RESEARCH ON PROPAGATION TECHNIQUES OF *Arundinaria sp.* BY RHIZOME CUTTING

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SUMMARY

Arundinaria sp. is a valuable non-timber forest product, capable of improving the economic life of local people based on export demand to countries such as Japan, Taiwan, and Europe. The need for materials in the area for processing *Arundinaria sp*. culm to export is quite high in recent year. Therefore, develop *Arundinaria sp*. plantation becomes a key solution to supply sustainable raw material for *Arundinaria sp*. culm processing and producing seedling is the first and an important method that need to be well prepared. *Arundinaria sp*. rhizome was treated with IBA growth regulator agent at a concentration of 200 ppm for the best rooting rate and root quality. Age of cuttings at age 1 gave the best results in terms of rooting rate, while at age 2 with the best root quality. Container that has mixture of top soil + NPK fertilizer with IBA 200 ppm gave better rooting rate and root quality than that of clean sand. Treatment of *Arundinaria sp*. cuttings on 95% top soil + 5% NPK fertilizer with 200 ppm IBA gave the best rooting rate and root quality compared to the other experimental treatments. The technique of propagating *Arundinaria sp*. by cutting from rhizome is a good method, it is necessary to apply and conduct propagation from rhizome cuttings to serve the future afforestation work.

Keywords: *Arundinaria sp*., growth regulator, rhizome, root quality, rooting rate.

1. INTRODUCTION

Since the 18th century, choosing natural seeds has been used to regenerate in deforestation areas. Multiplication is of primary concern in the study of forest trees. Breeding is a scientific method that creating and improving plant varieties, animal breeds and microbial strains with useful genetic characteristics, high yield, physiological parameters as well as necessary patterns. The most important methods of plant breeding are hybridization, selection, and asexual propagation. Purpose of vegetative propagation is to maintain and strengthen the purity, vigor, and typical condition of the variety, to create the number of necessary varieties for mass production, and bring good varieties to rapidly disseminate in production.

Kebede Y et al. (2017) when studying the propagation of highland bamboo species in Northwest Ethiopia, pointed out that the method of propagation by rhizome had no difference between the growth rate of seeds in each period of material processing, meanwhile the cutting season (dry season and rainy season) has significantly affected to the germination rate of each cutting material. Nguyen Van Phong et al (2009) with research on the propagation of *Phyllostachys edulis* in Cao Bang by rhizome cuttings, exemplified that some growth regulators could be used to increase the rate of cuttings formation, such as 50 ppm and 100 ppm of ABT1, 25 ppm and 50 ppm of Atonik, 25 ppm and 50 ppm of IBA, 100 ppm of NAA.

Nonetheless, there are a limitation in the research literature of *Arundinaria sp.*. Most of these researches were mainly focusing on describing the morphological and ecological characteristics of the plant, and has not studied in-depth on propagation techniques. *Arundinaria sp.* belongs to the Monotyledoneae class, Poales order, Poaceae family, and Bambusoideae subfamily. The bamboo is propagated from rhizome. The rhizome develops from bamboo stump, spreading in the soil at a depth of about 20-30 cm. One or several rizhomes can develop from a stump. The cutting method is easy to implement, less expensive to invest, easy to expand and transfer technology

to production facilities. The results of cuttings are determined by the short duration and high rooting rate. There are various factors influencing on the results of cuttings, but depends on three main elements: ability of generating cutting roots (individual, stage and location of cuttings), cutting environment and other factors to simulate roots.

From the researches on propagation in general and the propagation of *Arundinaria sp.* in particular, we carried out the project: "Research on propagation techniques of *Arundinaria sp.* by rhizome cuttings".

2. RESEARCH METHODOLOGY

2.1. Research Materials

+ Cuttings for research materials were taken from the rhizome of *Arundinaria sp.*, prioritizing cuttings selection that are glossy and bright color, and no diseases;

+ Growth regulators including IBA and NAA with concentrations of 50 ppm, 100 ppm, 200 ppm and 500 ppm;

+ Polyethylene bag size 13x18 cm;

+ Mixture material: topsoil; clean sand;

+ Well decomposed manure, NPK fertilizer at the ratio of 10:5:5; urea nitrogen; super phosphate;

+ Shade with a frame of iron 6 and covered with nylon net.

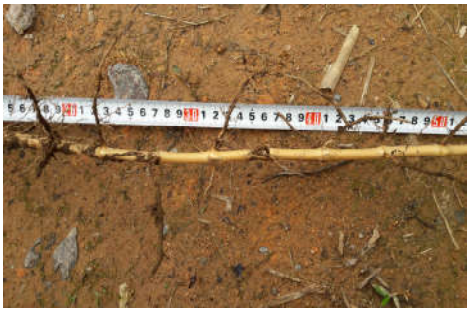


Figure 1. Rhizome of *Arundinaria sp.*

Figure 2. Site preparation for cutting

Figure 3. Rhizome cuttings soaked in pesticide solution

Figure 4. Rhizome cuttings put in container

2.2. Research Methods

2.2.1. Experimental preparation

2.2.1.1. The effects of growth regulators to rooting rate and quality of cuttings

Experiment layout: 9 treatments were set up, 3 replicates for each treatment, 30 cuttings for each treatment in each replicate, specifically as follows:

+ CT01 to CT04: using IBA at 50 ppm, 100 ppm, 200 ppm, and 500 ppm concentration;

+ CT05 to CT08: using NAA at 50 ppm, 100 ppm, 200 ppm, and 500 ppm concentration;

+ CT09: cuttings were not treated (control).

Thus, the total number of experimental cuttings is 810 cuttings (9 treatments x 03 replicates/CTTN x 30 cuttings/replicate). In each treatment, cuttings were cut and had the same care. The mixture of the container was topsoil.

2.2.1.2. Influence of rhizome age on rooting rate and quality of cuttings

*Experiment layout:*The treatment used rhizome cuttings at 3 different ages (1 year old, 2 years old and 3 years old). Thus, there were 3 treatments, each treatment replcated 3 times, 30 cuttings for each treatment in each replicate, specifically as follows:

+ CT01: using 1-year-old rhizome cuttings;

+ CT02: using 2-year-old rhizome cuttings;

+ CT03: using 3-year-old rhizome cuttings.

The age of the rhizome was determined by observing the rhizome in the field, each rhizome cutting segment contained two dormant buds.

2.2.1.3. Influence of potting mixes on the rooting rate and quality of cuttings

Experiment layout: There were 2 treatments, each treatment replcated 3 times, 30 cuttings for each treatment in each replicate, specifically as follows:

+ CT1: topsoil with 5% NPK 10:5:5 fertilizer added;

+ CT2: clean sand, treated with pesticide.

The total number of cutting for the 2 treatments were 180 pieces.

2.2.1.4 Effect of fertilizers on the rooting rate and quality of cuttings

Experiment layout: There were 5 treatments, each treatment replcated 3 times, 30 cuttings for each treatment in each replicate, specifically as follows:

+ CT1: 95% topsoil + 5% NPK;

+ CT2: 75% topsoil + 5% NPK + 20% well decomposed manure;

+ CT3: 75% topsoil + 20% well decomposed manure + 3% urea nitrogen + 2% superphosphate;

+ CT4: 60% topsoil + 40% well decomposed manure;

+ CT5: Control (only topsoil).

The total number of cutting is 450.

In all of the above treatments, the containers were placed in a 1m wide bed, covered with a nylon net. The canopy is pulled over when it's sunny and removed when it's shady. At the same time, after 3 months of covering the light, continue removing the cover so that the plants can adapt to the nursery conditions. Monitoring and collecting growth data of all cutting once two week. In the 4th month: measured data including survival rate, number of shoots, diameter of shoot base, length, and growth quality of shoots and young bamboo.

2.2.2 Data analysis

The parameters of the cuttings were calculated as follows:

+ Rooting rate = $\frac{n_r}{N}.100$

+ Sample mean:$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} f_i x_i$

+ Number of medium roots/cutting = Total number of roots/Number of rooted cuttings.

+ Rooting index = average number of roots per cutting x average root length per cutting.

+ Check the effect of experimental factors on the rate of cuttings taking root, root quality by analysis of variance method conducted by Generalized Linear Models on SPSS software (version 20).

+ The best treatment in each experiment was determined based on Duncan criteria performed on SPSS software (version 20).

3. RESULTS AND DISCUSSION

3.1. Effect of growth regulators on rooting rate and quality of cuttings

The growth regulator is a factor that clearly affects the rooting time, rate and quality of cuttings as well. In order to find out the most suitable type of growth regulator and concentration of the regulator for cutting propagation of *Arundinaria sp.* species, the growth regulators were tested by NAA (axit nethalen - axetic), IBA (axit indol butyric) with different concentrations of 50 ppm, 100 ppm, 200 ppm, 500 ppm. The results of monitoring the effect of growth regulators on rooting rate and root quality of cuttings are shown in Table 1.

Table 1. Effect of growth regulators on rooting rate and root density of cuttings

Growth regulator	Concentration (ppm)	Number of cutting (piece)	Number of cutting rooting (piece)	Rooting rate (%)	Number of root/cutting	Root length (cm)	Rooting index
IBA	50	90	40	44.44	3.1	2.60	8.3
	100	90	39	43.33	2.9	3.47	10.3
	200	90	44	48.89	2.8	3.90	11.0
	500	90	38	42.22	3.6	3.13	11.1
NAA	50	90	39	43.33	2.7	3.77	10.2
	100	90	38	42.22	2.4	3.37	8.2
	200	90	38	42.22	2.4	3.20	7.8
	500	90	37	41.11	3.3	3.07	10.3
Control		90	24	26.67	2.6	1.87	4.8

From Table 1, it can be seen that the rooting rate of cuttings and the quality of the cuttings using growth regulators were higher than that of the control.

The concentration of growth regulators also affected the rooting rate. Using 200 ppm IBA had the highest results in rooting rate of cuttings (48.89%), then 50 ppm (44.44%), 100 ppm (43.33%) and finally 500 ppm (42.22%). Unlike IBA, at different concentrations of NAA there was no significant difference in rooting rate of cuttings.

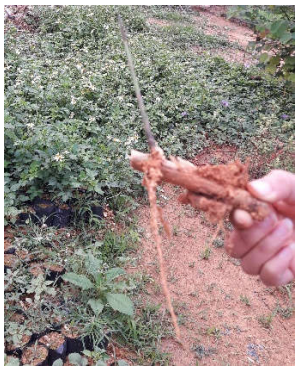
To evaluate the effect of using growth regulators as well as to choose the best experimental treatment, the percentage of rooting cuttings per whole experimental cuttings was used. The analysis results of variance illustrated that different growth regulators had a significant difference (Sig < 0.05) in the rooting rate of the cuttings. Using Duncan's criteria to check for selection, the best treatment was IBA growth regulator.

However, there was also a significant difference in the average number of roots per cutting. Ducan standard analysis indicated that the 500 ppm IBA treatment gave better quality of cuttings than other types and growth regulators.

Average root length per cuttings that treated with growth stimulants was higher than the control. Specifically, IBA 200 ppm gave the highest value (3.90 cm), 2.03 times higher than the control one. Followed by 50 ppm (3.77 cm) NAA, which is 1.9 times higher than the control one. Significant difference was found in the influence of the growth regulators on the root length (Sig = 0.000 < 0.05) and, 50 ppm NAA treatment comfirmed as the best root length of cuttings by.confirmed that using the Ducan standard

Similar to rooting rate, number of roots per cutting and root lenght, all experimental treatments had a higher rooting index than the control. The 500 ppm IBA treatment gave the highest rooting index (11.1), 2.3 times higher than the control.

a)



b)

Figure 5. Rhizome cuttings shoots

3.2. Effect of rhizome age on rooting rate and root's quality of cuttings

Plant roots play an important role in plant growth and development. In order to evaluate the quality and effectiveness of cuttings, it is necessary to determine the influence of rhizome age on the rooting rate and the quality of the root system. Studying results on the effect of cutting age on rooting rate and root's quality are shown in Table 2.

Table 2. Effect of cutting age on rooting rate and quality of cuttings

Rhizome year	IBA (ppm)	Number of cutting (piece)	Number of cutting rooting (piece)	Rooting rate (%)	Number of root/cutting	Root length (cm)	Rooting index
1st year	200	90	45	50,00	1.97	2.87	5.53
2nd year	200	90	33	36.67	1.86	3.03	5.71
3rd year	200	90	29	32.22	1.89	2.93	5.62

The results represented that the rooting rate decreased correspondingly with older ages of the rhizome. The difference in the rate of rooting cuttings at different rhizome ages significantly distinguished with statistical significance (Sig < 0.05). Duncan's standard results also proved that cuttings at the first age were the dominant treatment.

The number of roots of cuttings showed that at the age of 1 year old, almost roots were formed, with average of 1.97 roots/cutting. The average of roots per cutting of rhizomes aged 2 and 3 was not much disparate (1.86 and 1.89 roots/cutting). Analysis results of variance for all 3 experimental treatments proved that the influence of rhizome age on the number of roots per cutting was significant difference.

In terms of the root length of cuttings, it was indicated that the age of 2 had a root length of 3.03 cm. Under the same conditions, cuttings collected from rhizome aged 3 and 1 had slightly shorter root lengths, 2.98 and 2.87 cm respectively. This difference was significant with Sig test < 0.05.

Regarding the rooting index, the variance analysis based on the rooting index of the cuttings depicted that Sig < 0.05, which confirms that at different ages of rizhome there was a significant difference in the rooting index of the cuttings. Testing by Duncan's standard demonstrated that the rhizome at the age of 2 had the highest rooting index (5.71) among the experimental treatments.

3.3. Effect of mixture on rooting rate and quality of root of cuttings

The mixture is one of essential components affecting to the rooting and quality of cuttings. Inappropriate mixture will directly affect to the growth and development of the roots. Therefore, finding a suitable mixture is vital in propagating of *Arundinaria sp.*

Table 3. Effect of mixture on rooting rate and quality of root of cuttings

Background body	IBA (ppm)	Number of cutting (piece)	Number of cutting rooting (piece)	Rooting rate (%)	Number of root/cutting	Root length (cm)	Rooting index
Topsoil + NPK	200	90	45	50.00	2.15	2.80	6.01
Cleaned sand	200	90	44	48.89	1.65	2.37	3.89

Table 3 shows that cuttings on topsoil + NPK mixture reached to the rooting rate of 50%, meanwhile cleaned sand reached to 48.89%. The unequal rate between the 2 mixtures was not significant. The analysis result of variance with Sig < 0.05 showed that there was no significant difference between the experimental treatments.

About rooting index, it reflects the overall growth and quality of the roots. The mixture (topsoil + NPK) gave the rooting index of *Arundinaria sp.* was 1.29, which was 1.4 times higher than that of the substrate 2 (Cleaned sand). But two treatments had no significant difference.

The mixture of Topsoil and NPK gave a smaller average number of roots per cutting but the best root length. Therefore, it is easy to see that the rooting index in this mixture was the best. This is confirmed through statistical test results (Sig < 0.05). Using Duncan's criteria to test also showed that the topsoil substrate + NPK is the most suitable treatment for cutting rhizome of *Arundinaria sp.*

3.4. Effect of fertilizer on rooting rate and quality of cuttings

Fertilizer is an important nutritional factor that determines the growth and development of plants, even for seedings in the nursery stage. The results of monitoring the effect of fertilizers on the rooting rate and quality of the cuttings are shown in Table 4.

Table 4. Effect of fertilizer on rooting rate and quality of cuttings

Background body	IBA (ppm)	Number of cutting (piece)	Number of cutting rooting (piece)	Rooting rate (%)	Number of root per cutting	Root length (cm)	Rooting index
95% top soil + 5%NPK	200	90	45	50.00	2.93	2.83	8.47
75% top soil + 5%NPK + 20% manure	200	90	42	46.67	2.68	3.03	8.08
75% top soil + 20% manure +3% N + 2% P	200	90	38	42.22	2.75	2.80	7.87
60% top soil + 40% manure	200	90	42	46.67	2.91	2.67	7.70
Control (top soil only)	200	90	25	27.78	2.30	1.93	4.41

It is depicted that, when treated with the same growth regulator at the same concentration, cuttings on various fertilizer treatments gave different results on rooting rates (Table 4). Cuttings on the treatment of 95% soil + 5% NPK had the highest rooting rate (50,00%). The treatment 75% soil + 5% NPK + 20% manure and 60% soil + 40% manure gave the second highest ratio (both are 46.67%), followed by treatment of 75% soil + 20% Manure + 3% nitrogen + 2% superphosphate with rooting rate of 42.22%. The cuttings of the control treatment had a lowest rooting rate of 27.78%. This difference was significant at Sig < 0.05. Duncan's standard approved that the treatment 95% soil + 5% NPK being the best

rooting rate compared to other types of fertilizer treatments.

Regarding the quality of roots, the highest average number of roots per cutting (2.93 roots/cutting) was on 95% top soil + 5% NPK treatment also had, followed by 60% top soil + 40% manure (2.91 roots/cutting), 75% soil + 20% Manure + 3% nitrogen 2% superphosphate and 75% soil + 5%NPK + 20% manure, 2.75 and 2.68 respectively. The lowest cuttings was the control treatment with all topsoil, only 2.30 roots/cutting.

Similarly, the average of root length per cutting in the experimental plants was not the same. The treatment of 75% soil + 5% NPK + 20% manure gave the highest average root length (3.03 cm), followed by 95% soil + 5% NPK; 75% soil + 20% manure + 3% nitrogen 2% superphosphate, with root lenght of 2.83 and 2.8 cm, respectively. Cuttings on the treatment 60% top soil + 40% manure gave a root length of 2.67 cm. The lowest root length (1.93 cm) was the cuttings on the control which was only topsoil.

For the rooting index, cuttings on the mixture of 95% top soil + 5% NPK gave the highest rooting index (8.47), and then treatment of 75% top soil + 5% NPK + 20% fertilizer ; 75% top soil + 20% manure + 3% nitrogen 2% superphosphate and the treatment 60% top soil + 40% manure, rooting index reached up 8.08, 7.87 and 7.70 respectively. Similar to root lenght, cuttings on the control treatment with all topsoil had the lowest rooting index (only 4.41).

4. CONCLUSSION

This study was carried out to implement propagation from rhizome of *Arundinaria sp.* by cutting method under the influence of growth regulation, rhizome age, container mixture and fertilizers. *Arundinaria sp.* species has the ability to propagate by cuttings, so it is possible to do cutting propagation to serve bamboo afforestation in the context of very limited seed resources for afforestation. Cutting from rhizome of *Arundinaria sp.* at the age of 1, treated with IBA growth regulator at a concentration of 200 ppm gave the best rooting rate and at the age of 2 gave the best root quality compared to the rest of the treatments. Cutting from rhizome of *Arundinaria sp.* treated with IBA growth regulator at a concentration of 200 ppm then put in top soil + NPK mixture gave the best rooting rate and root quality compared to that in the cleaned sand. Mixture 95% top soil + 5% NPK fertilizer gave the best rooting rate and root quality compared to other fertilizer treatments.

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NGHIÊN CỨU NHÂN GIỐNG MẠY CHẢ (*Arundinaria Sp.*) BẰNG GIÂM HOM THÂN NGẦM

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TÓM TẮT

Mạy chả (*Arundinaria sp.*) là loài cây lâm sản ngoài gỗ có giá trị, có khả năng cải thiện đời sống kinh tế của người dân địa phương dựa vào nhu cầu xuất khẩu sang các nước như Nhật Bản, Đài Loan, châu Âu. Nhu cầu nguyên liệu cho chế biến than cây Mạy chả cho xuất khẩu của khu vực trong những năm gần đây rất cao. Vì thế phát triển diện tích rừng trồng Mạy chả trở thành giải pháp then chốt nhằm cung cấp nguồn nguyên liệu bền vững và sản xuất cây con là nhiệm vụ đầu tiên và quan trọng cần chuẩn bị ký lưỡng. Thân ngầm Mạy chả được xử lý bằng chất điều quá sinh trưởng IBA với nồng độ 200 ppm cho ra tỷ lệ ra rễ và chất lượng rễ là tốt nhất. Tuổi của hom giâm là tuổi 1 cho kết quả tốt nhất về tỷ lệ ra rễ, trong khi đó ở tuổi 2 với cho chất lượng rễ tốt nhất. Thể nền tầng đất mặt + NPK với IBA 200 ppm cho tỉ lệ ra rễ và chất lượng rễ tốt hơn so với thể nền cát sạch. Xử lý giâm hom cậy Mạy chả trên phân bón 95% đất + 5%NPK với IBA 200 ppm cho tỷ lệ ra rễ và chất lượng rễ tốt nhất so với các công thức thí nghiệm còn lại. Kỹ thuật nhân giống Mạy chả bằng thân ngầm là phương pháp tốt, cần vận dụng và tiến hành giâm hom để phục vụ cho công tác trồng rừng sau này được đảm bảo.

Từ khóa: chất điều hòa sinh trưởng, chất lượng rễ, Mạy chả, thân ngầm, tỷ lệ ra rễ.

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