EFFECTS OF DIFFERENT ROOTING SUBSTRATES AND ROOTING GROWTH ENHANCERS ON THE ROOTING OF *FICUS BENJAMINA* CUTTINGS

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ABSTRACT
The species of the Genus *Ficus* are ornamental plants in which rooting percentage is lower than in other plants. This is why we aimed, in our experiment, at multiplying this species using different rooting substrates and several rooting growth enhancers in guided climate factors hothouses. After the *Ficus* cuttings rooted, we could see that the conditions in these hothouses are optimal for this type of operation. After processing experimental data, we could see that both the three types of rooting substrates and the three rooting growth enhancers have different effects on the *Ficus* cuttings' rooting percentage. The first plants that rooted were obtained about 30 days after being planted in the rooting substrate, and the duration of rooting was about 40 days. The conclusion we can draw from our experiments is that rooting and development in *Ficus* spp. depend on both the quality of the culture substrate and the amount of assailable nutrients in the culture substrate.

Keywords: ficus, rooting substrate, growth enhancer, rooting, variance analysis

INTRODUCTION

Ficus benjamina, known as the weeping fig, has a main stem from which grow secondary flexible, arched branches with numerous small leaves intensely coloured, resembling pear-tree ones (CANTOR, 2008). It is a bush or even a small, bushy tree with rapid growth, extremely decorative and elegant due to its leafage (BALA, 2012). It grows dense, elastic branches with arched or even pendant growth. The leaves are small (6-8 cm), slightly waved and with a sharp tip, with a skinny aspect and different shades of green from green-yellowish (very light) to dark green and even very dark green, or brimmed with white, cream or golden shades (KISELEV, 1956).
There are no researches so far in this species, which make the data of our experiment the only ones in literature. To get scientific results that improve the ficus cultivation technology in greenhouses, our researches have aimed at several objectives: the impact of the rooting substrate, bio-growth enhancers and foliar fertilisers on the rooting of ficus cuttings, the growth and development of *Ficus* plants from cuttings after planting in pots, the impact of the type of rooting substrate on root development, the measurement of root length depending on the rooting bio-growth enhancer and on the cultivation rooting substrate.

MATERIAL AND METHODS

The experiment was carried out during three years (2010-2011, 2011-2012, 2012-2013) using ficus cuttings as plant material. These were harvested from mature plants cultivated in pots in protected areas that we selected carefully from the point of view of the phyto-sanitary aspect of the *Ficus* species (*Ficus benjamina*).
To carry out the experiments, we used the following materials:

- rectangular wooden boxes 60x30x15 cm;
- round plastic pots Ø=15 cm, height=17cm.

The *Ficus* plants were established according to the classical technology of multiplication of flowering plants through semi-lignified ficus cuttings. We have chosen this method because ficus cuttings supply a better study material than other multiplication methods.
To produce new plants of *Ficus*, ficus cuttings were planted at two times: 1st (spring: March) and 2nd (fall: October). Ficus cuttings were planted on several rooting substrates of flower soil, in boxes, 4 cm far from one another, and 5 cm deep in the soil.
The experiments were carried out in the greenhouses of the Faculty of Horticulture and Sylviculture of the Banat's University of Agricultural Science and Veterinary Medicine of Timisoara, where climate factors are automated.
The experiment had a polyfactorial character, and the variants were set after the randomised block methods with three replicas specific to forced, protected areas for flower cultivation (CIULCA, 2006). The processing method we used was variance analysis (CIULCA, 2002).
In the experiment, we used cuttings of *Ficus benjamina*: cuttings are parts or fragments of plants cut in a particular way and which, once set to root, remake the organs missing in the new plant. The organs used to get cuttings can be shoots, stems, leaves, buds, roots (CANTOR, 2009). The rooting substrates we used were: sand, perlite, perlite + peat, perlite + peat + sand. These rooting substrates, before being used in the experiment, were disinfected to remove possible sources of diseases and pests.
The growth enhancers we used to root *Ficus* cuttings were Atonik, Radistim and Revital.

RESULTS AND DISCUSSION

Table 1. Analysis of variance for the effect of rooting substrate and growth enhancer on the rooting of *Ficus benjamina* cuttings

Source of variation	SS	DF	MS	F-test
Total	6641.48			
Repetitions	81.29	2	40.65	F=1.83
Rooting substrate	1116.73	3	372.24	F= 16.77**
Growth enhancer	3656.73	3	1218.91	F= 54.90**
Rooting substrate x Growth enhancer	1120.69	9	124.52	F= 5.61**
Residual	666.04	30	22.20	

According to the data presented in *Table 1*, both factors studied had a real, distinctly significant effect on the rooting of the cuttings of *Ficus benjamina*, on the ground of homogeneity of the environmental conditions of the experiment. Growth enhancers had a significantly higher effect (62.04%) on the variability of this feature compared to the effect of the rooting substrates (18.95%).

Table 2. The effect of the rooting substrate on the rooting of *Ficus benjamina* cuttings

Rooting substrate	Mean (%)		Relative value (%)	Difference/ Significance
Perlite - Sand	53.75	42.58	126.23	11.17***
(Perlite+Peat) - Sand	42.67	42.58	100.21	0.09
(Perlite+Peat+Sand) - Sand	50.08	42.58	117.61	7.50***
(Perlite+Peat) - Perlite	42.67	53.75	79.39	-11.08^{000}
(Perlite+Peat+Sand) - Perlite	50.08	53.75	93.17	-3.67
(Perlite+Peat+Sand) - (Perlite+Peat)	50.08	42.67	117.37	7.41***

$LSD_{5\%}$=3.93, $LSD_{1\%}$=5.29, $LSD_{0.1\%}$=7.01

Under the impact of different rooting substrates, the rooting percentage of the ficus cuttings reached 11.17%, with values ranging between 42.58% in sand and 53.75% in the perlite, on the background of a medium variability (11.78%) between the results of the four rooting substrates (*Table 2*). Simple perlite proved to be the best rooting substrate taking into account that it allowed very significant increases in the rooting of ficus cuttings (about 11%) compared to sand and sand + peat.

Table 3. The effect of the rooting growth enhancers on the rooting of *Ficus benjamina* cuttings

Rooting growth enhancer	Mean (%)		Relative value (%)	Difference/ Significance
Radistim - Control	52.58	32.67	160.94	19.91***
Revital - Control	55.08	32.67	168.60	22.41***
Atonik - Control	48.75	32.67	149.22	16.08***
Revital - Radistim	55.08	52.58	104.75	2.50
Atonik - Radistim	48.75	52.58	92.72	-3.83
Atonik - Revital	48.75	55.08	88.51	-6.33^{00}

$LSD_{5\%}$=3.93, $LSD_{1\%}$=5.29, $LSD_{0.1\%}$=7.01

As for the unilateral effect of the growth enhancers, the rooting percentage of the ficus cuttings reached 22.41%, ranging between 32.67% in the control variant and 55.08% in the treatment with Revital, on the background of a high variability (21.31%) between the growth enhancers. As such, the growth enhancer Revital had a higher effect on the rooting of the ficus cuttings compared to the other treatments applied, reaching statistically ensured increases between 6.33% more than in Atonik and 22.41% more than in the control.

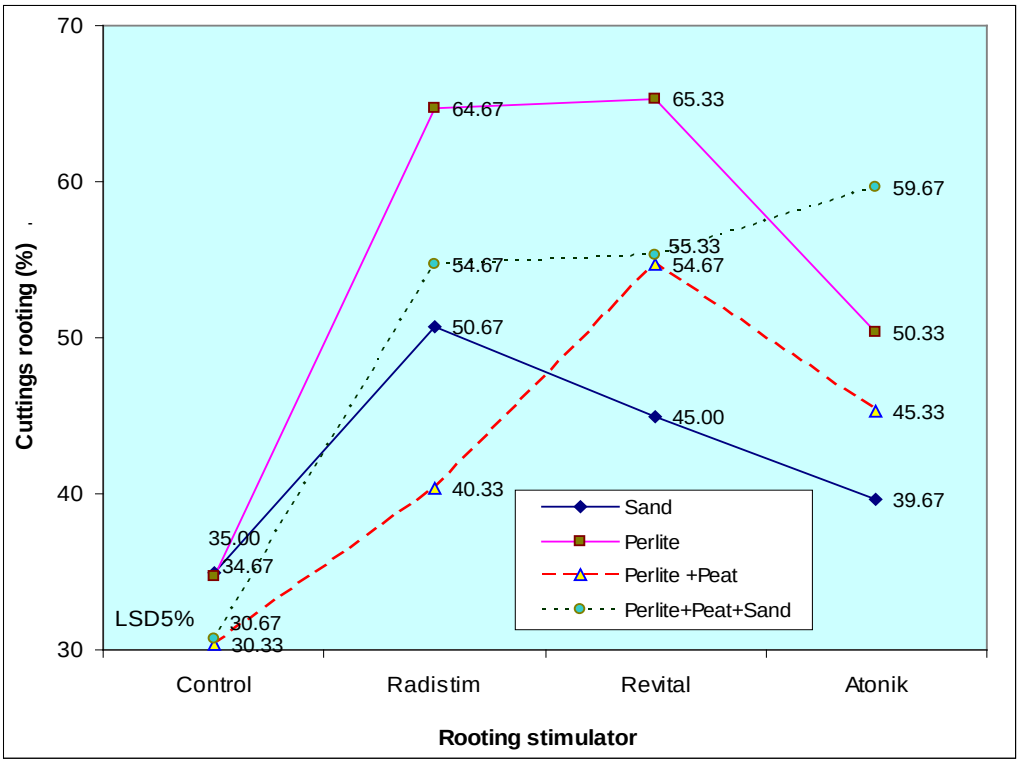

Figure 1. Rooting of *Ficus benjamina* cuttings under the influence of different substrates and enhancers

The rooting percentage of the ficus cuttings on perlite showed a higher variability (26.94%), with an amplitude of 25.47%, and ranging between 34.67% in the control variant and 65.33% in the variant treated with Revital (*Figure 1*). On this rooting substrate, growth enhancers had the highest impact on ficus cuttings rooting. Thus, treatments with Revital and Radistim resulted in a significant increase of the percentage of ficus cuttings rooting compared to the other variants, with increases of over 14.33-30.66%. The treatment with Atonik on this rooting substrate resulted in a significant increase of 15.66% of the rooting process.

The rooting substrate of perlite and peat allowed the ficus cuttings to reach an amplitude of the rooting percentage of 24.34% associated to high variability, but intermediary compared to the other two rooting substrates (23.47%), ranging between 30.33% in the control variant and 54.67% in the treatment with Revital. Thus, on this rooting substrate, the treatment with Revital allowed a significant increase of the rooting percentage compared to the other growth enhancers. The treatments with Atonik and Radistim had similar effects, determining in a significant increase (10-15%) of the ficus cuttings rooting.

On the substrate with a complex composition made up of perlite, peat and sand and under the impact of different growth enhancers, the rooting of cuttings showed an increase of 29%, varying between 30.67% in the control variant and 59.67% in the experimental variant treated with Atonik. Thus, in the case of this rooting substrate, applying treatments with growth enhancers resulted in significant increases of the rooting percentage, i.e. 24-29%.

CONCLUSIONS

Research carried out on the rooting of *Ficus benjamina* cuttings on different rooting substrates and with different rooting enhancers allows us to draw the following conclusions:

- the combined effect of the rooting substrates and growth enhancers was distinctly significant, i.e. 19.01% more variability of cuttings rooting in the *Ficus* species (*Table 1*);
- using a complex mixture of perlite, sand and peat allowed a significantly higher rooting percentage of ficus cuttings, i.e. about 7.5% more than the sand rooting substrate or the mixture of perlite and peat: the sand rooting substrate had an efficacy similar to that of the mixture of perlite and peat on ficus cuttings rooting (*Table 2*);
- treating with Atonik and Radistim resulted in a very significant increase of ficus cuttings rooting, i.e. 16.08-19.91% more compared to the control variant;
- treating with Radistim on the sand rooting substrate was the most effective treatment resulting in a significant increase of the rooting percentage of 11% more than Atonik and 15.88% more than the control variant;
- as for the effect of the different growth enhancers on the ficus cuttings rooting on the four rooting substrates, we could see that the rooting substrate had a real, statistically ensured impact on the efficacy of the treatments.

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