Studies on Cutting Propagation of *Pyracantha fortuneana*

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Abstract. The effects of matrices and concentrations of NAA and IBA on cuttings of the perennial *Pyracantha fortuneana* were studied. The results showed that Vermiculite, perlite and the mixture of vermiculite and perlite were all beneficial for rooting growth of the perennial *Pyracantha fortuneana* cuttings, while the best matrix was the mixture of them. The best concentration of NAA for rooting of the perennial *Pyracantha fortuneana* cuttings in summer was 100mg/L. Both of the most proper concentration of NAA and IBA for rooting of the perennial *Pyracantha fortuneana* cuttings in fall were 100mg/L.

1. Introduction

*Pyracantha fortuneana* is an evergreen wild shrub tree in the family Rosaceae, also known as ‘Huobaguo’, ‘Jiujuangjian’, ‘Chiyangzi’ and so on. It’s widely distributed in the south of the Yellow River and in the vast southwest of China, in addition, Shaanxi, Jiangsu, Zhejiang, Fujian, Hubei, Hunan, Guangxi, Anhui and other provinces are also distributed [1]. *Pyracantha fortuneana* is as high as 2~3 metres, its short lateral branches are often spiny and branchlets are slender, horizontal extension or supine. The leaves are obovate or obovate-oblong, the apex of which is rounded or retuse and the margin has obtuse serrate. Flowers are integrated with corymbose, white or yellowish and have 20 anthers, 5 carpels. Pear fruit is obovate, orange or crimson. Flowering time is during May to June and fruit last from September to December [2]. The white flowers are numerous in early summer while the red fruit is full of branches in autumn, the flowering red is beautiful, the flower and fruit viewing period is long, it can be planted widely in the mountains and rocks, on the slope, it can also be used as a hedge [3]. Cheap small, miniature bonsai ornamental value high, and that is what makes the market prospects very broad [4]. The fruits of *Pyracantha fortuneana* are rich of nutrients, vitamins, amino acids and mineral elements. Therefore, it is also widely used in food, beverage, medicine and so on. Fruit can be used for making wine [5], fruit peel [6], fruit vinegar beverage [7], pastry, and also grinding powder instead of grain. The roots, leaves, flowers, and fruits of *Pyracantha fortuneana* can be used in medicine, with the effect of invigorating the body and clearing away heat and detoxification [8]. The extract of red pigment from fruit of *Pyracantha fortuneana* can be used in cosmetics [9]. It grows rapidly and can be used as tree species for soil and water conservation [10]. Seeding and cutting propagation are the main factors of propagation of *Pyracantha fortuneana*, but the reproductive coefficient of seeding is low, and the reproduction coefficient of cutting propagation is higher, which can keep the good character of female parent. At present, there are few reports on cuttage propagation of *Pyracantha fortuneana*, and they mainly focus on the treatment of cuttings with physical methods and different growth regulators. In this experiment, the effects of different concentrations of NAA and IBA on the rooting of cuttings of *Pyracantha fortuneana* were studied in different seasons, in order to explore the suitable conditions of different seasons and different concentrations of biological
hormones, to provide technical reference for the popularization, application of Pyracantha fortuneana as well as collection and conservation of germplasm resources.

2.Materials and Methods

2.1 Materials
The experiment was carried out from April 2017 to December 2017 in the cutting bed of the No. 6 shed of the Teaching Farm in Sichuan Agricultural University. The materials were collected from Hanyuan County, Shimian County, Ya'an City, Sichuan Province and ‘Laoban’ Mountain Reading Park, Sichuan Agricultural University. The cut length is about 10cm, the upper incision is flat, the lower cut is oblique, and 4 pieces of blade are left.

2.2 Methods
2.2.1 Effect of different substrates on rooting and Seedling of Pyracantha fortuneana cuttings
On April 14, 2017, perennial branches were cut from the parent plant of Pyracantha fortuneana, and then treated with 100mg/L NAA for 1 h, then cut into the perlite, vermiculite and the mixed matrix with volume ratio of them respectively. Repeat 3 times for each treatment of 30 cuttings.

2.2.2 Effects of different concentrations of NAA and IBA on rooting and Seedling of perennial Pyracantha fortuneana cuttings
On October 19, 2017, perennial cuttings about 10cm were cut from collected materials. After being soaked in different concentrations of NAA and IBA for 12 h, the concentration of NAA and IBA in the mixed matrix of vermiculite and perlite was set to 100 mg / L and 200 mg / L, respectively. Repeat 3 times for each processing of 40 cuttings.

2.2.3 Effects of different concentrations of NAA on rooting and Seedling of hard Branch cutting of perennial Pyracantha fortuneana cuttings
Perennial cuttings were cut from female plants on May 10, 2017, and were soaked with different concentrations of NAA for 12 hours, then put the cuttings into the mixed matrix with volume ratio of vermiculite and perlite. The concentration of NAA was set to 100 mg / L, 200 mg / L, 300 mg / L and 400 mg / L. Repeat 3 times for each treatment of 30 cuttings.

2.3 Preparation and Management of cutting Seedling bed
The base of the experiment is perlite, vermiculite and mixed matrix of them(vermiculite: Perlite =1:1), disinfecting with 800~1000 times methyl tobusin and 1000 times green worm to kill the worm, deeping turn to disinfect the substrate. The substrate is raked evenly before cutting, and the hole is preplayed at 5 x 5cm ,3cm deep in the matrix by using the chopsticks, and after the cutting is well-treated ,they were sheathed straightly into the hole and gently compacted. In the autumn, the cutting is put on the plastic arch to keep warm and moisturizing. The artificial water spray is used to manage it. The relatively high air relative humidity is required in the early stage, and the relative humidity of the air and the matrix is reduced properly in the late stage of cutting, in favor of the growth of the fixed root.

2.4 Investigation items and statistical analysis
After cutting, the survival and rooting situation of cuttings were checked every two weeks. 60 days after cutting, the survival rate, rooting rate, root length, root number, rooting position, rooting quality and the occurrence of fibrous roots were measured. The test data were statistically analyzed by DPS software, and the difference significance was tested by Duncan's new complex difference method.
3. Results

3.1 Effect of different substrates on rooting and seedling formation of

Table 1 shows that the survival rate and rooting rate of cuttings in vermiculite, perlite and their mixed substrates are higher, adventitious roots are more and longer, and the length of plant is about 0.5cm higher when using perennial *Pyracantha fortuneana* cuttings in late spring and early summer. Except for adventitious root number and root length, there were no significant differences in survival rate, rooting rate and plant growth of the three substrates. With the exception of adventitious root length, vermiculite and perlite were the most suitable substrate for rooting and seedling formation of perennial cuttings (Figure 1).

Table 1. Effect of different substrates on rooting and seedling formation of perennial *Pyracantha fortuneana* cuttings

| base material       | survival Ratio (%) | rooting rate(%) | Mean root number | Mean root Length (cm) | Cuttings increment (cm) |
|---------------------|--------------------|----------------|------------------|-----------------------|-------------------------|
| Vermiculite         | 91.28 aA           | 85.26 aA       | 11.56 bB         | 1.65 aA               | 0.52 aA                 |
| perlite             | 85.32 aA           | 56.38 aA       | 7.34 bB          | 1.24 aA               | 0.41 aA                 |
| mixed matrix        | 95.27 aA           | 98.85 aA       | 13.69 aA         | 1.88 bA               | 0.83 aA                 |

Figure 1. Rooting and germination of summer perennial cuttings treated with 100mg/L NAA in mixed substrates

3.2 Effects of different concentrations of NAA and IBA on rooting and Seedling formation of perennial *Pyracantha fortuneana* cuttings

The results showed that the survival rate, rooting rate and average root number of cuttings were higher in late autumn season (82.36% and 96.25%), and the survival rate, rooting rate and average root number of cuttings decreased with the increase of NAA and IBA concentration. The difference of
survival rate of cuttings reached a significant level (Table 2), which indicated that perennial *Pyracantha fortuneana* cuttings in late autumn season, NAA and IBA could be used as rooting reagents, and the concentration of 100mg/L was the best (Figure 2).

Table 2. Effects of different concentrations of NAA and IBA on rooting and Seedling formation of perennial *Pyracantha fortuneana* cuttings

| NAA (mg/L) | IBA (mg/L) | Survival ratio (%) | Rooting Rate (%) | Mean root number | Mean root Length (cm) |
|------------|------------|---------------------|------------------|------------------|-----------------------|
| 100        | 0          | 96.25 aA            | 76.52 a          | 11.32 a          | 2.05 a                |
| 200        | 0          | 85.38 bA            | 72.31 a          | 10.25 a          | 1.92 a                |
| 0          | 100        | 95.46 aA            | 78.23 a          | 11.83 a          | 2.25 a                |
| 0          | 200        | 82.36 bA            | 74.58 a          | 11.52 a          | 2.23 a                |

Figure 2. A The rooting situation of perennial cuttings in late autumn treated with 100mg/L NAA. B The rooting situation of perennial cuttings in late autumn treated with 200mg/L NAA. C The rooting situation of perennial cuttings in late autumn treated with 100mg/L IBA. D The rooting situation of perennial cuttings in late autumn treated with 200mg/L IBA in mixed substrates.

3.3 Effects of different concentrations of NAA on rooting and seedling formation of perennial *Pyracantha fortuneana* cuttings

The results showed that there were significant differences in rooting and seedling formation among different cuttings. With the increase of NAA concentration, the survival rate of cuttings decreased significantly, but there was no significant difference between cuttings rooting rate. When the concentration of NAA was 100mg/L, the survival rate, rooting rate, root number and root length of cuttings were high, while the survival rate of cuttings were very low when NAA concentration was 300–400mg/L. It was 18.33% and 11.67% respectively, which seriously affected the effect of cutting
seedling formation (Table 3). Considering the survival rate, rooting rate, average root number and root length of cuttings, 100mg/L NAA was suitable for perennial cuttings in summer.

Table 3. Effects of different concentrations of NAA on cutting seedling of Pyracantha fortuneana

| NAA (mg/L) | survival ratio(%) | Rooting Rate(%) | Mean root number | Mean root Length(cm) | Germination rate(%) |
|------------|-------------------|----------------|-----------------|----------------------|--------------------|
| 100        | 98.34 aA          | 89.89 a        | 11.83 aA        | 7.16 aA              | 38.49 aA           |
| 200        | 66.67 bA          | 95.84 a        | 17.77 aA        | 6.95 aA              | 44.92 aA           |
| 300        | 18.33 cB          | 62.50 a        | 7.14 bA         | 2.11 bB              | 0.00 bB            |
| 400        | 11.67 cB          | 87.50 a        | 17.67 aA        | 6.11 aA              | 30.55 aA           |

Figure 3. Rooting and germination situation of perennial cuttings treated with 100mg/L NAA in summer

4. Conclusions

4.1 Investigation items and statistical analysis

NAA is a plant growth regulator of auxins, which promotes cell growth by loosening cell walls, promoting synthesis of RNA and proteins, and forming adventitious roots[14]. It can promote the hydrolysis of starch stored in cuttings into reducing sugar, provides abundant energy for root formation, thus promoting cuttings rooting[15]. NAA has been widely used in cutting propagation of Taxus chinensis[16] and Cymbidium chinensis[17], but the application of NAA in Pyracantha fortuneana propagation is less. In this experiment, the perennial cuttings were treated with NAA at the end of spring, early summer and autumn, respectively. The results showed that 100mg/L NAA could promote the rooting of cuttings into seedlings and be used in the breeding of Pyracantha fortuneana seedlings. The results of Zhou et al.[13] showed that with the increase of NAA concentration, the rooting effect of cuttings was better. It was considered that 800mg/L NAA was the most suitable concentration for the treatment of perennial cuttings, which was inconsistent with the results of this experiment. The main reason is that Zhou et al. used the method of high concentration NAA to deal with cuttings in short time. IBA is a good rooting agent, which induces the formation of root primordium and promotes cell division and expansion. It can promote the formation of adventitious roots of plant cuttings, and has been applied to the production and breeding of seedlings[18]. The results also showed that IBA could promote rooting and root growth of cuttings, which was similar to
that of NAA. As a matter of fact, the price of NAA is lower than that of IBA, combining the effect of rooting and the cost of rooting reagent, it is more economical and applicable to raise seedlings with NAA.

4.2 The substrate of cuttings of Pyracantha fortuneana
In vermiculite, perlite and mixed matrix (vermiculite: perlite 1: 1), the effect of the semi-lignetized cuttings of Pyracantha fortuneana was better than that of the latter (vermiculite: perlite 1: 1). The survival rate and rooting rate of the three groups were all higher but no significant difference. With the exception of adventitious root length, vermiculite and perlite were the most suitable for rooting and seedling formation of semi-perennial cuttings. This is inconsistent with the report of Deng et al.[19] in the perennial herbaceous plant. It may be related to the different species of experimental materials. Both perlite and vermiculite belong to light matrix with small bulk density and large porosity. If used separately, perlite has poor water retention although it has larger void and better permeability; vermiculite has strong water retention, but its pore space is smaller than that of perlite, and its permeability is a little worse than that of perlite. The combination of the two can make the advantages and disadvantages of a single substrate complement each other, and it is an ideal cutting medium, which is more conducive to the growth of root system[20].

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