevifolia*.

The characteristic of regenerative trees: the number of presence tree in sample plots fluctuates from 22 to 24 species, there has 4-5 predominant species, the *Pseudotsuga brevifolia* has the species composition rate of 26.76 - 27.09%. The regenerative density of *Pseudotsuga brevifolia* is from 270 - 380 trees/ha. *Pseudotsuga brevifolia* has a high rate of potential regenerative

tree at 59.26 - 63.16%. The rate of regeneration trees from seeds obtains from 92.89 - 93.7%, mostly is at height >1, the density of regenerative trees at the lowest is <0.5m. The regenerative trees randomly distributes on the forest floor, mostly outer shade of parental trees, the growth capacity is relatively low. During growth progress, it is under the influence of many factors such as shrubs, fresh floor, topography and human impacts.

The results of cutting propagation of *Pseudotsuga brevifolia*: the experiments were carried out three replication: in the first replication, after 90 days, entire of cutting were dead. In the second, at Institute of Forestry Research and Development, the survival rate of cutting propagation reached 21.90%, the rate of taking root cutting is at a very low of 3.8% in the 500ppm concentration (IAA 500ppm). The result of the last experiment at the Center of Pine Consevation, Can Ty commune, Quan Ba district, Ha Giang province is more positive when the NAA 500ppm stimulants has the highest survival rate (53.33%) compared to other formulas. After 180 days, there are 8 formulas of growing roots, and NAA 500ppm has the most number of cutting taking root (occupy 23.33%).

The dissertation has identified factors which affected to growth and development of species including the exploitation of wood for use and sale, forest fire, cultivation expansion which is the consequence of separating population, the limited awareness of local about *Pseudotsuga brevifolia*, the high rate of poverty, ineffective management, and flowering and coning cycle of year period, the low regenerative ability in nature. In addition, there are some other reasons such as disasters or global warming.

2. Limitation

- Due to a short period of time, the flowering and fruit-bearing cycle have not been observed yet.

- Yet harvesting the seeds, the experiment of multiplication by seeds for *Pseudotsuga brevifolia* is not yet conducted.

3. Recommendation

- Continuing the observation of flowering and coning cycle of *Pseudotsuga brevifolia* to make plan for harvesting

- Carried out the multiplication by seeds for *Pseudotsuga brevifolia* to preserve the seedling sources for conservation

- The experiment to build model of growing *Pseudotsuga brevifolia* in the distributed region.

RESEARCH PAPERS PUBPISHED RELATED TO THE DISSERTATION

1. Le Van Phuc, Nguyen Thi Thoa (2015), "Study on biological features of *Pseudotsuga brevifolia* W. C cheng & L. K. Fu 1975 in Ha Giang province", *Journal of Agriculture and Rural development* (11) pp. 200 - 204.

2. Le Van Phuc (2015), "Stand structure characteristics of *Pseudotsuga brevifolia* W. C cheng & L. K. Fu, 1975 in Ha Giang province, *Journal of Agriculture and Rural development*, (15), pp. 142 - 148.

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4. Le Van Phuc (2015), "An earlier experiment in propagation of *Pseudotsuga brevifolia* W.C cheng & L.K.Fu, 1975, *Journal of Agriculture and Rural development*, (6), pp. 214 - 219.