MINISTRY OF EDUCATION AND TRAINING

THAI NGUYEN UNIVERSITY

LE SY HONG

STUDY OF BIOLOGICAL CHARACTERISTICS AND PROPAGATION TECHNIQUES OF PHAY'S SEEDLINGS (*Duabanga Grandiflora* Roxb. ex DC) IN BAC KAN PROVINCE

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INTRODUCTION

1. Necessary of the study

The *Circular 35/2010/MARD* has introduced an additional list of forest trees which can be lucratively planted and produced in 63 poor districts of 21 provinces. This list included both timber and non-timber product species. Further, the Resolution 30 A/2008/NQ-CP of Prime Minister has determined *Phay (Duabanga grandiflora Roxb.Ex DC)* as one of prioritized species which can be applied for both watersheds and production forests in Bac Kan province.

However, information depicting this species is limited and unavailable in national data systems of forest trees. Accordingly, the: "***Study of biological characteristics and propagation techniques of the Phay's seedlings (Duabanga grandiflora Roxb.Ex DC) in Bac Kan province"*** is necessary since it is likely to contribute in development and production oflarge timber forests.

2. Purposes of the study

2.1. Contribute to national data systems of forest trees

The study is expected to provide scientific data of the Phay (Duabanga grandiflora Roxb.Ex DC) species including the morphological, physiological, ecological, silvicultural features and seedlings-producing techniques.

2.2. Contribute to development and production of large-timber forests

The study is also expected to build a technical guidance for producing Phay's seedlings contributing to development and production of Phay, a native large-timber species, in Bac Kan province and other provinces with similar natural conditions.

3. Significances of the study

3.1. Scientific significance

- Supplement and complete a biodata and production technics of a native species with high economic values.

- The findings of the study are references for future researches, curriculums, technical officers, advisors and students.

3.2. Practical significane

- Identifying technical solutions to produce seedlings and plant Phay trees.

4. New scientific findings

- Supplement information and data about biological, ecological and silvicultural features of Phay into national forestry data system.

- Assess the ability of reproduction of Phay from seeds and cuttings through which propose standard for seedlings to be planted within the province.

5. Limitations of the study

5.1. Content

- Biological characteristics: morphology, ecology, phenology.

- Silvicultural features in the areas where this species distributes: structural composition, layers, natural generation, soils components.

- Physiological features of seedlings (purity, moisture absorption, germination…) and seedlings in the nursery period to 9 months of the demand for light, water and nutrients.

5.2. Study areas

- The study of the biological, ecological and silvicultural characteristics of Phay (*Duabanga grandiflora Roxb.Ex DC)* is conducted in 4 districts of Bac Kan province.

- Experiments about physiological features of seedling germination which conducted in laboratory and nursery of Thai Nguyen university of Agriculture and Forestry.

6. Structure of the study report

Beside of introduction and conclusion, the report includes 3 chapters:

Chapter 1: Overview of study issues

Chapter 2: Content and study methods

Chapter 3: Findings and Discussion

Chapter 1

OVERVIEW OF STUDY

Based on reviewing 109 literatures in which 16 are in English and 91 are in Vietnamese, the study has sumarised previous findings relevant to **(1)** study of natural forests: structural composition, morphological forest structures and generation characteristics; **(2)** study of morphology, biological features of timber trees; and **(3)** study of sexual and asexual reproduction. Also from literature review, the author had comments.

- The previous studies have identified the suitable structure of the forest vegetation and established the table of index system of vegetation, building standard forest structures through conclusive targets, initially estimate the ability of protection, preventing soil erosion of vegetation layers.

- The studies on taxonomy, physological and ecological characteristics, using values, breeding, technical plantation and propagation...

- However, the studies on the Phay species (*Duabanga grandiflora Roxb.Ex DC)* is still limited by domestic and abroad. There are scientific basis for author to study on this thesis.

Chapter 2

CONTENT AND STUDY METHODOLOGY

2.1. Content

The study has 5 main contents: (1) biological characteristics of Phay (*Duabanga grandiflora Roxb.Ex DC);* (2) physiological features of Phay's seeds; (3) physiological and biological characteristics of Phay at the nursery stage; (4) Phay's reproduction by cuttings; and (5) suggestion of technical measures for Phay's reproduction and forestation in Bac Kan province.

2.2. Study methodology

2.2.1. Study approaches

- Approach natural distribution areas of the species

- Systematic approach

- Experimental approach

2.2.2. Methods of data collection

1) Study of biological charateristics of Phay (*Duabanga grandiflora Roxb.Ex DC)*

The data is collected from 48 temporary standard plots (OTC), representative for 4 typical forest conditions. Within OTC, different species and their characteristics are collected such as H_{vn}, H_{dc} and $D_{1.3}$, regenerants, shrubs, vegetation, soils following the silviculture survey methods.

2) Study of physiological features of Phay's seedlings

The methods of experimental research have been conducted in labs, nurseries to estimate some criteria such as: seedling purity, preservation, rates and speeds of germination and moisture absorbtion of seedlings, impact of treating water temperature and influence of particles fill depth to germinate.

3) Study of physiological and biological characteristics at the nursery stage

- Study light mode: experiments were arranged randomly with 3 replications (Vu Tien Hinh, 1995).

- Amount of chlorophyll: determination the amount of chlorophyll by Photocolorimeter machine.

- Determining the intensity of photosynthesis and transpiration: using the method of LA I-Va-Nop (Nguyen Huu Hong, 2009).

- Amount of dry matters: Drying samples at 105^0C.

- Amount of water: Using the research method of water for flora's demand (Valter and Pinhevich, 1975).

- The study on amount of mineral nutrition: Research the demands about mineral nutrition of Phay at the nursery stage following the method (of Nguyen Nhu Khanh, 1975).

4) Study of reproduction techniques by cuttings: Experiments were arranged by fully randomization block with 3 replications (Vu Tien Hinh, 1995).

3.3.3. Data analyses

- Data analysis: Collected data will be processed and analyzed by EXCEL and SPSS, and being checked by Duncan's standards (Ngo Kim Khoi and colleagues, 2001).

- Determine the compositional formula by index IV %.

- Analyze samples in the laboratory: The quantity of plant dry matter was determined by drying sample method at105^0C, Phosphorus in leaves analyzed by electronic colorimeric methods; Potassium in leaves analyzed by flame photometer method; Nitrogen in leaves following Kjeldan method; Soil samples were analyzed by: Nitrogen total (%), Humus by Dumas method; P_2O_5 total (%) according ISO 6498: 1999; K2O total (%) according to ISO 8660:2011; PH Kcl ISO 5797: 2000.

Chapter 3

FINDINGS AND DISCUSSION

3.1. Biological charateristics of Phay species

3.1.1. Morphological and phenological charateristics

Phay *(Duabanga grandiflora)* belongs to angiosperm sector (Angiospermae), Ban relative (Sonneratiaceae), *Duabanga* family. Phay is a big large timber species, evergreen, height reaches 35 m, diameter can reach from 90 - 130 cm, straight trunk, small bread at origin, thick bark from 0.6-1.9 cm, single leaf opposite sprouting on, 14 - 40 cm length, 3.2 - 7.2 width, tendon feathers, small leaf with reddish color, old leaf with dark green smaller. Big flower with panicles at te top of branches. Calyx includes 4 - 7 wings, thick, smoothly, ovoid. Stamen arranges along the row, wrapped filaments, dry capsule, spherical, riped fruit become woody bark from 4 - 7 wings. Granules, thin hairness at both sides. Sprouting and pruning

leaves from January - February, bud fluctuates February - March, flowering between March - April, small fruits at the end of April and riped fruiton May - June.

3.1.2. Ecological characteristics and distribution

Phay distributes at the elevation from 270 - 596 m, slope from 10-40^0. The average annualtemperature from 20.2° - 22° C. Humidity fluctuates from 78.6 % - 81.2 %, amount of average annual rainfall from 1148.1 - 2144.5 mm. Phay grows on different type of soils, but the best developing on the soil of ferarit clay with schist stone. The thickness soil layer A is from 20 - 30 cm, layer B from 30 - 45 cm, high humidity, texture from close to soft. Soil components: pH_{kcl}: 4.02 - 5.56 acidic soils, humus from 1.036 % - 3.796 %, N_{ts}: 0.06 % - 0.219 %; P_2O_5: 0.05 - 0.14; K_2O: 0.47 - 1.34. Therefore, Phay is favorable with many types of soils, from poor to nutrient soils.

3.1.3. Structural composition of areas with Phay's distribution.

3.1.3.1. Structural composition of high tree layer

Table 4.1: Structural composition of areas where Phay distributes

Forest status	Compositional formula
IIA	11.79Mt+ 11.69Va + 7.51G +7.2**P**+ 5.81Thb + 56LK (46)
IIB	15.63G + 11.36Thb + 8,79T + 8,63**P** + 55.9LK (72)
IIIA1	16.26Mt + 10.28G + 9.65Va + 9.11**P** + 5.79Thg + 48.91LK (61)

(P=Phay, Va=Vang anh, G=Gao, Mt=Muong trang, Thb=Thoi ba, T=Trau, Thg =Tu hu, LK=others

The required number of species participates in the structural composition is between 2 - 27 species in which from 2 - 5 are main species formulating composition.

IV % Index: Phay ranked the fourth in the forest composition with index of between 7.2 and 9.11 at IIA and IIIA1 forest status, therefore, have been considered as one of the meaningful ecology species within the forest composition.

3.1.3.2. Structural density and relationship between Phay and dominant species within forest.

(1) At the status IIA, the density of high tree layer is 138 trees/ha, of which highest number is Muong Trang reaches 13 trees/ha, Gao with 9 trees/ha; **(2)** IIB status, with density of 138 trees/ha including Gao with 25 trees/ha, Thoi Ba with 14 trees/ha, Trau is 13 trees/ha, Phay is only 9 trees/ha; **(3)** IIIA1 status, Muong Trang reaches 45 trees/ha, Gao is 24 trees/ha, Vang Anh with 21 trees/ha, Phay is 16 trees/ha. The distributed density of high layers of total forest composition reaches 155 trees/ha. Structural density and relationship between Phay and dominant species within forest is random.

3.1.3.3. Structure of second layers and canopy of the highest layer

* Status IIa: The forest is recovering with dominance of light-demanding species, fast growing, one layer, some high tree species are mostly no stratification. Layer A3 has height which fluctuates from 6-18m. Mainly forest canopy by Gao, Muong Trang, Phay, Thoi Ba, Vang Anh species. In addition, there are some other species as: Trau, Co Ke, Nuc Nac, Bua… with averaged height about 10.5 m.

*Status IIb: Woody trees had stratification but unclearly the height ranges from 7-20m. Layer A3includes the trees from 10-20m such as: Gao, Phay, Muong Trang, De, Trau, Thoi Ba,…reaches the majority of the trees within OTC, mainly canopy created by this layer.

*Status IIIa1: Woody trees with stratification, main layers are A2 and A3(under canopy layer). The stable layer structures include Phay, Vang Anh, Muong Trang, with the height from 12-24m. Layer A3 includes: Sung, Me co ke, Nhan Rung, Mo Long… with average height from 11m.

* The canopy of high tree layer includes Phay's distribution ranges from 0.3-0.5. The average is 0.4

3.1.3.4. Composition of Phay with other species

Within surveyed 48 OTC with Phay distribution, thesis has identified the tree woody species accompanied with Phay species presented at table 3.9: is 19 species*:* Muong trang *(Zenia insignis),* Gao *(Anthocephalus indicus),* Dau da xoan (*Allospondiaslakonensis),* Thoi ba (*Alangiun chinense),* Me co ke (*Grewia paniculata),* Ke duoi giong (*Markhamia cauda-felina),* Goi gac (*Aphanamixis grandiflora),* Soi huong (*Lithocapus sphaerocarpus),* Ca lo (*Caryodaphnopsis tonkinensis),* Sung ve (*Ficus racemora),* Sau (*Dracontomelon duperreanum),* Xoan ta (*Melia azedarach),* Vang anh (*Saraca dives*) Nuc nac (*Oroxylon indicum),* Dau da đat (*Baccaurea sapida),* De gai (*Cartanopsis boisii),* Tram trang (*Canarium album),* Bua (*Garcinia oblonggifolia),* Trau (*Vernicia montana)*

Characteristics of shrub and vegetation where Phay distributes: at state IIa, the average coverage rate of shrubs is 26.05 %, vegetation is 67.75 %. IIb, shrub is 20.08 % and vegetation with 63.5 %. IIIa1, shrub is 16.63 % and vegetation with 55 %.

3.1.4. Natural reproduction of Phay

3.1.4.1. Contribution of Phay in composition of self-reproduction species

Structural composition of regenerants is presented at table 3.11

There are 52 regenerant species at IC status (TS) with structural formula (CTTT): 1.17Mđt + 0.58Dg + 0.52Mt +7.73LK; (2) IIA status has 48 regenerant species TS, with CTTT: 0.7Tb + 0.55Sx + 0.52Hq + 8.23LK; (3) IIB has 53 species TS, with CTTT: 0.63Lx + 0.57Dg + 0.54Tb + 0.54K + 0.51P + 7.24LK; (4) IIIA1 with 37 regenerants species with CTTT: 0.98Xn + 0.72Mđt + 0.59Ts + 0.52G + 1.19LK.

Note: Mđt = Man dia thuong, Dg =De gai, Mt=Man tang, Tb= Thoi ba, Sx =Sang xoan, Hq =Hoac quang, Lx =Lim xet, Tb=Thoi ba, K =Khao, P=Phay, Xn =Xoan nhu, Ts =Truong sang, G=Gao, LK=others

3.1.4.2. Density and proportion of naturally-reproduced Phay trees

(1) Status IC: Density of naturally-reproduced Phay trees is 3106 trees/ha, plants is expected to reach 20.1%. Phay has 65 plants/ha, potential trees occupy 23.1 %; **(2)** The status IIA: is 3344 trees/ha, potential trees are 18.2 %. Phay has 80 plants/ha, expectation tree 30 %; **(3)** status IIB: 2800 trees/ha, potential expectation trees 17.6 %. Phay has 141 trees/ha, potential expectation trees 39.9 %; **(4)** status IIIA1: is 2661 trees/ha, potential expectation trees 15.0 %. Phay has 87 plants/ha, potential expectation trees reach 29.9 %.

3.1.4.3. Quality and origin of reproduced Phay trees

The origin of Phay trees within the forest is mainly from seeds with quality shown as follows: The rate of good trees ranged from 45.4 % - 62.8 %, average trees fluctuated from 25.9 % - 35.3 % and the bad trees from 6.2% - 19.3%. Therefore, most of the good and normal quality trees within the forest. For the Phay species from IC to IIIA1: The rate of good trees reached 44.4 % - 72.2 %

3.1.4.4. Distribution of reproduced Phay trees according on their heights

State IIIA1 (2661 trees/ha), IIB (2800 trees/ha), IC (3106 trees/ha) and highest is IIA (3344 trees/ha). The density of regenerants fluctuates by height without growing at status (TT). With height <1 m: at (TT) IIA is lowest (624 trees/ha), highest (TT) IIB (714 trees/ha). From 1 - 2 m, is lowest in (TT) IC (664 trees / ha), the highest of IIA (848 trees/ha). From 2 - 3 m, at (TT) IIA is 980 trees/ha is the highest, the lowest at (TT) IIIA1 (440 trees/ha). With height >3 m, ranging from 400 trees/ha (IIIA1) to 625 trees/ha (IC).

3.1.4.5. Influence of natural condition on reforestation

(1). Influence of canopy on natural reproduction of Phay

At state of IC without canopy, the density of reproduced Phay trees is 3106, potential expectation trees 20.1 %. At (TT) IIA, with canopy is 0.3 that regenerants reach 3344 trees/ha, potential expectation trees reach 18.2 %. At (TT) IIB, the average canopy 0.4 that regenerants is 2800 trees/ha, the rate of potential regenerants 17.6 %. At (TT) IIIA1, with canopy 0.5 that regenerants reach 2661 trees/ha, potential expectation trees are 15.0%, good quality trees are 45.5 %, lower than canopy of 0.3 and 0.4. Therefore, the adjustment of canopy is necessary to improve the regenerants quality and potential trees (including Phay).

(2). Influence of shrubs, surface vegetation on natural reproduction of Phay.

The coverage of shrubs, surface vegetation from 25.5 - 38.5 and trending to decrease when forest coverage increasing.

(3). Influence of soils on reproduction of Phay.

Natural reproduction of Phay has shown that the forest status from IC to IIIA1, Phay without natural regeneration on the lands without cultivation.

3.2. Physiological features of Phay's seeds.

3.2.1. Features and age of Phay's seeds

Phay's seeds with grey column shape. The rate of seed/fruit is calculated by amount of 2.5 kg fresh fruit equivalent with 1 kg dried fruit and 6.25kg dried fruits equivalent to 1 kg of seed. The 1000 seeds weight 0.098 grs, high relatively purity (79.3 %). The age of seeds through 2 experiments (fresh dry and cold dry preservations) has shown that the rate of germination is decrease when increasing the time of preservation at both experiments. Therefore, we should sow the seeds after harvesting. In case of preservation, cold dry preservation is the best ways and not to exceed over four months.

3.2.2. Desiccate characteristics of Phay's seeds

The experiment is conducted to dip Phay's seeds in 35°C water and let it gradually cool down at different time periods. The results have presented at figure 3.8. The data has shown that, after soaking 8 hours, 1 gram of Phay's seeds can absorb 0.64 gram water (from 1 gram to 1.64 gram), that it illustrates the easy absorb water of Phay's seeds.

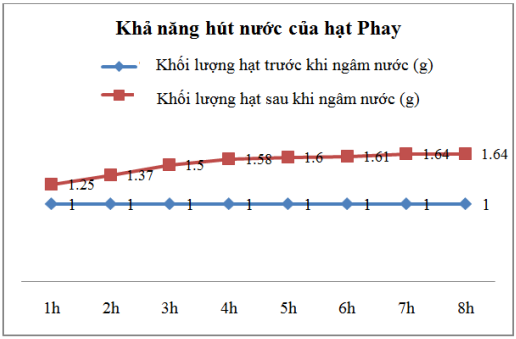

Figure 3.8: Processing of water absorbtion of Phay's seeds by the time

Dipping seeds in warm water will improve the rate of seeds germinating, sometimes reaching 100 % (Le Dinh Kha, 1995). The impact of time for dipping seeds in water under the room's temperature to the rate of Phat's seeds germination is shown at Table 3.21. The results data have indicated that: After soaking in water at different times, rate of germination, day and time of germination has significant difference. Soaking seeds in water 4 hours, necessary time for germination (9 days) the highest rate of germination (75.67 %). Therefore, the study has determined the formula of dipping seeds in water for Phay species is 4 hours.

3.2.3. Influence of water temperature on germination of Phay's seeds.

The influence of water temperature to seed's germination at experimental formulas has displayed at Table 3.22. Analysis of variance showed that the water temperature used for

encouraging seeds has significant impact to the rate of germination. Using the standard of Ducan for inspection, the thesis has identified the treating formula with Phay's seeds the best is at 35°C.

3.2.4. Influence of soil's depth on seeds sowing

Effects of soil's depth to the rate of Phay's seeds germination following the soil depth layers are: 0.1 cm, 0.25 cm, 0.5 cm and 0.75 cm. Data of Table 3.23 has shown that there is significant difference about germinated rate, starting time of germination at experimental formulas about the soil depth coverage SiF < 0.05.

Through the Ducan's standard has determined the experimental formulas of soil depth coverage with the highest geminated rate at (CT1) 82.333 % when soil depth coverage 0.1 cm, the fastest time for germination (11 days), starting day of germination (5 days).

3.3. Phychological and ecological characteristics of Phay at nursery stage

3.3.1. Light and shading

3.3.1.1. Influence of shading on the growth of Phay's seedlings.

The effect of shading to the growth of Phay's seedlings at nursery stage following CTTN represented at Table 3.24 has shown that Ducan standard to check the difference between averaged samples. At the age of 3 months, the highest growth of diameter at shading formula with 50 % (0.38 cm) and lowest at shading formula >90 % (0.18 cm). From age of 6-9 months, the highest diameter growth of formula shading with 25 % (0.52 %), and lowest at shading formula > 90% of value of the minimum diameter.

Growth in height: At age of 3 months, Hvn reaches the highest with shading coverage with 50 %, lowest is without coverage, 6-9 months with shading formula 25 %, growing with the best height, lowest at shading formula > 90 %.

3.3.1.2. Influence of shading on intensity of photosynthesis and transpiration of Phay

The intensity of photosynthesis (CDQH) of Phay species depends on the light mode is shown at figure 3.13: showing from age from 3-6

months reached the highest when shading 50 %, lowest is shading 90 %. Evaporation intensity gradually decrease when shading rate increasing following the age of trees through Ducan's standard has confirmed.

3.3.1.3. Influence of shading on amount of chlorophyll in Phay's leaves

Amount of chlorophyll (HLDL) within Phay's leaves reflected in Table 3.25: changing by the light shading system. At age of 3 months, highest when shading 50 % and lowest without covering. From age of 9 months, highest when shading 25 % and lowest with covering 90 %.

3.3.2. Influence of water on growth of seedlings at the nursery stage.

Influence of irrigation on the growth of Phay's seedlings at Table 3.26: by checking the difference between average samples has shown that CT1 is formula with the highest height and biggest diameter at age of 2 months. Similarly, at age of 4 months CT1 (2 times/day with 60 ml/pot) is formula for growing highest height and biggest diameter. Therefore, irrigation on dry season following CT1to saturation 2 times/day with 60 ml/pot or 1.8 l/m^2 for the best growing of Phay species.

3.3.3. Influence of mineral and nutrient components on the growth of seedlings at nursery stage.

Table 3.27: Amount of NPK within Phay' leaves which natural reproduction

Sample	N (%)	P_2O_5 (%)	K_2O (%)
Leaves of Phay species	2.38	0.30	0.70
Rate of nutrients within leaves	8	1	2

Amount of protein within natural leaves reaches 2.38 %, phosphorus 0.3 %, potassium 0.7 %

Mixture potting is presented by Table 3.28

Table 3.28: Chemical components of potting mixtures

Sample	pH_{KCL}	Humus	N (%)	absorbability (mg/100 g soil)	
				P_2O_5	K_2O
Nursery soils	5.04	1.04	0.15	0.09	1.05
Manure	4.05	14.75	0.93	11.10	14.07

For Phay species, table 3.27 and 3.28 have shown that the demanding of protein for the Phay's seedlings is very high, and phosphorus and potassium is average. The rate N: P2O5: K2O within the leaves equivalent with 8:1:2. This is basis for mixing three of nutrients for trees.

3.3.3.1. Influence of minerals and nutrients on the growth of height and diameter of Phay species.

Influence of minerals and nutrients on growth of Phay species has shown in the Table 3:29: Formula 2 is the highest biomass and lowest is CT5, the gap was 1.75 times at 3 months of age; 1.83 times at 6 months and and 1.75 at 9 months. Thus, CT2 (89 % surface soil + 10 % manure + 1 % phosphorus) is CT for the highest growth index and the basis for the use of fertilizers for Phay species at the nursery stage in real production.

3.3.3.2. Influence of minerals and nutrients on the amount of N, P, K in Phay's leaves.

Table 3.30: Amount of N, P, K in Phay's leaves

at experimental formulas

Quota	Formula				
	CT1	CT2	CT3	CT4	CT5
Age of 3 months					
N (%)	2.09	2.56	2.20	2.10	2.03
P_2O_5 (%)	0.30	0.33	0.31	0.30	0.29
K_2O (%)	0.58	0.66	0.62	0.60	0.57
Age of 6 months					

N (%)	2.20	2.79	2.31	2.22	2.10
P_2O_5 (%)	0.32	0.36	0.33	0.32	0.31
K_2O (%)	0.63	0.74	0.68	0.65	0.63
Age of 9 months					
N (%)	2.22	2.94	2.65	2.38	2.14
P_2O_5 (%)	0.33	0.38	0.35	0.33	0.32
K_2O (%)	0.64	0.78	0.7	0.65	0.62

The amount of N. P. K has gradually increasing by the age at all formulas. At CT2. the rate of N. P. K. within leaves is approximately 8:1:2 as amount of N. P. K has been analyzed by the natural leaves regeneration.

3.4. Reproduction of Phay by cutting method

3.4.1. Influence of stimulus IAA and IBA on rooting capacity of Phay's cuttings

Table 3.31: Rooting quotas of Phay cutting branches under impacting of IAA. IBA medicines

Type of medicine / CTTN	IAA (indol axit axetic)				IBA (indol butiric axit)			
	Root rate (%)	Number of average root /cutting (piece)	Average root length (cm)	Average rooting index	Rooting rate (%)	Number of average root /cutting (piece)	Average root length (cm)	Average rooting index
I (300ppm)	33.33	8.13	2.86	23.25	42.22	14.07	4.69	65.99
II (450ppm)	51.11	15.40	4.45	68.53	56.67	18.89	6.30	119.01
III(600ppm)	66.67	16.78	4.77	80.04	77.78	25.93	8.64	224.04
IV(750ppm)	86.67	23.67	5.34	126.4	95.56	31.85	10.62	338.25
V (900ppm)	63.33	16.73	4.67	78.13	76.67	25.56	8.52	217.77
VI-without medicine	12.22	2.81	1.70	4.777	12.22	2.81	1.7	4.777

Percentage of rooting: using IAA and IBA with concentration of 300 ppm. 450 ppm. 600 ppm. 750 ppm and 900 ppm. Using Ducan's standard to check the difference between

averaged samples aim to select a formula with the highest rooting rate at CT4 (750 ppm) is the best. With IBA is 95.56 and IAA is 86.67

Quality of roots: according to the Ducan standard has shown that medicine (IAA. IBA) 750 ppm is formula with highest rooting rate (338.25; 126.4) within the experimental formulas

3.4.2. Influence of bases on rooting rate of cuttings

Table 3.32: Influence of bases on rooting rate of cuttings

Experimental Formula	Rooting rate (%)	average number of roots/ cutting (pieces)	Average rooting length (cm)	Average rooting index
CT 1: Soil frame	88.89	18.83	5.63	106.01
CT 2: Sand frame	91.11	22.75	5.45	123.99

Rooting rate: cuttings on the soil and sand frame showed high percentage (88.89 - 91.11 %).

The quality of roots: the number of average roots/ cutting ai soil frame is lower than sand frame by 3.92 pieces. the the averaged root length/cutting of soil frame is higher than sand frame. Thus. both of these frames are favorable for Phay's cutting branches.

3.4.3. Influence of cutting positions on rooting and sprounting capacity of Phay

3.4.3.1. Rooting capacity of Phay's cuttings at different parts

Table 3.33: Rooting capacity of Phay's cuttings at differnet parts

Experimental formulas	Rooting rate (%)	average number of roots/cutting (pieces)	Average rooting length (cm)	Average rooting index
CT1: top cutting	81.11	15.83	4.60	72.82
CT2: middle cutting	34.44	5.61	3.90	21.88
CT3: original cutting	5.56	3.17	2.02	6.40

Percentage of rooting: type of top cuttings show the highest rooting (81.11 %). 2.36 times higher than middle cutting (34.44 %) and 14.6 times higher than original cutting (5.56 %).

The quality of roots: the average number of roots/cutting: top cutting (15.83 pieces). 2.82 times higher than middle cutting (5.61 pieces) and 4.99 times of original cuttings (3.17 pieces). The average roots length/cutting: top cutting (4.6 cm). 1.18 times higher than middle cutting (3.9 cm) and 2.28 times original cutting (2.02 cm).

Therefore. CT1 (top cutting) has the most quality roots with the best cutting growing.

3.4.3.2. Pruning rate of Phay's cuttings at different experimental formulas

Table 3.34: ***Pruning rate of Phay's cuttings at different experimental formulas***

Experimental formula (CTTN)	No. of cutting	No. of cutting with bud	Budding rate (%)	Average number of bud (pieces)	Average length of bud (cm)	Budding index
CT1(top cutting)	90	73	81.11	1.1	6.4	7.13
CT2(middle cutting)	90	31	34.44	1.4	4.8	6.71
CT3 (original cutting)	90	5	5.56	1.0	3.2	3.17

+ Pruning rate: CT1 (top cutting) shown the highest budding (81.11 %). CT2 (middle cutting) with 34.44 %. CT3 (5.56 %). Thus. type of cutting is also influenced to the rate of budding of Phay species.

+ Average number of prunes per cutting: Table 4.52. figure 4.36b: The average number of bud/cutting at CT1 (1.12 pieces). CT2 (1.39 pieces). CT3 (1.0 pieces). not too much difference.

+ The average length of prunes per cutting: Table 4.51. figure 4.36c: Top cutting is (6.35 cm). middle cutting (4.84cm). original cutting (3.17 cm).

+ Pruning index of Phay's cuttings: Table 4.51. figure 4.36d: Top cutting has budding index of 7.13 which 1.06 times middle cutting (6.71) and 2.25 times original cutting (3.17).

Conclusion: The living rate. rooting and prunes capacities of Phay's cutting with the best of top cutting. no using middle and original cuttings.

3.4.3.3. Influence of mother trees's age to rooting and pruning *capacities of cuttings.*

Table 3.35: Rooting capacity of cuttings at different experimental formulas and different mother tree's ages

CTTN	Living cutting rate (%)	Rooting cutting rate (%)	Rate of cutting with callus (%)	Average roots/cutting/ (pieces)	average rooting length (cm)	Rooting index
CT1 (mother trees age 1)	94.44	94.44	0	27.46	2.37	65.08
CT2 (mother trees age 3)	46.67	28.89	17.78	3.64	1.51	5.50
CT3 (mother trees age 6)	38.89	23.33	15.56	3.27	1.28	4.19

Survival rate of Phay's cuttings (rooting and callus cuttings): CT1 (mother tree of age 1) with survival rate (94.44%). CT2 (mother tree of age 3: 46.67%). CT3 (mother tree of age 6 with 38.89%)

Rooting rate: CT1 (94.44%). CT2 (28.89%). CT3 (23.33%).

Callus rate: CT1 is 0%. CT2: 17.78%. CT3: 23.33%.

When cutting should select mother trees of age 1 has shown the highest quality roots and survival percentage.

The quality of roots: Mother trees of age 1 has the highest quality roots (65.08). from mother trees age 3 (5.5) and from age 6 (4.19)

(2). Influence of mother trees's agesonsprounting capacity of Phay's cuttings

Table 3.36: Pruning capacity of cuttings influenced by mother tree's ages at different experimental formulas

CTTN	Rate (%)	Average buds/cutting(pieces)	Average bud length (cm)	Budding index
CT1 (mother trees age 1)	94.44	1.23	3.63	4.48
CT2 (mother trees age 3)	43.33	1.95	2.38	4.66
CT3 (mother trees age 6)	36.67	1.74	1.26	2.18

General comments: the age of mother trees for cutting influences survival percentage. rooting and budding ability of Phay's cuttings. Therefore. it needs to select carefully young mother trees.

3.4.3.4. Influence of cutting length to rooting and sprounting capacities of Phay's cuttings.

(1). Influence of cutting length to rooting capacity of cuttings.

Table3.37: Rooting capacity depends on cutting length at different experimental formulas

Experimental Formulas	Rooting rate (%)	Average roots/cutting (pieces)	Average length (cm)	Rooting index
CT1: 4 cm	21.11	3.1	1.2	3.72
CT2:>4-6cm	25.56	4.15	1.92	7.97
CT3:>6-8cm	34.44	5.38	3.22	17.32

Therefore: The length of Phay's cutting from >6 - 8 cm (3 sleeping buds couple) has shown the highest results of rooting and budding index.

(2). Influence of cuttings length to sprounting capacity of cuttings.

* The number of cuttings with sprunes: The highest number belongs to formula CT3 with 52.22 %. followed by formula CT2 with 42.22 % and the lowest number of prunes is at the formula CT1 with 37.78 %.

Table 3.38: Sprounting capacitydepends on cutting length at different experimental formulas

CTTN	Budding rate (%)	Average buds/ Cutting (pieces)	Average length (cm)	Budding index
CT1: 4cm	37.78	1.5	0.65	0.97
CT2: > 4- 6cm	42.22	1.89	1.27	2.39

CT3: > 6-8cm	52.22	2.64	1.66	4.38

*Average sprounts per cutting: Table 3.38 has shown that: The average bud is highest at CT3 is 2.64 pieces. CT2 with 1.89 pieces and CT1 with 1.5 pieces.

* Average sprount length: Highest at CT3 (1.66cm). CT2 (1.27cm) and CT1 (0.65cm).

* Sprounting index: Formula CT3 gave the highest index of 4.38. followed by CT2 with 2.39 and CT1 with 0.97

3.5. Proposing technical measures to adopt Phay for reforestation in Bac Kan province

3.5.1. Conditions for planting

Climate: The favorable temperature from 20 - 22°C.

Precipitation: From 1448 - 2144 mm with air moisture from 78 - 81 %.

Topography: The elevation < 700 m. sloping between 25 - 30°. vegetation of status IA; IB; IC. reforestation after exploitation. mountain with stone and soil.

Soil conditions: Appropriate feralit yellow land development on clay schist or land development feralit on kast. moisture soils with stone. thick layer from 20 cm.

Methods of planting: Alternative with other species such as: Muong Trang. Gao… with the density from 1100 - 1500 trees/ha.

3.5.2. Sowing techniques

3.5.2.1. Preparation of seeds

- Collected seeds: Must be taken from the selected mother trees. fruits began to turn from green to brown to gray. from 5-6 months for harvesting.

- Seeds processing: The fruits harvested are classified. keep them from 2 - 3 days for ripening. drying under the sun light for separating particles. not dry fruits. seeds under the sunlight directly. When drying seeds. starting to remove the impurities before sowing or preservation. Number of seeds/kg (dry) from 8.500.000 - 8.670.000 seeds. The rate of germination: 85.3 %. amount of water: 10 - 12 %. average volume of 1000 seeds: 0.098 gram. purity with 79.3 %.

- Seeds preservation: Phay's seeds germinate incapacitation very quickly. so need to sow after harvesting. If storage is required. it should be taken into plastic bag. drying preservation within the cold room for less than 3 months. Seeds must be dried and kept at moisture of 7- 8 % when putting into storage.

3.5.2.2. Seedling production

- Nursery is selected according to the sector's standards 04-TCN-52-200 was issued together with decision No 3588/QD-BNN-KHCN. dated 3th September/2002 of Minister of Agriculture and Rural Development.

- Favorable season for sowing from June-August. Soaking seeds into water at 35°C for 4 hours. Phay has tiny particles. it's hard to sow straight into pots that should apply measures sowing on tray. when seedlings have 2 leaves conduct to plant them into pots.

- Seeds sown on the beds covered by 1 soil layer (0.1 cm) can help to germinate the best.

- The size of pots: 9x12 cm or 9x14 cm. with bottom and hole around. The component of potting (volume) including: surface soil: 89 % + manure: 10 % + super phosphorus: 1 %

- She most favorable shading for delelopment of Phay's seedlings at stage of 3 - 6 months is 50%. From 6 - 9 months is 25 %.

- During the summer months. it's necessary to water 1 time/day at 6 - 7 AM or late afternoon with amount of water 1.8 l/m^2. weeding. breaking scum 15 days/time from the fourth month. every month need to change the position of pot 1 time to reduce the main roots expanding into beds.

- Phay at the nursery stage often faces with disease of rooting and insect. should pay attention to prevent measures periodically spraying 10-15days/time by Viben WP50 with a concentration of 0.5 % or catching insect in the morning.

- Standard for planting: Trees from 6 - 9 months. rooting diameter from 0.6 - 0.8 cm. Height: 0.6 - 0.7 m. trees with good quality. balancing development without diseases. not many trunks and the rooting systems well-developed.

3.5.3. Cutting-producing techniques

- Taking cuttings from strong mother trees (1 year) in the nursery. mother trees with buds in forest or natural forest if old mother trees. Buds of cutting branches and kept in the cool weather condition or soaking the roots into water. Cuttings by the sharp knife. the best is top cuttings with length from >6 cm - 8 cm and about of 45°.

- Cuttings in a greenhouse: after cutting. soaking cuttings imediately into a solution of Viben CWP50 with 0.3 % concentration from 25 - 30 minutes. then encourage rooting by soaking into IBA or IAA concentration 750 ppm. Cuttings are implanted into sand or B soil layer.

- The best season for cutting is Spring

- Maintenance: Spraying water following semi-automatic mode. 60-10 seconds in summer.

- When implanting cutting into soil pots that after 50-60days. removing the coverage. reduce the amount and time of spraying. After 2-3 months. conducting to change the positions of pots. Maintenances. cutting the inappropriate buds. spraying N. P. K with the rate of (8:1:2). From 6 - 7 months. the trees in nursery can reach 55 - 60 cm in height. and ready for planting.

CONCLUSION. EXISTENCE. RECOMMENDATION

1. Conclusion

1) Biological features of Phay trees

- Phay *(Duabanga grandiflora)* is a big large timber species. evergreen. height reaches 35m. diameter can reach from 90 - 130 cm. straight trunk. small bread at origin. thick bark from 0.6 - 1.9 cm. single leaf opposite sprouting on. 14 - 40 cm length. 3.2 - 7.2 width. tendon feathers. small leaf with reddish color. old leaf with dark green smaller. Big flower with panicles at te top of branches. Calyx includes 4 - 7 wings. thick. smoothly. ovoid. Stamen arranges along the row. wrapped filaments. dry capsule. spherical. riped fruit become woody bark from 4 - 7 wings. Granules. thin hairness at both sides. Sprouting and pruning leaves from January - February. bud fluctuates February - March. Flowering between March - April.

small fruits at the end of April and riped fruit on May - June. Phay distributes at the elevation from 270 - 596 m. slope from 10 - 40°. The average annual temperature from 20.2°C - 22°C. Humidity fluctuates from 78.6 % - 81.2 %. Amount of average annual rainfall from 1148.1 - 2144.5 mm/year

- Phay species can be planted on many types of soil but preferably land feralit development on clay schist rocks with high humidity.

- The number of species participated in formula composition from 2 - 72 species with 5 main species.

- The relationship between Phay and other dominant species within the forest is random and following by: Vang Anh. Muong Trang. Thoi Ba. Gao. Ke duoi dong…

- The structural layers of forest status: IIA. IIB. IIIA1 has height fluctuate from 6 - 24 m. average canopy is 0.4.

- Structural composition. dendity. Quality and origin of regenerants following the level of height of surveyed plots: status (TT) IC has 3/52 species. IIa with 3/48 species. IIb has 5/53 species and IIIa1with 4/37 species participated in formula composition. The original regenerants mostly based on seeds. the quality of regenerants ranged from 45.4 % - 62.8 %.

- The influence of canopy. shrub and vegetation to natural regeneration: (TT) Ic has no canopy with density of regenerants is 3106 trees/ha. potential trees rate is 20.1%. IIIa1. the highest canopy average reaches 0.462. density of regenerants is 2661 trees/ha. potential trees with 15 %. The coverage of shrub (38.5 %). vegetation (66 %) (Ic) that the rate of potential trees is only 41.8%. the coverage of shrub is 25.5 %. vegetation 25 % at Ic status that IIIa1 reduces to 15 % with significantly affects natural regeneration.

- Phay species is rarely regenerated on the natural forest land. and can see much on the conditions of working roads or construction.

2) Physchological characteristic of Phay's seeds

- Fruits ripe in early June. Each fruit has many seeds which column shaping. after harvesting kept incubation for ripening.

then exposed to particles. conducting preservation by drying cold method within refrigerators about 8°C. survival rate after 5 months as 25.3 %. Rate seeds/fruits calculated by volume that 6.25kg dry fruits equivalent to 1 kg seeds.

- Humidity of seeds is 12.4 %; purity is 79.3 %. Average weight of 1000 seeds is 0.098 grs. The number of seeds/1kg from 8.500.000 - 8.670.000 seeds.

- Rate of germination of seeds treating with warm water (35°C) is 85.3 % with the average germinated speed is 10.5 days. Phay's seeds can attract moisture rapidly. after 8 hours soaking in the water (1 gram - 1.64 gram). The time for stimulating germination when soaking in water for 4 hours. then conducting to sow. the fastest time for germination (9 days). highest germination rate (75.67 %).

- When sowing seeds. landfill at the depth of 0.1cm for the highest germination rate (73.3 %).

3) Physiological and ecological characteristics of Phay at nursery stage

- The favorable shading percentage of Phay at age of 3 - 6 months is 50 %. trees from 6 - 9 months is 25 %.

- In dry season. watering for Phay 1time/day with 1.8 l/m^2 is the most suitable.

- Potting mixes suitable for Phay species is 89 % surface soil +10 % manure + 1 % phosphorus

4) Results from reproducing Phay by cutting method.

- When propagating Phay species by cutting method can use medicine of IBA or IAA with a concentration of 750 ppm for the most efficiency results.

- Using sand or B surface soils frame are also shown the high rooting rate. but Sand frame is still better than.

- Cuttings from mother trees (age 1) have shown the rooting rate higher than mother trees (from age 3 - 6).

- The most favorable season for propagation Phay species is Spring.

- The length of cutting: from 6 - 8 cm and 3 couple of sleeping buds. Using the top cuttings for propagation by cutting method.

- The study has proposed a guiding processing technique of propagation Phay species from seeds and cuttings.

2. Existence

- Have not researched the fruiting cycles of Phay species yet.

- Have not studied the techniques. of large timber plantation. protection and evaluation of growth and development of Phay species.

3. Recommendations

- Phay is a large timber species. with high protective effects. so choose this species for large timber planting supplying and protecting purposes for Bac Kan province and other regions with similar natural conditions.

- Application the technical guidance in breeding seedlings from seeds and cuttings for Phay species in practical production.

- Continuing resolve the remained problems. Especially construction the large timber forest protection by Phay species.

RESEARCH PAPERS PUBPISHED RELATED TO THE DISSERTATION

1. Le Sy Hong. Le Sy Trung (2015). “Studying on propagation of Phay (*Duabanga grandiflora* Roxb.ex DC) species by cutting method” - *Journal of Agriculture and Rural development*. June. pp. 228 - 236.
2. Le Sy Hong. Le Sy Trung (2015). “Some silvicultural characteristics of Phay species (*Duabanga grandiflora* Roxb.ex DC) in Bac Kan province” - *Journal of Agriculture and Rural development*. July. No 13. pp. 121 - 128.
3. Le Sy Hong (2015). “The influence of mineral nutrients and watering to the growth of Phay species (*Duabanga grandiflora* Roxb.ex DC) at the nursery stage” - *Journal of Agriculture and Rural development*. July. No 14. pp. 137 - 142.