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The effect of auxins on the rooting of cuttings in several species of *Fabaceae*

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Abstract: *The effect of auxins on the rooting of cuttings in several species of* Fabaceae. In view of their diversity, plants of the family *Fabaceae* are very popular among gardeners and landscape architects. They are used as solitary plants, ground covers or climbers, as well as for mass planting in green urban areas. The aim of this trial was to evaluate the effect of commercial rooting powders containing respectively 0.4% IBA (indolilo-3-butyric acid), 0.2% NAA with 0.1% IBA, and 1% IBA, and a water solution of IBA (200 mg·dm^{-3}), on the rooting of three *Fabaceae* species: *Cytisus decumbens*, *Genista tinctoria* 'Royal Gold' and *Wisteria floribunda* 'Ludwik Lawin'. The tested preparations significantly improved the degree and percentage of rooting in cuttings of all taxa. For *W. floribunda* and *G. tinctoria* the best results were obtained from the application of the preparations containing 1% IBA and 0.2% NAA with 0.1% IBA, while in the case of *C. decumbens* the rooting powder with 0.4% IBA was equally effective. Foliar application of the water IBA solution gave results comparable to the rooting powders in dyer's broom, while in wisteria its efficiency was lower than that of the commercial preparations.

Key words: IBA, ornamental shrubs, propagation, rooting powders

INTRODUCTION

Vegetative propagation is the most popular method used to propagate plants of the *Fabaceae* family in commercial nurseries. Non-commercial methods include layering, used for the genera *Caragana* and *Wisteria*. Most leguminous plants are propagated by semi-lignified cuttings harvested in July–August, or in June in the case of bean-tree. In dyer's broom the rooting of such cuttings lasts longer than in other *Fabaceae* species [Hrynkiewicz-Sudnik et al. 2001, Hartmann et al. 2011].

Root formation is induced and controlled by endogenous and exogenous factors, such as temperature, light, plant hormones and organic compounds. Phytohormones directly affect plant regenerative abilities. Auxins are especially important for the control of growth and development, including formation of adventitious roots [Šebánek 2008]. Nowadays, foliar application of rooting stimulators is broadly used in the production of leafy ornamental shrubs. For over a century it has been known that substances produced in the leaves control the growth of other plant parts. Auxins from water solutions may be applied on leaves, as they penetrate the inner tissues through the stomata and pass to the plant conductive system, where they move basipetally affecting rhizogenesis in cuttings [Kroin 2014]. Since the discovery

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of natural plant hormones [Thimann and Went 1934] and production of synthetic growth regulators, auxins have been systematically used to stimulate rooting of cuttings. Indolilo-3-butyric acid (IBA) is the most frequently used auxin, being a more effective hormone than indolilo--3-acetic acid (IAA) [Pop et al. 2011]. Water IBA solutions are now widely used by producers of annual, perennial and woody plants. The high efficacy of water auxin solutions was proved by Davies [1980, 1982a, b]. The commercial method of foliar auxin application developed by Kees Eigenraam in 1985 was first used by Dutch chrysanthemum growers [Kroin 2014]. Later, studies carried out by nurserymen led to the extension of this method to woody plants [Drahn 2007].

The aim of this work was to evaluate the effect of several commercial rooting powders on the degree and percentage of rooting in cuttings of *Wisteria floribunda* 'Ludwik Lawin', *Genista tinctoria* 'Royal Gold' and *Cytisus decumbens*. The development of an efficient method of rooting will allow to lower the production costs of leguminous plants and their market prices. This will further increase the popularity of leguminous plants and result in their more frequent planting in urban green areas and in private gardens.

MATERIAL AND METHODS

The experiment was carried out on three taxa of woody shrubs: *C. decumbens*, *G. tinctoria* 'Royal Gold' and *W. floribunda* 'Ludwik Lawin' at the M.M. Kryt commercial nursery in Wola Prażmowska near Warsaw. Two nodal cuttings approx. 5 cm long were made in on July 1, 2014, from shoots harvested from four-year-old stock plants growing outdoors. In each species there were three replicates, each including 20 cuttings. The cuttings were rooted in styrofoam flats filled with a peat substrate of pH 4.9–5.1. The flats with cuttings were placed under a tunnel covered with double milky foil and equipped with an irrigation/mist system. On the first day the cuttings were treated with the fungicide Topsin (0.1%), and later every 10 days with Bravo (0.2%), Teldor (0.1%) or Previcur (0.1%). Substances applied to stimulate rooting were commercial powders containing auxins: 0.4% IBA, 1% IBA, and 0.2% NAA with 0.1% IBA. A water solution of IBA (200 $mg \cdot dm^{-3}$) was applied on leaves, and untreated cuttings formed the control treatment (Table 1). Conditions under the tunnel where the cuttings for measurements were grown and sampled were 24–28°C, RH 90–100%.

TABLE 1. The experimental treatments

Treatments and active substances	Application method
Control	–
Water solution 200 $mg \cdot dm^{-3}$ IBA	spraying of cuttings
Powder 0.4% IBA	powder applied on base of cutting
Powder 1% IBA	powder applied on base of cutting
Powder 0.2% NAA, 0.1% IBA	powder applied on base of cutting

On August 7 the experiment was ended, the rooted cuttings counted and the root ball development evaluated on

a five-point evaluation scale, where one represented an unrooted cutting and five represented a cutting with the best developed root system (Table 2).

TABLE 2. Evaluation scale of root development

Characteristic of the degree of rooting	Score
Cutting without visible roots	1
A few (1–3) short roots	2
4–5 roots, some of them branched, no root ball formed	3
Medium-sized root system composed of 6–10 branched roots forming a root ball	4
Well-developed, branched root system forming a root ball (over 10 roots)	5

To compare the means, percentages of rooted cuttings were transformed according to Bliss [Wójcik and Laudański 1989], while the degree of rooting was subject to root transformation: $y = x^2 + (x + 1)^2$. All of the data underwent one-factorial ANOVA followed by Duncan's test at $p = 0.05$. The Statgraphics 4.1 program was used.

RESULTS

In *C. decumbens* the rooting percentage was 90% for the control cuttings, and 100% for those treated with auxin – either in powder form or as a foliar application (Fig. 1). The least developed root ball was observed in the untreated control cuttings, which attained a score of 3.3, while in cuttings treated with any of the three powders the score was improved by more than one unit. There was no statistical difference in root ball development between the two powders containing only IBA (0.4% IBA and 1% IBA) and the foliar IBA application, but the powder containing IBA and NAA was significantly better than the water solution of IBA alone.

In *G. tinctoria* 'Royal Gold', application of any of the three rooting powders resulted in 100% rooting, while the untreated control cuttings and those sprayed with the water IBA solution had a rooting percentage of 90% (Fig. 2). The root ball in the control treatment was poorly developed (1.75). Applica-

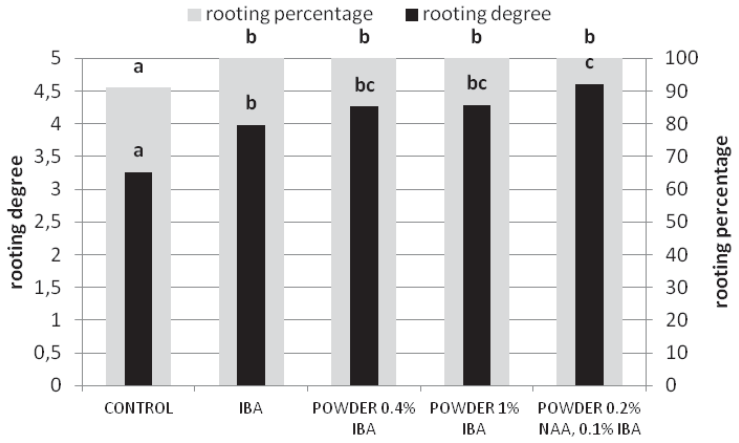

FIGURE 1. The effect of the treatments on rooting degree and percentage of rooted cuttings in *Cytisus decumbens* (means marked with the same litter are not significantly different at $p = 0.05$)

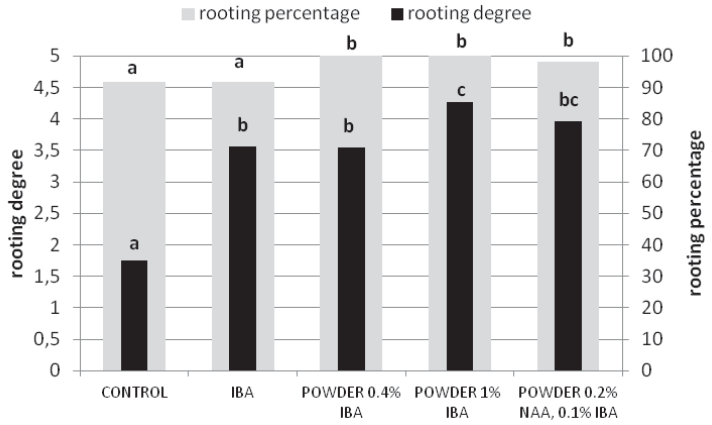

FIGURE 2. The effect of the treatments on rooting degree and percentage of rooted cuttings in *Genista tinctoria* 'Royal Gold' (means marked with the same litter are not significantly different at $p = 0.05$)

tion of the powder with 0.4% IBA or spraying of cuttings with the water IBA solution doubled the score (3.5), while use of the powder with 1% IBA and that containing 0.2% NAA plus 0.1% IBA further improved the degree of rooting, to 4.3 and 4.0 respectively.

The rooting percentage for control cuttings of *W. floribunda* 'Ludwik Lawin' was 70% (Fig. 3). Foliar IBA application did not improve the percentage, while the powder with 0.4% IBA produced a small but significant increase (to 79%). For cuttings treated with the powders containing 1% IBA and 0.2% NAA with 0.1% IBA the percentage was 90%. Root ball development in the control cuttings was poor, with a score of 2.2. Spraying cuttings with the water IBA solution gave a slight but significant

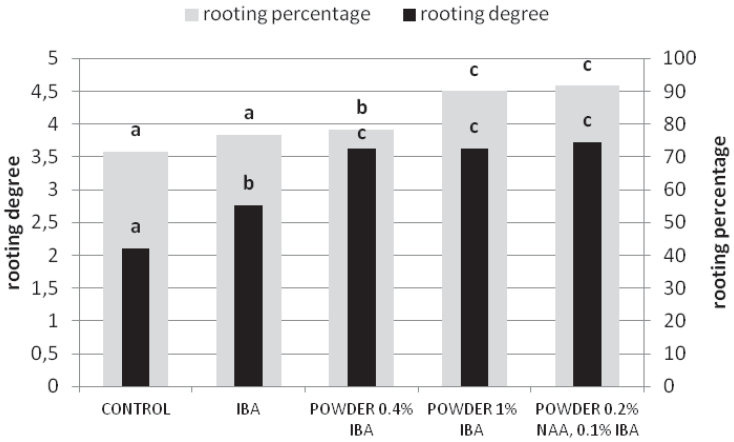

FIGURE 3. The effect of the treatments on rooting degree and percentage of rooted cuttings in *Wisteria floribunda* 'Ludwik Lawin' (means marked with the same litter are not signifcantly different at $p \leq 0.05$)

rise in the degree of rooting (2.8), while in cuttings treated with each of the three powders the score was over 3.5.

DISCUSSION

To obtain plants with well-developed root systems and vigorous above-ground parts, nurserymen use growth stimulators. Rooting powders containing auxins are used to increase the percentage of rooted cuttings, to improve root ball development and to shorten the production cycle, as the auxins enhance the initiation of roots and increase their number [Jankiewicz 1997]. IBA and NAA are acids commonly used in commercial plant production because of their effects on root development [Parađiković et al. 2013]. Rooting powder containing 1% IBA significantly improved the rooting of cuttings in all three species included in this study. The positive effects of Rhizopon AA on the rooting of stem cuttings in ninebark 'Dart's Gold' and 'Red Baron', dogwood 'Aurea' and 'Elegantissima' and smoke tree 'Royal Purple' were reported by Jacygrad and Pacholczak [2010] and Pacholczak et al. [2012, 2013b, 2015]. To stimulate rhizogenesis in smoke tree 'Royal Purple', which is difficult to root, Rhizopon AA containing 2% IBA was used [Pacholczak et al. 2013a]. According to Aminah et al. (2006) IBA in the lower concentration of 0.8% gives a satisfactory percentage of rooted cuttings in *Shorea parvifolia* and *Sh. macroptera*. By contrast, Badji et al. [1991] showed that cuttings of *Acacia senegal* treated with the much higher IBA concentration of 8% achieved 70% rooting over two months, while 2% IBA gave only 30% rooted cuttings. Bąbelewski and Strzelecka [2006] obtained an increase in the percentage of rooting in boxwood cuttings using the powder preparation Ukorzeniacz AB, which proved better than foliar application of IBA. Also, according to Czekalski [1998], boxwood cuttings treated with the powder Ukorzeniacz A rooted twice as well as the untreated controls. Blazich [1988] is of the opinion that IBA is more effective than NAA. The opposite was shown by Czekalski [2003], who tested the effect of three root stimulators on rhizogenesis in *Aphelandra squarrosa*. He showed that Ukorzeniacz AB, which apart from IBA also contains NAA, improved rooting, although it did not significantly affect the percentage of rooted cuttings. In the present trial, powder with 0.2% NAA and 0.1% IBA gave good results in all three species, similarly as in the experiment of Kapczyńska and Kubińska (2007) on rooting of gentian cuttings, where the preparation improved the rooting degree. According to Bhattacharjee and Balakrishna [1983], NAA (4,000 $mg \cdot dm^{-3}$) increased the percentage of rooted bougainvillea cuttings to 80%. Also, Bąbelewski and Szajsner [2014] reported that juniper cuttings treated with Ukorzeniacz AB (0.2% NAA and 0.1% IBA) had better developed root balls than the control cuttings.

In this work the efficiency of foliar auxin application was compared with that of the powders applied to the bases of cuttings. The results of the foliar IBA were comparable to those resulting from the use of the powders only for *C. decumbens*, while in the other two

taxa the results were inferior. Similarly, Szydło and Maksim [1997] showed that spraying cuttings of *Juniperus chinensis* 'Stricta' and *J. scopulorum* 'Skyrocket' and 'Blue Heaven' with water IBA solution was less effective than using a rooting powder.

The above results show that auxins improved the rooting of the tested taxa of the family *Fabaceae.* Our observations may be useful for further investigations into improvement of propagation methods for ornamental woody plants. Such investigations are necessary, as each taxon even within a given family may differ in its response to an auxin and the form of its application.

CONCLUSIONS

1. Rooting powder containing 1% IBA and a powder with 0.2% NAA and 0.1% IBA were the most suitable auxin-containing preparations for the rooting of cuttings in *W. floribunda* 'Ludwik Lawin' and *G. tinctoria* 'Royal Gold', while in *C. decumbens* the powder with 0.4% IBA was equally effective.
2. Foliar application of the IBA water solution gave results comparable to the rooting powders in dyer's broom, while in wisteria its efficiency was lower than that of the powders.

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Streszczenie: *Wpływ auksyn na ukorzenianie sadzonek wybranych gatunków z rodziny* Fabaceae. Rośliny z rodziny *Fabaceae*, dzięki swej różnorodności, cieszą się dużym zainteresowaniem wśród ogrodników oraz architektów krajobrazu. Są stosowane zarówno jako rośliny solitorowe, okrywowe, pnące, jak i wykorzystywane do masowych nasadzeń w przestrzeni miejskiej. Celem pracy było sprawdzenie wpływu wybranych preparatów auksynowych zawierających odpowiednio: 0.4% IBA, 0.2% NAA i 0.1% IBA, 1% IBA oraz wodnego roztworu kwasu indolilo-3-masłowego (IBA 200 mg·dm^{-3}), na ukorzenia-

nie trzech gatunków z rodziny *Fabaceae*: *Cytisus decumbens*, *Genista tinctoria* 'Royal Gold' oraz *Wisteria floribunda* 'Ludwik Lawin'. Wykazano, że zastosowane preparaty istotnie poprawiły stopień oraz procent ukorzenionych sadzonek. W przypadku ukorzeniania sadzonek glicynii kwiecistej i janowca barwierskiego najlepsze wyniki uzyskano po zastosowaniu dwóch preparatów: jeden zawierający 1% IBA oraz drugi mający w swym składzie 0.2 % NAA i 0.1% IBA, zaś u żarnowca położonego równie dobrze zadziałał ukorzeniacz zawierający 0.4% IBA. Dolistna aplikacja wodnego roztworu IBA dała porównywalne wyniki do ukorzeniaczy w formie pudrów dla sadzonek żarnowca, a w przypadku glicynii jej wydajność była mniejsza w stosunku do preparatów handlowych.