10 *Egypt. J. Hort.* **Vol. 47**, No. 2. pp. 119-128 (2020)

Egyptian Journal of Horticulture
https://ejoh.journals.ekb.eg/

Organic Stimulant Uses in Natural Plant Production

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THIS study focuses on the effects of a commercially available synthetic rooting preparation that includes chemicals of the auxin group with indolebutyric acid (IBA) and natural and organic origin biostimulant on rooting in cuttings, root and twig development. Cuttings of commercially available ornamental plant Trachelospermum jasminoides and potential ornamental plants from natural flora *Hypericum calycinum* and *Hypericum androsaemum* were used in the study. The cuttings were kept at a temperature of 24-26 ^{o}C and humidity of 80-85% in a greenhouse, perlite environment for 90 days. According to the variance analysis results, the application of biostimulants in *T. jasminoides* was more effective in cutting rooting rates (69%), whereas there was no difference between the applications in *H. calycinum* (100%) and *H. androsaemum* (86.67%) species. As for the number of roots, all applications were equally effective in *T. jasminoides* (3.86 pieces) and *H. androsaemum* (2.94 pieces), and biostimulant was the most effective in *H. calycinum* (8.20 pieces). Biostimulant application in total root length, average root length, main root length, total twig length, average twig length, wet root weight data were found to be at the same level or more effective than the other applications. As a result, this study has found that natural species in flora can be successfully produced by using organic origin biostimulants instead of synthetic preparations for landscape applications.

Keywords: Auxin, Organic stimulant, Cuttings, Rooting, Development, Trachelospermum, Hypericum

Introduction

Uncontrolled and senseless use of plant growth regulators causes toxic effects on human and environmental health. Therefore, less harmful chemicals should be preferred, and the use of natural origin chemicals should be encouraged. Manufacturers should be directed to safer chemicals. National and international standards should be established on this matter (Morsünbül et al., 2010).

Synthetic plant growth regulators have widely been used for many years. However, restrictions are imposed in traditional agriculture today due to the harms of certain agricultural practices to natural resources and the environment (Bhargavi et al., 2018). The new policies and restrictions of the European Union on environmental protection and pesticides urge member countries to limit, change and remove active ingredients of synthetic growth preparations (Khan et al., 2009, Pacholczak et al., 2013 and Pacholczak et al., 2017). Substances that are effective in plant development are also supposed to be not harmful to the environment according to the limitations (Pacholczak et al., 2012a).

Production in the modern world now requires a high and consistent balance of productivity for consumers, agricultural workers and the

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(*Received* 01/09/2020, *accepted* 17/11/2020)
DOI: 10.21608/ejoh.2020.41337.1142

environment. A large number of biostimulants are considered safe in the USA (Adams 2014). Most of the compounds found in biostimulants are metabolites of vegetable or microbial origin. Increasing the activity of rhizosphere microbes and soil enzymes, they can enhance the production of growth regulators in soil and plants, and photosynthetic processing (Calvo et al., 2014 and Nardi et al., 2016). When applied at low doses, they are considered safe. Hence, it has been suggested that biostimulants can be used as environmentally friendly products for sustainable agriculture (Thomas et al., 2013 and Yakhin et al., 2017).

With the green revolution, organic, sustainable and environmentally friendly practices have been in effect in the cultivation of ornamental plants recently. The use of biostimulants for adequate, sustainable and high-quality production in modern ornamental plant cultivation is also one of such new approaches (Bhargavi et al., 2018).

Hypericum calycinum is a species with high potential for use as a ground cover plant due to its spreading developmental form, and it is found naturally in the flora of Yalova, Turkey. It is naturally found in shadowed and penumbral areas up to 1200 m above sea level. With its evergreen structure, horizontal development, effectively blooming flowers between May and August, and low water consumption, it has a very high potential for use in ecological landscaping. Although it is already used in some areas, its potential is much higher for the future (Robson 1967 and Aslan 2012). *Hypericum androsaemum* is a natural species found in Europe, West Asia and North Africa. It is deciduous, develops in an upright form, and blooms in yellow during the summer. Its value as an ornamental plant is thanks to its potential to be used as cut greens with its fruits that turn red first, and then black. Although it is currently used as an ornamental plant, it is a species that carries much more potential for future use (Clara et al., 2010 and Reid et al., 2016).

Many plant species in their natural flora are in danger of vanishing due to unplanned development and activities. In the next 30-40 years, approximately 60.000 economical, medicinal and ornamental plants will face this danger (Sharma et al., 1991). The vast majority of species in natural flora have the potential to be used as ornamental plants with floral beauties or green accessories. It is necessary to cultivate these species, study their production techniques and ensure their sustainable use. The production of natural plants with the least harmful methods is one of the primary issues to protect species at risk and to cultivate potential ornamental plants. Sustainability should be at the forefront in cultivation and production studies, the number of which is increasing day by day, and the least harmful chemicals should be used in the environment. This study aims to emphasize the use of organic origin biostimulants in production methods and to suggest that they may be an alternative to synthetic auxins.

As an active substance, a synthetic auxin-based powder rooting preparation (Toniroot), commonly used in routine production and widely available on the market, synthetic auxin (IBA) and Albit®, an organic origin biostimulant, were used in this study. The aim was to compare the effects of such substances on the rooting cuttings and development of commercially available ornamental plant *Trachelospermum jasminoides* and potential ornamental plants from natural flora such as *Hypericum calycinum* and *Hypericum*. It was also aimed to demonstrate the reproducibility of natural species, which can be potential ornamental plants in the flora for landscape applications, with the help of environmentally friendly biostimulants.

Materials and Methods

Materials

In the study, *Trachelospermum jasminoides* (syn. *Rhyncospermum jasminoides*), *Hypericum calycinum* and *Hypericum androsaemum* were used as materials to compare the effects of the preparations on rooting, root and twig growth. *T. jasminoides,* a climber type species*,* is used as an ornamental plant and in the perfume industry. This species has also been used as a potted plant in terraces (Hogan 2003 and Rood 2004).

Auxins most commonly used in rooting ornamental plant cuttings are indole butyric acid (IBA), naphthaleneacetic acid (NAA) and indole acetic acid (IAA). IBA and NAA are the most widely used of these auxins. Generally, either or both are used as a mixture (Hartmann et al., 1990, Ludwig-Müller 2000 and Mason 2004). In this study, Toniroot (powder preparation), which is a mixture containing both auxins and widely used in commercial production, is used as synthetic auxin. Toniroot, which is sold as a ready-made commercial preparation in the market contains 0.032% 2- (1-Naphthyl) Acetic Acid (NAA) + 0.078% 2- (1-Naphthyl) Acetamide (NAD) + 0.066% Indole Butyric Acid (IBA).

Albit®, a biological origin biostimulant, was used as an alternative to synthetic auxins in the study. It is a biological preparation based on bacteria (*Bacillus megaterium*) (Gins et al., 2017). It has been suggested that Albit®, which increases seed germination percentage, seedling growth and plant growth, has been developed as an environmentally friendly product that can be an alternative to synthetic fertilizers and fungicides (Anjorin et al., 2011). Unlike synthetic preparations such as indole acetic acid, indole butyric acid, gibberellic acid, which are frequently used in plant growing, it contains biofungicide, biological fertilizer and anti-stress agent (Anjorin et al., 2010).

The study was conducted between March 23, 2018, and August 20, 2019, in Yalova Vocational School Research and Application Greenhouse.

Methods

Randomized blocks were set up in the trial pattern with 3 repetitions and 100 cuttings in each repetition. Perlite was used as the rooting environment. Cuttings were prepared from a year old, 8-10 cm, twigs with 2-3 knots. Care was taken to keep 1/3 of the cuttings in perlite while planting. Rooting was done at a temperature of 24-26 °C and humidity of 80-85% in greenhouse conditions (Hartmann et al., 1990, Mason 2004). Trials ended 90 days after planting.

The prepared cuttings were treated in a way that their bottoms were completely mixed with powder Toriroot up to 2 cm, and they were planted in rooting pans with perlite as the rooting environment. For the application of Albit®, the cuttings were kept in a solution prepared at a dose of ١cc/l for ١٠ hours, then they were planted in the perlite environment. The stimulant application continued in the form of irrigation from the bottom, which was 5cc/l every 15 days as of planting The application was made by irrigating each parcel with 1 liter of solution. Indole-3-butyric acid (IBA) application was made by dipping into the solution. Having been immersed in the IBA solution that was prepared at a dose of 1000 mg/l for 10 seconds, the cuttings were planted in the perlite environment after 1 minute.

At the end of the trial period in cuttings, the number of rooting cuttings, number of roots, root length, number of twigs, twig length, wet root weight, dry root weight data were counted, measured and weighed.

If at least one 5 mm root had formed on a cutting, the cutting was considered to have rooted. To calculate the total root length, all roots formed on a cutting and the side roots formed on them were measured. For the main root length, the longest single root that had formed on the cutting was measured. The average root length was calculated by dividing the root length of the main root, other roots and the side roots by the number of roots. The twig number was calculated by the number of twigs, which had risen above the rooted cutting, were at least 1 cm long and had at least one leaf formed on them. The number of side twigs formed on the twigs was not included in this count. Total twig length refers to the total length of all main twigs on a cutting and the side twigs if there are any. The average twig length was calculated by dividing the total twig length by the number of twigs. To calculate the wet weight for roots, the cuttings were dismantled and sorted, washed under tap water, abscised from the cuttings, and weighed after they were dried thoroughly. To calculate the dry weight for roots, the samples were dried in an oven at a temperature of 105 °C for 7 hours (until there was no difference between two weighings of the samples). After drying, the samples were cooled and weighed, and their dry weight in mg was determined (Anonymous 2003).

Analysis of variance (ANOVA) was performed to investigate the effect of stimulants on rooting, root and twig development using General Linear Models (GLM) in SPSS Statistics 22.0 (SPSS, 2014). Duncan's multiple range test was applied to test the differences between the treatments when they were found to be significantly ($P<0.05$) different in the main model of ANOVA.

Results and Discussion

The results of the statistical analysis regarding the effects of IBA, synthetic auxin mixtures, commercially available preparation Toniroot and organic origin mixtures on *T. jasminoides*, *H. calycinum* and *H. androsaemum* cuttings and the number of roots are given in Table 1. According to the results of variance analysis, while the organic stimulant had a statistically significant effect ($p<0.05$) on the rooting of *T. jasminoides* cuttings, the effect of synthetic auxin was not statistically significant and was in the same group as the control application. None of the applications had a positive effect on the rooting of *H. calycinum* and *H. androsaemum* cuttings. The number of roots in the rooting cuttings of *T. jasminoides* and *H. androsaemum* species remained at the same level as the control group. In *H. calycinum* species, IBA and biostimulant applications had a positive effect on the number of roots, while Toniroot had a negative effect on the number of roots.

It has been found in the literature that Albit® reduces the pathogens in the root region of sugar beet while increasing the useful microflora (Karpun et al., 2017). Luo et al., 2009, in a study of *Hypericum patulum* species, investigated the effect of NAA and IBA on the rooting of cuttings. They determined that IBA application was to some extent effective on plantlet growth and rooting. In this study, the effect of biostimulant on the rooting of *Hypericum* cuttings was found to be at the same level as synthetic auxins. Similarly, (Monder et al., 2018), reported that Root Juice™ ve Bio Roots increased the rooting percentage of the cuttings taken in different bud stages of Rosa helenae 'Semiplena'. In their studies, (Pacholczak et al., 2012b) and (Pacholczak et al., 2014) compared the preparations containing IBA and NAA with the organic stimulant Algaminoplant and Route on the rooting and root development of Cornus, and they found that Algaminoplant and Route significantly increased root mass and rooting percentage of cuttings. (Ferrante et al., 2013) also observed that Actiwave® (Valagro Spa), a biostimulant, had a stimulating effect on the rooting of *Camellia japonica* cuttings. In a study conducted by (Nicola et al., 2006) on *Mentha×Piperita*, the use of natural rooting hormones for organic farming and environmental protection was recommended although the effects of natural rooting hormones and synthetic auxin group hormones on rooting of cuttings were found to be at the same level (Gomes et al., 2018) investigated the effect of brown seaweed on the rooting of *Passiflora* cuttings. 40% concentration of the organic-based preparation of brown seaweed increased the rooting rate by 10%. (Pacholczak et al., 2016) reported that contrary to all these studies, biostimulator Goteo applications were less effective on rooting of *Physocarpus opulifolius* cuttings than synthetic auxin IBA applications.

The application of organic origin biostimulant was statistically effective on the total root length, main root length and the average root length of the roots on the cuttings of *T. jasminoides and H. calycinum* (Table 2). Biostimulant (186.19 mm) and synthetic auxin preparation application (147.33 mm) were found to be statistically different on the total length of each root of each cutting of *T. jasminoide,* and they were placed in a different group than the other two applications after Duncan's test. Unlike all other applications, biostimulant was found to be effective alone on *H. calycinum.* In terms of the main root length in each cutting, the biostimulant application was the only effective application on *T. jasminoides* and *H. calycinum.* Root lengths of 74.03 mm and 100.61 mm were obtained from them, respectively. When

TABLE 1. Effect of synthetic auxin (IBA), mix commercial synthetic auxins (toniroot) and biostimulant on rooting and root number of *T. jasminoides, H. calycinum, H. androsaemum* cuttings.

Species	Treatments	Rooting (%)	Root number (number)
Trachelospermum jasminoides	Control	61.00 ± 1.55 b	3.32 ± 0.18 a
	Mix. Com. Synthetic Auxin	59.33 ± 0.39 b	4.19 ± 0.73 a
	Biostimulant (Albit)	69.67 ± 0.75 a	3.86 ± 0.09 a
		p = 0.011	p = 0.42
Hypericum calycinum	Control	100.00 ± 0.00 a	6.27 ± 0.62 ab
	Mix Com. Synthetic Auxin	100.00 ± 0.00 a	5.20 ± 0.51 b
	Synthetic Auxin (IBA)	100.00 ± 0.00 a	7.60 ± 0.75 a
	Biostimulant (Albit)	100.00 ± 0.00 a	8.20 ± 0.66 a
		P=0.05	P=0.042
Hypericum. androsaemum	Control	83.33 ± 3.33 a	2.63 ± 0.40 a
	Mix Com. Synthetic Auxin	83.33 ± 3.33 a	2.70 ± 0.30 a
	Synthetic Auxin (IBA)	86.67 ± 3.33 a	3.17 ± 0.28 a
	Biostimulant (Albit)	86.67 ± 3.33 a	2.94 ± 0.49 a
		P=0.802	P=0.747

Values marked with the same letter do not differ significantly at p = 0.05

evaluated in terms of average root length in each rooting cutting, both synthetic auxin mix and biostimulant (Albit) were found to be effective on *T. jasminoides* while biostimulant was the most effective application. While an average root length of 50.05 mm was obtained from the biostimulant application, the synthetic auxin preparation mix was effective in comparison with the control group with 35.55 mm while being in the second group (Table 2). For *H. calycinum*, while all other applications were in the same group as the control, biostimulant was statistically different and most effective application with an average root length of 83.03 mm. For *H. androsaemum*, all applications were found to be ineffective in terms of the data of total root length, main root length and average root length.

The results from *T. jasminoides* and *H. calycinum* species are in parallel with the studies conducted by (Cambri et al., 2008) on the stimulant support on root growth and by (Khan et al., 2009) on the positive effects of biostimulants the root formation and total volume increase in the root system. (Gawronska et al., 2008) also reported that stimulants also increased the tolerance of the plant to environmental and stress conditions. (Pacholczak et al., 2012a) made a Route and Algamino plant+humiplant, an organic stimulant in *Cotinus coggygria,* application and obtained the best results from the Route application in terms of root number and length. The findings obtained from the study are similar to the positive results in the development of root system in *Lilium* bulbs with those of the biostimulant application by (De Lucia et al., 2012) ineffective results obtained from *H. androsaemum* are contradictory results with these studies. This result is thought to be related to the slow development of *H. androsaemum*.

When the roots developed on each rooting steel were analyzed in terms of total live wet weight, the applications were effective at different levels in the species (Table 3.) Biostimulant in *T. jasminoides* was in the first place and a different group with an average weight of 249.42 mg/cutting. Synthetic auxin mix preparation was found to be ineffective and in the same group as control with 178.93 mg/cutting live wet weight. While biostimulant was found to be the most effective application in terms of root wet weight and root dry weight in *H. calycinum*, the mix had an adverse effect with a worse result than that of synthetic auxin control. Biostimulant was found to be more effective in terms of wet root weight in *H. androsaemum*, and synthetic auxin (IBA) was the most effective application in terms of dry root weight.

TABLE 2. Effect of synthetic auxin (IBA), mix commercial synthetic auxins (toniroot) and biostimulant on root length, maximum mean root length and mean root length of T. jasminoides, H. calycinum, H. androsaemum cuttings

Species	Treatments	Total Root Length averages (mm)	Main Root Length averages (mm)	Average Root Length (mm)
Trachelospermum jasminoides	Control	94.38 ± 6.65 b	40.24 ±1.80 b	28.45 ± 0.97 c
	Mix Com. Synthetic Auxin	147.33 ± 23.48 ab	52.54 ±3.05 b	35.55 ± 0.90 b
	Biostimulant (Albit)	186.19 ± 13.02 a	74.03 ±5.57 a	50.05 ± 2.97 a
		p = 0.019	p = 0.002	p = 0.001
Hypericum calycinum	Control	417.24 ± 47.37 b	84.12 ± 4.55 b	64.71 ± 2.52 b
	Mix Com. Synthetic Auxin	305.74 ± 46.92 b	69.69 ± 6.56 b	55.93 ± 5.91 b
	Synthetic Auxin (IBA)	474.25 ± 44.42 b	83.47 ± 2.29 b	58.67 ± 1.46 b
	Biostimulant (Albit)	724.58 ± 81.47 a	100.61 ± 3.91 a	83.03 ± 3.53 a
		p = 0.005	p = 0.010	p = 0.004
Hypericum androsaemum	Control	105.01 ± 23.49 a	44.54 ± 6.93 a	35.58 ± 3.97 a
	Mix Com. Synthetic Auxin	91.71 ± 10.00 a	38.29 ± 1.93 a	32.54 ± 1.36 a
	Synthetic Auxin (IBA)	134.99 ± 86.66 a	48.85 ± 7.07 a	37.36 ± 4.75 a
	Biostimulant (Albit)	128.09 ± 28.33 a	45.85 ± 0.74 a	38.42 ± 0.45 a
		p = 0.482	p = 0.541	p = 0.602

Values marked with the same letter do not differ significantly at p = 0.05

Considering the amount of dry matter per cutting, the roots formed in each steel seem to be ineffective compared to other applications. Synthetic auxin mix with control in *T. jasminoides*, only synthetic auxin mix in *H. calycinum* and synthetic auxin (IBA) with control in *H. androsaemum* were found to be the most effective applications (Table 3).

Harasimowicz-Hermann et al., 2008, also obtained better results from the standard synthetic rooting preparation Korzonek D DS of organic origin stimulant Ashai SL-bios of Salix cuttings in terms of root mass and twig weight. In the study conducted by (Ferrante et al., 2013), the effects of the biostimulant Actiwave® (Valagro Spa) on the rooting of *Camellia japonica* cuttings, as well as its positive effects on wet and dry weight were found significantly different. In our study, the fact that biostimulant applications are found to be ineffective or negative in the dry matter amount data per cutting unlike other data can be attributed to the ratio of the rapid development of the dry matter in the plant, which is a normal and expected result.

Considering the average of twig count per cutting, a higher number of twigs were obtained in the control group and synthetic auxin applications on *T. jasminoides* (Table 4). On *H. calycinum* ve *H. androsaemum*, all other applications were found to be ineffective by being in the same group as the control, whereas biostimulant application was and found effective and placed in a different group. Considering the data of total twig length per cutting, biostimulant application was found to be different and significantly different in comparison with the other applications. Biostimulant application was found effective on *Hypericum* species in terms of the average twig length (Table 4). It is plausible that the inefficiency of the stimulant application on the number of twigs per cutting is because of its apical dominance in parallel with the rapid development of the plant. Growth is more dominant through the twig tip in rapidly growing cuttings with the stimulant support. For this reason, tillering in twigs was low.

The results on the total twig length and average twig length were thanks to the stimulant's acceleration of plant growth [9]. These results are in parallel with those obtained by (Zeljković et al., 2013), (Jawaharlal et al., 2013) and (Bulgaria et al., 2015) on the morphological development improvements of plants with the help of the nutritional supplement features of biostimulants. Also, the results (Parađiković et al., 2017) obtained from the biostimulant applications on the development parameters of *B. semperflorens* are similar to the increase in the plant height and leaf number data (Manda et al., 2014) found with the application of the humic acid and grape seed extract on the *Spathiphyllum wallisii* plant.

TABLE 3. Effect of synthetic auxin (IBA), mix commercial synthetic auxins (toniroot) and biostimulant on live and dry root weight of T. jasminoides, H. calycinum, H. androsaemum cuttings

Species	Treatments	live root weight (mg/cutting)	dry root weight (mg/cutting)	Kuru madde (%)
Trachelospermum jasminoides	Control	142.94 ± 13.40 b	21.91 ± 1.68 a	15.36 ± 0.52 a
	Mix Com. Synthetic Auxin	178.93 ± 8.53 b	28.30 ± 2.0 2 a	15.93 ± 0.97 a
	Biostimulant (Albit)	279.42 ± 21.93 a	31.29 ± 2.98 a	11.26 ± 0.26 b
		p = 0.019	p = 0.108	p = 0.003
Hypericum calycinum	Control	648.67 ± 116.77 ab	52.67 ± 7.86 ab	8.20 ± 0.23 bc
	Mix Com. Synthetic Auxin	360.00 ± 64.43 b	38.67 ± 6.77 b	10.78 ± 0.21 a
	Synthetic Auxin (IBA)	678.33 ± 57.78 ab	47.33 ± 6.83 ab	6.93 ± 0.52 c
	Biostimulant (Albit)	858.67 ± 128.36 a	73.67 ± 12.67 a	8.54 ± 0.65 b
		p = 0.040	p = 0.47	p = 0.002
Hypericum. Androsaemum	Control	94.77 ± 22.74 c	10.32 ± 2.70 b	10.72 ± 1.09 ab
	Mix Com. Synthetic Auxin	118.98 ± 25.49 bc	10.23 ± 2.37 b	8.52 ± 0.17 b
	Synthetic Auxin (IBA)	178.15 ± 5.19 ab	20.65 ± 2.03 a	11.54 ± 0.79 a
	Biostimulant (Albit)	193.01 ± 18.65 a	10.00 ± 1.92 b	5.19 ± 0.75 c
		p = 0.022	p = 0.027	p = 0.001

Values marked with the same letter do not differ significantly at p = 0.05

TABLE 4. Effect of synthetic auxin (IBA), mix commercial synthetic auxins (toniroot) and biostimulant on the number of shoot, total shoot length and mean shoot length of *T. jasminoides, H. calycinum, H. androsaemum* cuttings

Species	Treatments	Average of twig Count (Number)	Total twig length average (mm)	Average twig length (mm)
Trachelospermum jasminoides	Control	1.49 ± 0.0 3 a	36.28 ± 1.16 b	25.21 ± 1.60 b
	Mix Com. Synthetic Auxin	1.56 ± 0.10 a	44.75 ± 1.63 b	29.70 ± 2.55 b
	Biostimulant (Albit)	1.18 ± 0.02 b	71.74 ± 5.00 a	62.70 ± 4.43 a
		P = 0.012	P = 0.000	P = 0.000
Hypericum calycinum	Control	1.77 ± 0.26 b	77.74 ± 6.28 b	46.16 ± 5.84 b
	Mix Com. Synthetic Auxin	1.37 ± 0.28 b	66.58 ± 7.67 b	49.91 ± 4.13 b
	Synthetic Auxin (IBA)	1.43 ± 0.03 b	80.42 ± 14.27 b	55.33 ± 7.91 b
	Biostimulant (Albit)	2.87 ± 0.66 a	293.85 ± 29.46 a	109.62 ± 9.29 a
		P = 0.002	P = 0.000	P = 0.001
Hypericum. androsaemum	Control	0.49 ± 0.20 b	24.90 ± 9.48 b	22.53 ± 5.97 ab
	Mix Com. Synthetic Auxin	0.28 ± 0.18 b	15.34 ± 7.67 b	15.34 ± 7.67 ab
	Synthetic Auxin (IBA)	0.45 ± 1.16 b	24.48 ± 3.40 b	21.78 ± 4.81 ab
	Biostimulant (Albit)	1.68 ± 0.15 a	66.56 ± 3.41 a	41.20 ± 4.31 a
		P = 0.002	P = 0.002	P = 0.044

Values marked with the same letter do not differ significantly at p = 0.05

Conclusion

According to these results, Biosimulant has been found more effective in the rooting of cuttings than synthetic auxin mix on *T. jasminoides* species, equally effective as the other applications on *H. calycinum* and *H. androsaemum* species, more effective than synthetic auxin mix and equally effective as synthetic auxin in terms of the number of cutting roots in *H. calycinum*, equally effective as the other applications on *T. jasminoides* and *H. androsaemum* species, more effective than the other applications in terms of total root length, main root length and average root length in *T. jasminoides* and *H. calycinum* species, equally effective on *H. androsaemum* species, more effective than the other applications in terms of live root weight in *T. jasminoides, H. calycinum, H. androsaemum* species, more effective than the other applications in terms of dry root weight in *H. calycinum* species, equally effective on *T. jasminoides* species, more effective than the other applications in terms of the average of twig count in *H. calycinum* and *H. androsaemum species*, and more effective than the other applications in terms of total twig length and average twig length in *T. jasminoides, H. calycinum and H. androsaemum* species. Biostimulant application for rooting of cuttings has had adverse effects in dry root weight on the development of *H. androsaemum* species, in dry matter ratio on *T. jasminoides*, *H. calycinum*, *H. androsaemum* species, and in the average of twig count in comparison with the other applications on *T. jasminoides* species.

According to these results, it has been found that natural and organic origin biostimulants can be used instead of synthetic origin auxins on the rooting of cuttings of commercial ornamental plant *Trachelospermum jasminoides* and potential natural ornamental plants *Hypericum calycinum* and *Hypericum.* Apart from the dry root weight of cuttings, dry matter ratio and the average of twig count in a species, the biostimulant has either performed equally or better than synthetic auxins. Therefore, it has been found that natural organic biostimulant can be used instead of synthetic origin auxins in nature protection, sustainable production, cultivation of natural species and rooting of cuttings in ornamental plants.

Acknowledgment

We want to thank to Pınar Akay and Prof. Dr. Başak Yücel for their technical support.

Funding statements

No funding sources.

Conflict of interest

The authors declare no conflict of interest.

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استخدامات المنشطات العضوية في إنتاج النباتات الطبيعية

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في هذه الدراسة تمت مقارنة تأثيرات حمض إندوليبوتريك (IBA) ، وهو مستحضر تجذير اصطناعي يحتوي على مواد كيميائية لمجموعة أوكسين ، والتي تُستخدم تجاريًا في السوق ، ومحفز حيوي من أصل طبيعي وعضوي، على نمو الجذور والبراعم في تجذير العقل. في هذه الدراسة، تم استخدام عقل نباتات الزينة التجارية الياسمينويد ونباتات الزينة الكاليسينوم و أندروسايموم الطبيعية. تم حفظ العُقل المعالج في درجة حرارة ٢٤-٢٦ درجة مئوية ، ورطوبة ٨٠-٨٥٪ ، و في دفيئة ، وبيئة بيرلايت لمدة ٩٠ يومًا. بناء على نتائج تحليل التباين، لم يوجد فرق بين التطبيقات في أنواع الكاليسينوم (١٠٠٪) وأنواع الأندروسايموم (٨٦,٦٧٪) بينما وجد أن استخدام المحفز الحيوي أكثر فاعلية في الياسمينويد (٦٩٪) في معدلات تجذير العقل. أما بالنسبة لعدد الجذور ، فإن (عدد ٣,٨٦) من الياسمينويد و(عدد ٢,٩٤) في الأندروسايموم كانت فعالة بنفس المستوى ، و (عدد ٨,٢٠) من المنشطات الحيوية في الكاليسينوم كانت الأكثر فعالية. في بيانات الطول الكلي للجذر ، ومتوسط طول الجذر، وطول الجذر الرئيسي ، وطول الجذع الكلي ، ومتوسط طول الساق ، ووزن الجذر الرطب في استخدام المحفز الحيوي وجد أنه على نفس المستوى أو أكثر فعالية من التطبيقات الأخرى. نتيجة لهذه الدراسة ، تم الكشف عن أن الأنواع الطبيعية في النباتات يمكن إنتاجها بنجاح باستخدام المحفزات الحيوية ذات الأصل العضوي بدلاً من مستحضرات المنشأ الاصطناعية لتطبيقات المناظر الطبيعية.