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Effect of Different Concentrations of IBA and Time of Taking Cutting on Rooting, Growth and Survival of *Ficus binnendijkii* 'Amstel Queen' Cuttings

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Abstract

In this research, in order to study the effect of different concentrations of IBA and time of taking cutting on rooting, growth and survival of *F. binnendijkii* 'Amstel Queen' cuttings, a test was conducted in a randomized complete block design with four replications. Treatments were consisted of four levels of hormones: 0 (control), 2000, 4000 and 6000 mg/l, with two intervals of time for taking cuttings (late June and early September). Results showed that highest root percentage, root number and fresh weight of root were for IBA concentrations of 4000 and 6000 mg/l and cuttings taken early in September. The maximum of mean length of root and longest root were achieved in concentration of 6000 mg/l IBA, taking cutting in early September. The highest survival percentage of plants was recorded in concentrations of 4000 and 6000 mg/l IBA, early September being the appropriate time of taking the cutting. The greatest length of new shoots was obtained in concentration of 4000 mg/l IBA, cutting in late June, while the maximum number of new leaf was in IBA concentration of 2000 and 4000 mg/l, with cuttings taken also in late June.

Keywords: auxin, cutting time, *Ficus binnendijkii*, propagation, root length

Introduction

Ficus binnendijkii 'Amstel Queen' is suitable for various applications, known as Ficus Amstel Queen and belongs to family Moraceae. This plant is used for several purposes, including indoor environments and topiary art. This plant is propagated through vegetative method (Shah *et al.*, 2006).

Cutting is at the moment the easiest and cheapest technique to mass propagation and production of plants more uniform and genetically similar to the genitors (Hartman *et al.*, 2011). As in most ornamental plants and fruit trees that are propagated by woody cuttings, physiological stage of the mother plant, time of cuttings taking and the type of growth regulators are very important factors for the success of rooting cutting (Elgimabi, 2008).

Auxin has the effect of speeding up and increasing the rooting percentage of cuttings. Plants produce natural auxin in young shoots and leaves, but the synthetic auxin should be used for successful rooting to prevent cuttings death (Kasim and Rayya, 2009; Stefanic *et al.,* 2007). Several studies have reported the benefit of auxin application in promoting adventitious root development of cuttings. Indole butyric acid (IBA) has been successfully used to rooting of *Poinsettia pulcherrima L.* (Ramtin *et al.,* 2011), *Shores parvifolia* (Aminah *et al.,* 2006), *Camellia japonica* (Blythe *et al.,* 2004) and Stevia *rebaudiana* (Debnath, 2008).

Siddiqui and Hussain (2007) studied the effect of IBA application on rooting of *Ficus hawaii* with varying concentration of IBA (control, 1000 mg/l, 2000 mg/l, 3000 mg/l, 4000 mg/l, 5000 mg/l). They showed that the maximum of length and number of roots per cutting, maximum number of shoots and leaves and highest sprouting percentage was obtained at a concentration of 4000 mg/l IBA.

Tewfik (2002) studied the effect of different concentrations of auxin (0, 2000, 4000, 6000 mg/l) on rooting of *Nemaguard* peach. He showed that the concentration of 6000 ppm IBA has the highest rooting percentage.

The time of taking cuttings plays an important role in success of the rooting and the development of cuttings. This may be related to changes in the indigenous plant growth regulators or carbohydrate conditions and the environmental conditions in nursery (Abdou *et al.*, 2004; Elgimabi, 2008).

Klein *et al.* (2000) in their study on two cultivars of *Myrtus communis* in Palestine, showed that cuttings taken between December-February, had the highest rooting compared with cuttings that were taken in May- August.

Ercisli *et al.* (2002) in their study on kiwi fruits showed that the highest rooting percentage, maximum length and number of root were noted after hormonal treatments of 6,000 mg/l IBA application. Also, taking cuttings in February had better rooting compared with the ones from January.

Considering the positive roles of IBA and cutting time on rooting, in the present study, the effect of different concentration of IBA and time of taking cuttings on rooting,

growth and survival of *F. binnendijkii* 'Amstel Queen' cuttings were studied.

Materials and methods

This experiment was performed in mist greenhouse at Gorgan University of Agricultural Sciences and Natural Resources, Iran, in 2012. The experiment was performed as completely randomized block design, with four replications, each with ten samples of cutting. The treatments included four concentrations of IBA (0, 2000, 4000 and 6000 mg/l) and two time of cuttings taking (in late June and early in September). Cuttings were taken from leafy shoots with 3-4 leaves, considering them to be 15 to 20 cm in length. Bottom of the cuttings were treated with hormone of indole butyric acid (IBA) at different concentrations, for five seconds in each concentration, and then were placed in coco peat and perlite medium at 1:1 ratio. After 50 days, samples were harvested and the interest traits were measured. These traits include the percentage of rooting, longest root length, average root length, roots' number, root fresh weight, length of new shoots, number of new leaves and survival percentage. During the first period (late June), the average temperature of the greenhouse, average relative humidity and the average incoming light inside were 31°C, 73% and 10000 lux, respectively. During the second period (early September), the average greenhouse temperature, average relative humidity and the average incoming light were 26°C, 85% and 7000 lux, respectively. To prevent fungal infection, samples were sprayed with fungicides (benomyl) every 15 days. For measuring the survival percentage, the rooted cuttings were planted in plastic pots in a mixture of garden soil and compost at 2:1 ratio. After 50 days, survival percentage was measured and the number of cuttings that had a good root system, shoots and leaves were counted. After measuring and taking notes, data analysis conducted via SAS software and mean comparison was done using LSD test.

Results

Based on analysis of variance (Tab. 1), the effect of treatments was significant on rooting percentage ($p \leq 0.01$). Mean comparison results (Tab. 2) indicated that IBA concentrations of 6000 and 4000 mg/l and time of cutting in early September have dedicated the highest rooting percentage (100% and 96.66% respectively).

Based on analysis of variance (Tab. 1), the effect of treatments was significant on mean length of root ($p \leq 0.01$). As it can be seen in Tab. 2, IBA concentrations of 6000 mg/l correlated with time of taking cutting in early September has maximum of mean length of roots (6.14 cm).

Based on analysis of variance (Tab. 1), the effect of treatments was significant on longest root length ($p \leq 0.01$). Mean comparison results (Tab. 2) indicated that an IBA concentration of 6000 and time of taking cutting in early September has the longest root length (16.61 cm).

Based on analysis of variance (Tab. 1), the effect of treatments were significant on number of root ($p \leq 0.01$). Mean comparison results (Tab. 2) showed that in terms of roots' number, the highest value was obtained at 6000 and 4000 mg/l of IBA and time of taking cutting in early September (15.69 and 14.27, respectively).

Based on analysis of variance (Tab. 1), the effect of treatments were significant on root fresh weight ($p \leq 0.01$). Mean comparison results (Tab. 3) showed that plants treated with 4000 and 6000 mg/l and time of taking the cuttings in early September have the highest fresh weight of root (0.838 g and 0.767 g respectively).

Based on analysis of variance (Tab. 1), the effect of treatments was significant on length of new shoot ($p \leq 0.01$). As it can be seen in Tab. 3, IBA concentrations of 4000 mg/l + late June has maximum of length of new shoots (5.92 cm).

Based on analysis of variance (Tab. 1), the effect of treatments was significant on number of new leaf ($p \leq 0.01$). Mean comparison results (Tab. 3) showed that plants treated with 4000 and 2000 mg/l + late June have the maximum number of new leafs (2.65 and 2.20 respectively).

Based on analysis of variance (Tab. 1), the effect of treatments was significant on survival percentage ($p \leq 0.01$). Mean comparison results (Tab. 3) indicated that IBA concentrations of 6000 and 4000 mg/l + early September have dedicated highest on survival percentage (98.76% and 98.41%, respectively).

Discussion

As the results showed, the highest rooting percentage and the maximum of root number were obtained in IBA concentrations of 4000 mg/l and 6000 mg/l, while traits such as mean length of root and longest root length were noted for plants treated with 6000 mg/l IBA and reached the highest values. These results are consistent with those obtained by Siddiqui and Hussain (2007) and Tewfik (2002), who stated that increasing IBA concentration, increases rooting percentage, number of roots and roots' length in *Ficus hawaii* and Nemaguard peach, respectively. Natural or synthetic auxin is necessary for root formation on stem. The division of the first cell of root primordia is related to internal or external auxin (Hartman *et al*., 2011). Ingle (2008) showed in their study on rooting of *Stevia* that increasing the concentration of IBA from 50 to 500 mg/l, caused an increase of rooting percentage, root number, root length and fresh weight of root. They stated that the reason may be attributed to enhanced tissue sensitivity and increased rooting via increased internal free auxin.

Ajaykumar (2007) expressed that the increase in length of the roots might be due to an early initiation of roots at higher concentrations of IBA and therefore more utilization of the nutrients due to early formation of the roots. Singh *et al.* (2003) stated that IBA increases rooting and root length in *Piper longum*; they outlined that the reason may be attributed to the action of auxin activity, which might have caused hydrolysis and translocation of carbohydrates and nitrogenous substances at the base of cuttings, and this resulted in accelerating cell elongation and cell division in suitable environment.

Based on the presented results, root fresh weight at the level of 4000 and 6000 mg/l was significantly increased. The increases in number of roots and length of roots have directly influenced the fresh weight of roots (Ingle and Venugopal, 2009). Similar effect has also been observed by Ingle (2008) in *Stevia*. According to the results, it is observed that the highest value of survival percentage was obtained at 4000 mg/l and 6000 mg/l of IBA. Number and

root length and root weight are closely related to the percentage survival of young seedlings. By increasing the number and length of roots at IBA concentrations of 4000 mg/l and 6000 mg/l, contact area of the roots with the soil has also increased. Thus, the roots absorb more water and nutrients and increase the survival rate (Mobli and Baniansab, 2009; Nair *et al.*, 2008).

The results showed that the highest length of new shoots was with IBA concentration of 4000 mg/l, and maximum number of new leafs was obtained in concentration of 2000 mg/l. Auxin concentration has a positive impact in stimulation of growth of pre-formed buds (Ajaykumar, 2007). At high auxin concentrations, it has an inhibitory effect on growth of buds, effect that can be caused by apical dominance (Hartman *et al.*, 2011). It can be reason for the decreasing length of new shoot in the concentration of 6000 mg/l, compared to 4000 mg/l. Chandramouli (2001) showed in their research on *Bursera penicillata* cuttings, that with the increasing of auxin concentration, shoot length and number of leafs also increased. He reported that the probable reason for the increase in length of shoots may be the better utilization of carbohydrates, nitrogen and other nutrients, which has been aided by growth regulators. Shoot growth also increases the number of nodes in the shoot, and therefore leaf number is increased, eventually (Ingle, 2008).

Based on the presented results, the highest rooting percentage, maximum root length, number of roots, most fresh weight of root and highest survival percentage were obtained when cuttings were taken in early September. The amount of endogenous growth regulators, rooting cofactors and carbohydrates are different during the different intervals of growing and for this reason, taking cuttings should be done at a suitable time of the year (Hartman *et al.*, 2011). Curir *et al.* (1992) reported in their study on rooting of *Genista monosperma* cuttings that the effect of cutting time on rooting is associated with the amount of phenolic compound in maternal plant. They showed that the amount of 3-hydroxymandelic acid, known as an inhibitor of rooting, was higher in October and it was reduced in February. In contrast, the amount of Luteolin-7-O glucoside, which is known as stimulator of rooting, was increased in February and reduced in October. These factors causes that rooting was higher in cutting time of February than October. Environmental conditions in the greenhouse can also be effective for rooting of cutting (Nair

Tab. 1. Analysis of variance of treatments effect upon the measured traits

		MS							
Source of variables	df	Rooting percentage	Mean length of root	Longest root length	Number of roots	Fresh weight of root	Length of new shoots	Number of new leafs	Survival percentage
Block	3	12.50	0.08	1.11	0.91	0.02	0.50	0.04	12.08
Treatment	7	1194.64 **	1.26 **	23.56 **	28.36 **	0.14 **	11.34 **	1.82 **	1059.59 **
Error	21	41.07	0.23	1.54	1.01	0.006	0.28	0.18	34.93
CV.%	-	8.68	10.26	12.23	8.70	14.22	21.12	30.52	7.96

Note: No significant differences , ** & *:significant difference at 1% and 5% level, respectively

Tab. 2. Data mean comparison of treatments effect upon root percentage, mean length of root, longest root length and number of roots

(Treatment) IBA concentration (mg/l) + cutting time	Root percentage (%)	Mean length of root (cm)	Longest root Length (cm)	Mumber of roots
0 (control) + late June	46.66 e	4.31 bc	8.45 c	6.86 e
0 (control) + early September	56.66 de	4.26 c	8.57 c	8.69 d
2000 (mg/l) + late June	56.66 de	4.30 bc	8.71 c	9.72 cd
2000 (mg/l) + early September	66.66 d	4.35 bc	8.76 c	10.51 c
4000 (mg/l) + late June	80.00 c	4.54 bc	8.96 c	13.92 b
4000 (mg/l) + early September	96.66 ab	5.13 b	8.54 bc	14.27 ab
6000 (mg/l) + late June	86.66 bc	4.60 bc	11.60 b	12.75 b
6000 (mg/l) + early September	100.00 a	6.14 a	16.61 a	15.69 a

Note: The dissimilar letters in each column indicate significant differences between them in %1 level of probability using LSD

Tab. 3. Data mean comparison of treatments effect upon fresh weight of root, length of new shoots, number of new leafs and survival

(Treatment) IBA concentration (mg/l) + cutting time	Fresh weight of root (g)	Length of new shoots (cm)	Number of new leafs (cm)	Survival percentage (%)
0 (control) + late June	0.195 e	3.76 bc	1.80 b	44.43 d
0 (control) + early September	0.358 d	0.70 d	0.48 d	61.00 c
2000 (mg/l) + late June	0.493 cd	4.00 b	2.20 ab	65.07 c
2000 (mg/l) + early September	0.508 c	0.98 d	0.76 cd	65.81 c
4000 (mg/l) + late June	0.690 b	5.92 a	2.65 a	79.32 b
4000 (mg/l) + early September	0.767 ab	1.02 d	1.02 cd	98.41 a
6000 (mg/l) + late June	0.694 b	2.87 c	1.47 bc	80.73 b
6000 (mg/l) + early September	0.838 a	0.77 d	0.71 d	98.76 a

Note: The dissimilar letters in each column indicate significant differences between them in %1 level of probability using LSD

et al., 2008). High temperature and high light cause heat stress and loss of cutting moisture, which may result in a reduction of rooting in late June, compared with early September. The higher fresh weight of roots may be attributed to the increased number of roots and roots length (Ingle and Venugopal, 2009). The maximum of survival percentage in early September may be related to the environment conditions of the greenhouse, and also can be favored by the increasing number of roots and their length, which has increased the contact area of the roots with the soil, and therefore roots absorb more water and nutrients, and by this increase the survival percentage (Mobli and Baniansab, 2009; Nair *et al.*, 2008).

During the experiment, unlike rooting, the highest length of new shoots and the greatest number of new leaves were noted in late June as the interval of taking cuttings, compared to early September. Suitable environmental and climatic conditions for growth of shoots (more light and high photoperiod) can be the cause for the increase in length of shoots and the number of leaves at time cutting of late June (Abdou *et al.*, 2004).

Conclusions

According to the research results, different concentrations of IBA and time of taking cuttings had a large impact on the success of rooting, growth and survival in cuttings of *F. binnendijkii* 'Amstel Queen'. Auxin concentration of 6000 mg/l and time of taking cutting in early September, were the best treatments that are to be considered for the propagation of *F. binnendijkii* 'Amstel Queen' via cutting.

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