Research on Cutting Seedling Cultivation Technology of *Abies chensiensis* Tiegh. in Shade Shed

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Abstract: As a unique tree species in China, *Abies chensiensis* Tiegh. boasts hardwood that is both strong and corrosion-resistant, thus possessing significant economic value. However, due to its specific growth environment and anthropogenic damage, the population of *Abies chensiensis* Tiegh. is gradually decreasing. Therefore, the protection and propagation of this species are particularly crucial. In terms of propagation, cuttage technology is an effective method for *Abies chensiensis* Tiegh. By selecting appropriate cutting seasons, cutting substrates, and cutting branches, the survival rate of cuttings can be improved. This study conducted a screening investigation on the cutting season, cutting substrate, and cutting maturity of *Abies chensiensis* Tiegh. under shade shelter conditions and drew the following conclusions: (1) There is a competitive relationship between rooting and decay during the cutting process; (2) *Abies chensiensis* Tiegh. belongs to a species with difficulty in rooting, and its suitable cutting season is from the middle to late June to the middle of July; (3) By selecting semi-lignified branches and substrates with good permeability, water retention, and nutrition for cuttings, a survival rate of 45.8% can be achieved. This study provides a beneficial exploration and reference for the cutting propagation of *Abies chensiensis* Tiegh.

Keywords: *Abies chensiensis* tiegh.; Cutting; Shade shed

1. Introduction

Abies chensiensis Tiegh. is a tree in the Qinling Mountains, reaching a height of 50 meters; The annual branches are light yellow gray, light yellow or light brown yellow, without hair or sparse fine hairs in grooves, while the second and third year branches are light yellow gray or gray; Winter buds are cone-shaped and have resin. The leaves are arranged in two or nearly two rows on the branches, in a strip shape, 1.5-4.8 cm long, with dark green on the top and two white stomatal bands below; The leaf tips of fruit branches are pointed or blunt, with resin ducts growing in the middle or near the middle. The leaves of nutrient branches and young trees are longer, with two split or slightly concave tips and resin ducts growing at the edges; There is a layer of subcutaneous cells arranged continuously or discontinuously from the top to the bottom on both sides of the cross-section, with one to two layers in the middle below, and the inner layer in the two layers being discontinuous. The cones are cylindrical or oval shaped, measuring 7-11 centimeters in length and 3-4 centimeters in diameter. They are nearly sessile, green before maturity and brown at maturity. The middle part of the cone is kidney shaped, measuring about 1.5 centimeters in length and 2.5 centimeters in width. The scales are densely covered with short hairs on the back; The bract scales are about 3/4 the length of the seed scales, not exposed, with a nearly circular upper part and fine missing teeth at the edge. The center has a short sharp tip, the middle and lower parts are nearly equal in width, and the base gradually narrows; The seed is longer than the seed wing, with an inverted triangular oval shape and a length of 8 millimeters. The seed wing is wide and inverted triangular, with an upper part about 1 centimeter wide, and the seed is about 1.3 centimeters long. As a unique tree species in China, it is found in the areas of southern Shaanxi, western Hubei, and southern Gansu at an altitude of 2300-3000 meters [1]. The reproduction of *Abies chensiensis* Tiegh. using seeds is relatively difficult, with a low fruiting rate. However, seeds collected in the wild have a high rate of abortion and are small. It is very difficult to use live reproduction in production, and this experiment aims to explore a breeding method with high reproduction rate and low cost [2,3].

2. Materials and Methods

2.1 Overview of the Experimental Site

The experimental site is located in Changzhuyuan Township, Shangcheng County, Henan Province, in the southeast corner of Henan Province, at the northern foot of the Dabie Mountains. The geographical coordinates are 115.06 to 115.37 east longitude and 31.23 to 32.05 north latitude. To the east is Jinzhai County, Anhui Province, and to the south is Macheng County, Hubei Province. The total area is 2130 square kilometers. Belonging to the northern edge of the northern subtropical zone, with a mild climate, abundant rainfall, and distinct four seasons. Annual average temperature of 15.4 °C, annual rainfall

The volume is 1241.4 millimeters, with an average annual rainfall of 125.8 days and an average frost free period of 222 days. There are four soil types within the territory: yellow brown soil, paddy soil, brown soil, and tidal soil. Yellow brown soil is mainly distributed in the central and southern parts of the county, accounting for 69.1% of the total area of the county. The terrain slopes from south to north. Gradually reduce and form three natural areas: middle and low mountains, low mountains and hills, and hills and ridges. Jingangtai has an altitude of 1584 meters and is the highest peak of the Dabie Mountains in Henan Province.

2.2 Test Materials

The experiment selected one year old strong and sprouting branches of the *Abies chensiensis* Tiegh., which were required to be free from pests and diseases, robust, and with full buds. After collecting on the same day, workers will remove leaves, cut ears, grade them, soak them in water, and cut them all on the same day.

The cutting substrate is a mixed substrate, river sand, and paddy soil.

2.3 Test Methods

Insert a bed to make a sunny bed, with a width of 80cm and a height of 15cm, and a width of 40cm for the water ditch between the beds. Three types of substrates are river sand, paddy soil, and mixed substrate (perlite: river sand: paddy soil=1:1:1), randomly arranged on the ridge, with a thickness of about 20 cm. The shade shed is made of wooden pillars, with a height of 1.5m. 75% shading net is used, and the garden is fully covered. After disinfecting the seedbed, irrigate the seedbed thoroughly and spray water once in the morning and evening during the hot and dry seasons [4].

The length of the cuttings is about 5cm. The upper incision is a flat incision, the lower incision is slightly inclined, and the upper incision is 1-2cm away from the nearest bud. When cutting, pay attention to the orientation of the cuttings and avoid tipping them over. The cuttings should be exposed about 1-2 cm above the bed surface, that is, the top bud of the cuttings should be level with the bed surface, and the distance between the cuttings should be 3cm x 8cm. The cuttings are classified into two categories: old branches and semi lignified branches.

Starting from June 12th to August 27th, a batch of 200 cuttings per substrate will be inserted in the week. After defoliation, investigate the height, ground diameter, root length, number of adventitious roots, survival rate and other indicators.

3. Results and Analysis

3.1 The Impact of Cutting Period on Cutting

Using one-year new shoots, a cutting period selection experiment was conducted on a mixed substrate. Starting from mid-June, a total of 11 cuttings will be cut every 2 weeks. The rooting situation will be checked 5 days after each batch of cuttings, and the time when the cuttings take root is known as the number of rooting days. After falling leaves in autumn, the height, diameter, and survival rate of each batch of seedlings were calculated and the results are shown in Table 1.

Because temperature changes over time, temperature is the key to determining the rooting of cuttings. So, the cutting period has a significant impact on the survival rate and seedling growth of cuttings [5,6]. From the survey results, the rooting days are negatively correlated with temperature, that is, the higher the temperature, the faster the cuttings take root, and the shorter the required days. The survival rate of cuttings is positively correlated with temperature [7]. Within a certain temperature range, the higher the temperature, the higher the survival rate of cuttings. The highest average survival rate in early July was 4.7% higher than the average, while in mid-August, when the average temperature was slightly lower, the survival rate of cuttings was 5.2% lower than the average. The growth rate of seedlings is only related to the growth time. As the cutting period advances, the growth period shortens, and the height and coarse growth of seedlings decrease.

Table 1. Influence of cutting period on cutting effect

Index / Date	Rooting days (d),	seedling height (cm)	ground diameter (cm)	survival rate (%)
6\12	28	21.5	0.32	41.2
6\26	30	22.3	0.31	42.1
7\10	26	15.4	0.22	45.0
7\24	25	12.6	0.23	46.6
8\7	37	15.8	0.21	34.1
8\21	36	14.5	0.19	37.5

3.2 The Influence of Cutting Substrate on Cutting

Select mid July for cutting substrate screening. Because local traditional seedling cultivation often uses locally sourced river sand or rice paddy soil, these two types are used as references [8]. Thoroughly disinfect the seedbed before cutting. After 5 days of cutting, the rooting situation was checked and it was found that the rooting time of the cuttings was the number of rooting days. The statistical results of seedling height, ground diameter, and survival rate after falling leaves in autumn are shown in Table 2.

Table 2 Influence of Cutting Substrate on Cutting Effect

Index / Substrate	Rooting days (d)	Seedling height (cm)	Ground diameter (cm)	Survival rate (%)
River sand	35	16.4	0.18	38.2
Mixed matrix	31	21.3	0.24	44.6
Paddy soil	34	22.5	0.29	30.5

The results showed that the mixed substrate had the highest survival rate among the three substrates, 14.1% higher than paddy soil and 3.6% higher than river sand, respectively. The growth performance is best in paddy soil, with high growth and coarse growth exceeding the average by 9% and 22.5%, respectively. This is because the mixed matrix mixed with perlite has a good insulation effect, which can relatively stabilize the temperature of the seedbed and facilitate rooting of cuttings. However, rice paddy soil with a harder texture is prone to damage to panicles and is more susceptible to disease and decay. However, there is almost no nutrients in the river sand, and various nutrients in the paddy soil are relatively balanced, which is the main reason for the difference in seedling growth.

3.3 The Influence of Branch Maturity on the Survival Rate of Cuttings

Comparative cutting of branches with different degrees of lignification using a mixed substrate. The three types of branches are old branches (fully lignified branches in the current year and two years), semi lignified branches, and non-lignified tender branches. The survival rates of cuttings at different stages are shown in Figure 1.

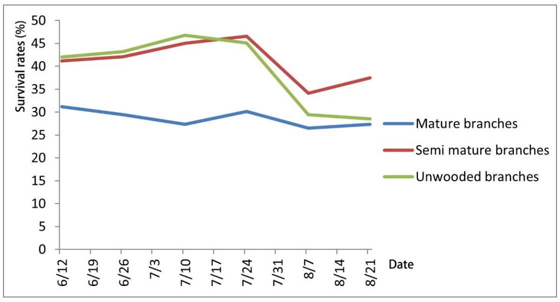

Figure 1 Effect of Branch Maturity on Cutting Survival

From the graph, the shape of the tender branches fluctuates greatly. The survival rates of old and semi lignified branches by cutting show a parabolic shape on the graph, with lower survival rates in the early and late stages. However, the survival rates of old and semi lignified branches reach their peak in late June and early July, but the survival rates of semi lignified branches by cutting are always higher than those of old branches. The overall survival rate of cuttings is as high as 45.8% for tender branches, and 41.6% for semi lignified branches, both of which are significantly higher than 35.8% for old branches. This indicates that semi lignified, and tender branches are more conducive to the survival of cuttings. As for the survival rate of tender branch cuttings, it is not significantly related to the cutting time, which may be due to the tendency of tender branches to lose water and cause death, as the sprouting shed is not like full light and fog, which can always replenish water. Especially during the hot season, short-term water shortage can cause temporary wilting of tender branches. When the water loss time is too long and reaches an irreversible state, the cuttings will wither or rot.

3.4 Effects of Rooting Agents on Cutting

A comparative experiment of rooting agent treatment was conducted on two consecutive batches of cuttings in mid to late July. Three rooting agents, namely naphthyl acetic acid, indole-3-butyric acid, and ABT2, were used to treat mature old branches, semi lignified branches, and non-lignified tender branches before rooting. The investigation results of rooting agents on the survival rate of different mature cuttings are shown in Table 3

Table 3 Effects of Different Rooting Agents on the Survival Rate (%) of Cuttings

Maturity / Rooting agent	Mature branches	Semi mature branches	Unwooded branches
Naphthylacetic acid	27.6	44.8	45.5
Indobutyric acid	28.9	44.9	45.3
ABT2	29.4	45.1	45.8
Contrast	20.3	44.6	44.9

Abies chensiensis Tiegh. is a difficult to root tree species. The effects of rooting agents on different maturity levels of cuttings are different. The analysis results show that the effect on the survival rate of cuttings without lignification or with poor lignification is not significant. The effect on cuttings with high lignification is more significant. The three rooting agents, naphthylacetic acid, indole-3-butyric acid, and ABT2, respectively, increased the survival rate by 7.3%, 8.6%, and 9.1% compared to the control group, but the difference between the three rooting agents is not significant [9,10].

4. Conclusion and Discussion

During the cutting process, there is a competitive relationship between rooting and decay, which is measured by the speed of the two. The earlier the rooting time, the higher the survival rate. On the contrary, if rooting is too slow, the probability and speed of decay will increase, leading to cutting failure. Regular disinfection of cuttings and seedbeds can often be used in production to slow down the rate of cuttings decay, but this is limited.

The optimal cutting time is from mid to late June to mid July. The rooting of cuttings is closely related to temperature, and appropriate high temperature is conducive to improving cell activity, thereby making use of rooting. But temperature is a double-edged sword. In high temperature and humidity environments, viruses and various microorganisms are also very active, which greatly increases the probability of cuttings rotting. At the same time, high temperature can easily cause wilting. Cutting should choose semi lignified new shoots. The survival rate of cuttings from non lignified and semi lignified branches is significantly higher than that of old branches, because the younger the branches, the higher the cell activity, and the faster the formation of callus tissue and adventitious roots. But the younger the branches, the more likely they are to lose water. So maintaining high humidity is the key to the survival of its cuttings.

A substrate with good permeability, insulation, and rich nutrients should be selected. For branches with high degree of lignification, conventional rooting agents can be used for treatment.

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