

Timing and Hormones Affected Rooting of Stem Cuttings of *Magnolia grandiflora* L.

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Abstract: *Magnolia grandiflora* L. (southern magnolia) is an evergreen tree native to the southeastern US. It is a popular and important landscape plant and shade tree because of its glossy green leaves and large white fragrant flowers. So far its clonal propagation has mainly relied on grafting and rooting of stem cuttings has rarely been reported although it has been introduced and cultivated for more than one hundred years in China. To meet the increasing of market demands on the clonal reproduction, we carried out the stem cutting propagation in March, June, August and November 2007 from 5–8-year-old plants and treated with various concentrations of IBA and NAA. *Magnolia grandiflora* could be vegetatively propagated by stem cuttings. Timing played a vital role on the rooting of southern magnolia and the cuttings collected in November produced 70.8% of rooting. Cuttings collected in June rooted up to 40.6% and only less than 21.9% of rooting was observed from the cuttings collected in March and August. Rooting hormones significantly affected the rooting of southern magnolia and the highest rooting rate, 70.8%, was obtained under the treatment of K-IBA at 20 g/L. K-IBA concentrations at 10 g/L yielded 60.4% rooting rate. Both higher (40 g/L) K-IBA concentrations reduced the rooting. The rooting percentage of K-NAA at 5, 10, and 20 g/L were 58.3%, 50%, and 60.4%, respectively. *Magnolia grandiflora* could be regenerated from stem cuttings and the better time to collect the cutting should be November. Both K-IBA and K-NAA could increase its rooting rates and the recommended concentrations should be 10–20 g/L for K-IBA and 5–20 g/L for K-NAA. Researchers and growers should focus on the selection of new southern magnolia clones and propagate them by stem cuttings.

Key Words: Cutting propagation; *Magnolia grandiflora*; Rooting hormone; Rooting rate; Timing

1 Introduction

Magnolia grandiflora L. (southern magnolia), a member of Magnoliaceae, is indigenous to the southeastern US (Ye *et al* 2003). It is an evergreen tree and has about 125 cultivars up to now (Dirr and Heuser 1987). This plant has commonly used as garden specimen plant and shade tree and could be pruned as green hedges (Callaway 1994; Li 1999; Shi *et al* 2006; Wang 1991). People love its various habit, foliage colors, and magnificent fragrant flowers. The plant tolerates many

soil conditions and resists low temperature to -19°C (Dirr 1998; Jiang *et al.*, 2000; Yang *et al.*, 2006). As an important landscape and shade tree, southern magnolia was introduced to China about one hundred years ago and performed well from subtropical to temperate China (Liu *et al.* 2004; Mao 2004).

The unique ornamental features and its function in landscape of *Magnolia grandiflora* bring a lot of attention to many horticulturists and gardeners. However, limited researches were conducted on this plant in China and a few reports about the vegetative propagation were founded. Propagation by stem cuttings is the most commonly used asexual method to regenerate many woody ornamental plants (Dirr and Heuser 1987). Lu (2005) reported that southern magnolia could be propagated by softwood cuttings, but no datum was presented. Southern magnolia could be propagated by leaf cuttings (Zhou and Cheng 1987). Once again, no rooting percentage and survival rates were included. In the early twenty centuries, the stem cutting propagation of southern magnolia had been studied (Dirr 1998) in abroad. The famous horticulturists, Dirr and Brinson (1985), had introduced the reproduction methods of this plant. Dirr and Heuser (1987) indicated that stem cutting propagation of southern magnolia was the most economical way to rapidly regenerate this plant. Rooting hormones could be applied to improve rooting rates (Dirr 1998). Other factors, such as timing, rooting media, temperature, humidity, and etc. had significant influence on rooting rates and root quality of southern magnolia stem cuttings (Dirr 1986).

The major reproduction method of southern magnolia in China is seed germination, which could not keep the clonal features. Grafting and layering had been conducted by some propagators and amateur gardeners, but they could not satisfy the marketing demand (Li and Ma 2003; Li *et al.* 2002; Tan *et al.* 2003). Tissue culture, which possesses the advantages of high propagation coefficient, uniform offspring traits, and high yield, had been reported for *Magnolia grandiflora* (Wang *et al.* 2001; Tan *et al.* 2003). No completed system for successfully culturing southern magnolia had been applied in the commercial production. Southern magnolia has a great market potential for its unique characteristics. However, no cultivar was published in China because of limited breeding work and its vegetative propagation difficulty. In this study, we investigated the feasible conditions of rooting southern magnolia stem cuttings.

2 Materials and Methods

2.1 Materials

Current year stem cuttings of *Magnolia grandiflora* were collected from 5–8-year-old plants at the Tian Jiling Forest Farm in Changsha, Hunan province. The cuttings were divided into three types: softwood, semi-hardwood, and hardwood. The propagation media was the mixture of peat-moss and perlite (1:3, by volume). The rooting hormones were potassium salt of indole-3-butyric acid (K-IBA), potassium salt of naphthaleneacetic acid (K-NAA), indolylacetic acid and α -naphthaleneacetic acid (ABT#1), naphthaleneacetic acid (NAA), and powdery indole-3-butyric acid (Hormodin#3).

2.2 Methods

The study was conducted from March to November 2007 in the propagation greenhouses at Central South University of Forestry and Technology in Changsha, Hunan. Terminal stem cuttings were respectively taken in the early morning on 5 March (hardwood), 7 June (softwood), 11 August (semi-hardwood), and 6 November (hardwood). All cuttings were placed into black plastic bags, immediately sprayed water, and then transported to the greenhouses. Each cutting was pruned from the base to an approximate length of 15 cm with 3–4 top leaves. To reduce respiration and other energy loss, two-third leaf area of each remaining leaf on the cuttings was removed. The bottom portion were stripped and received slightly double

wounded. Stem cuttings were treated with distilled water (as the control) and 7–10 rooting hormones, respectively (Table 1). The basal 3–4 cm of each cutting was dipped into the liquid solution for 10 seconds, then air-dry for at least 15 minutes. Some cuttings were dipped into water first, then dusted with Hormodin#3 (powder). All treated cuttings were stuck into the $6 \times 6 \times 8 \text{ cm}^3$ cell in 32-cell flat trays filled with the propagation media. All cuttings were randomly placed on a mist bench covered with 80% shade cloth. The mist system was set for 20 seconds for every 10 minutes in the first week, then 20 seconds for every 20 minutes thereafter during daylight hours.

A randomized complete block design was applied in this experiment. There were four replicates per treatment and eight cuttings per replicate per treatment. Rooting percentage, number of roots per cutting, and total rooting length for each cutting were recorded after four months. All data were analyzed using Excel and SAS software. Mean separation was carried out using the least significant difference method with alpha at a level of 0.05.

Table 1. Treatments of rooting hormones on stem cuttings of *Magnolia grandiflora* in 2007.

TR	Rooting hormones (concentration (g/L))			
	March	June	August	November
I	CK	CK	CK	CK
II	K-IBA(8)	Hormodin#3(8)	Hormodin#3(8)	K-IBA(10)
III	K-IBA(20)	K-IBA(3)	K-IBA(3)	K-IBA(20)
IV	K-IBA(40)	K-IBA(8)	K-IBA(8)	K-IBA(40)
V	Hormodin#3(8)	K-IBA(16)	K-IBA(20)	K-NAA(5)
VI	NAA(8)	NAA(3)	NAA(3)	K-NAA(10)
VII	NAA(20)	NAA(8)	NAA(8)	K-NAA(20)
VIII	NAA(40)	NAA(16)	NAA(20)	K-NAA(10)+ Hormodin#3(8)
IX	K-IBA(12)+ Hormodin#3(8)	ABT#1(3)	ABT#1(3)	
X	NAA(12) + Hormodin#3(8)	ABT#1(8)	ABT#1(8)	
XI		ABT#1(16)	ABT#1(20)	

Notes: TR: Treatments of stem cuttings; CK: Control.

3 Results and Discussion

The results indicated that *Magnolia grandiflora* could be propagated by stem cuttings in different seasons. The rooting hormones had significant influence on the rooting rates and root quality. In March (hardwood cuttings), the rooting rates, obtained from cuttings treated with rooting hormones, had significant difference with control. Control cuttings had no root. The highest rooting rate reached 21.9%, produced from the cuttings treated with liquid K-IBA(40 g/L), which also had

better root quality. Cuttings treated with liquid K-IBA (20 g/L), NAA (20 g/L and 40 g/L), and liquid K-IBA (12 g/L) + powder Hormodin#3 (8 g/L) had significant lower rooting percentages and poorer root quality. Both rooting rates and quality of cutting treated with liquid NAA of 8 g/L, 20 g/L and 40 g/L had no significant effect. Cuttings treated with powder or liquid rooting hormones also had no difference. Powder Hormodin#3 (8 g/L), liquid K-IBA (8 g/L), and liquid NAA (8 g/L) yielded rooting rates of 18.8%, 18.8% and 15.6%, which indicated that hormone types did not had significantly affected on rooting of hardwood cuttings. At the higher level of hormone concentrations, double dips (NAA (12 g/L) + powder Hormodin#3 (8 g/L)) had significantly higher rooting rate than that of double dips (K-IBA (12 g/L) + powder Hormodin#3 (8 g/L)). Unfortunately, the rooting rates were too lower for commercial production (Table 2). It is possible that cuttings might not have enough carbonhydrates after a long winter season.

In June (softwood cuttings), rooting hormones could promote the rooting rates and quality (Table 2). Cuttings treated with liquid K-IBA of 3 g/L, 8 g/L, and 16 g/L had rooting rates of 6.3%, 6.3%, and 18.8%. Cuttings treated with liquid ABT#1 of the same concentrations produced rooting rates of 15.6%, 12.5%, and 12.5%. The highest rooting rate (40.6%) was recorded under the treatment of liquid NAA (16 g/L), which was significantly higher than that of 3 g/L (6.3%) and 8 g/L (15.6%) liquid NAA. Even the softwood cuttings, stem cuttings of *M. grandiflora* needed higher concentrations of hormones to better induce the root. For the hormone formulations, cuttings treated at 8 g/L of Hormodin#3, liquid K-IBA, NAA, and ABT#1 had no significant effect on rooting rate and quality. Obviously, hormone type was not critical for rooting of softwood stem cuttings. The root quality had the similar trend as the rooting rates.

In August (semi-hardwood cuttings), cuttings treated with rooting hormones did not yield better roots than that of the control. At the 20 g/L of liquid K-IBA treatment, cuttings did not produce the root at all. Since the plants in August are in peak fruit development seasons, cuttings might not have enough carbonhydrates to regenerate roots at this season. High concentration of hormones was detrimental to the plants. Our results concluded that cutting propagation of *M. grandiflora* should be avoided in August.

In November (hardwood cuttings), rooting hormones had significantly increased the rooting percentages and root quality. All treated cuttings had the rooting rates from 50% to 70.8%, which were significantly higher than that of the control (10.4%). The highest rooting rate 70.8%, which obtained from the liquid K-IBA (20 g/L) treatment, could be recommended for nursery application. In November, plants were ready for the winter season and much more carbon hydrates were cumulated. With aid of rooting hormones, stem cuttings could be rooted at the commercial feasible rates and produced quality of roots for the market.

Table 2. Effect of rooting hormones on rooting of *Magnolia grandiflora* stem cuttings.

TR	March			June			August			November		
	RP	RN	RL	RP	RN	RL	RP	RN	RL	RP	RN	RN
I	0.0d	0.0b	0.0b	6.3b	1.0ab	5.2ab	6.3a	1.0a	3.2a	10.4c	0.8e	0.9d
II	18.8ab	2.0ab	6.3b	12.5b	2.3ab	12.0ab	6.3a	2.5a	11.2a	60.4ab	6.2cd	29.8bc
III	9.4bcd	1.8ab	4.0b	6.3b	0.5ab	2.4b	15.6a	2.3a	14.0a	70.8a	8.7abc	40.9bc
IV	21.9a	2.7a	6.1b	6.3b	0.8b	4.1b	15.6a	2.2a	9.6a	54.2b	10.4a	48.9ab

TR	March			June			August			November		
	RP	RN	RL	RP	RN	RL	RP	RN	RL	RP	RN	RN
V	18.8ab	1.0ab	3.1b	18.8b	2.9a	18.0a	0.0a	0.0a	0.0a	58.3ab	4.0de	24.8c
VI	15.6abc	1.6ab	7.21b	6.3b	1.3ab	8.6ab	15.6a	1.2a	7.0a	50.0b	6.3cd	37.2bc
VII	9.4bcd	1.5ab	5.6b	15.6b	2.4ab	10.1ab	12.3a	2.0a	10.6a	60.4ab	10.3ab	65.9a
VIII	6.3cd	1.3ab	2.7b	40.6a	2.2ab	10.1ab	3.1a	0.5a	2.7a	58.3ab	6.6bcd	39.6bc
IX	6.3cd	1.5ab	3.0b	15.6b	1.6ab	7.4ab	15.6a	0.9a	4.5a			
X	18.8ab	2.3ab	24.6a	12.5b	1.1ab	6.5ab	15.6a	1.2a	5.1a			
XI				12.5b	2.1ab	11.9ab	9.4a	2.5a	14.3a			

Note: 1) TR: Treatments of stem cuttings;

2) RP: rooting percentage(%), RN: rooting number, RL: rooting length(cm);

3) The same letter has no significant difference among treatments when $a < 0.5$.

4 Conclusion

Timing and rooting hormones had vital effect on the successful propagation of *M. grandiflora* from stem cuttings. Higher rooting percentages, more number of roots, and longer total rooting length could be achieved when stem cuttings were collected in November and treated with liquid K-IBA at concentration of 20 g/L. We recommended that stem cuttings should be collected when they were ready for the winter season. All cuttings should be treated with liquid K-IBA or K-NAA at concentrations of 10 or 20 g/L. Stem cuttings should not be collected after winter or during active growing seasons. Proper management of environmental factors during the rooting period should return higher rooting percentage and better quality of rooted cuttings, which could bring much more profit for propagators and nursery growers.

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