The Potential for New Auxins: Evaluation of Indole-3-Succinic Acid©

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INTRODUCTION

Indole-3-acetic acid (IAA) was described in the mid-1930s. It is the principal, most abundant, and most physiologically relevant natural auxin (Thimann and Went, 1934; Thimann and Koepfli 1935; Blazich, 1988; Armstrong et al., 2002; Taiz and Zeiger, 2002). At high concentrations, IAA and other auxins enhance adventitious root formation, which is of paramount importance to horticultural practitioners who rely on the initiation of adventitious roots when propagating plants asexually.

After the discovery of IAA, synthetic auxins were discovered or developed. Potency and stability account for the widespread use of these chemicals. Asexual propagation of many plants without synthetic auxins is almost unimaginable. Indole-3-butyric acid (IBA) and naphthleneacetic acid (NAA) are commonly used auxins today, but some plants are not responsive. Perhaps certain plants lack chemical receptors necessary for any form of auxin to be effective at promoting roots on detached stems. But it is at least equally plausible that new chemical forms of auxin could be developed that will overcome recalcitrance. Variation in the efficacy of known auxins among species justifies efforts to develop and evaluate alternative auxins. Indeed, the potential value of new auxins has been recognized for at least two decades (Blazich, 1988).

The *R* and *S* enantiomers of indole-3-succinic acid (ISA) were found by Armstrong et al. (2002) to be more potent promoters of root growth than IAA and IBA on stem cuttings of a *Fuchsia* hybrid. Enantiomers are chemical compounds that are mirror images of each other and that cannot be superimposed. Because the *R* and *S* enantiomers of ISA led to different responses, Armstrong et al. (2002) recommended that racemic ISA (an equal mixture of the two forms) be used to "elicit a broader range of responses than other simple synthetic auxins that currently are in use." Based on the published results with *Fuchsia*, our objective was to compare root development on stem cuttings of several woody taxa treated either with racemic ISA or with preparations of auxin available commercially.

MATERIALS AND METHODS

During 2004, complementary trials were conducted in Ames, Iowa, and Quincy, Florida, with *Hamamelis virginiana* L. and *Morella cerifera* (L.) Small (syn. *Myrica cerifera* L.). Stem cuttings from current-season wood were collected on 10 June and were assigned to each of five treatments. Bases of control cuttings were dipped in water before sticking in coarse perlite, whereas bases of other cuttings were dipped in either 100% or 50% strength Hormex (contains NAA and IBA), or in a solution of racemic ISA at 10^{-7} or 10^{-8}. Rooting was assessed on 20 August.

In 2006, softwood cuttings of *Daphne* ×*burkwoodii* 'Carol Mackie', *M. cerifera*, and *Diervilla lonicera* Mill. were obtained on 21 July in Ames, Iowa. The bases of control cuttings were dipped in water before sticking in coarse perlite, whereas other cuttings were dipped in either Rhizopon (Hortus USA Corp., New York, New York; active ingredient is IBA), or in a solution of racemic ISA at 10^{-1}, 10^{-2}, 10^{-4}, 10^{-8}. Root development on all cuttings was measured after 7 weeks.

RESULTS

Rooting percentages for *H. virginiana* treated in 2004 in Iowa were 67 (control), 75 (100% Hormex), 75 (50% Hormex), 83 (ISA at 10^{-7}), and 83 (ISA at 10^{-8}). Rooting for the same species/treatments in Florida were 58%, 75%, 58%, 67%, and 58%. Statistical analysis showed no differences among these values within locations. In Iowa, the number of roots on cuttings that rooted was highest after treatment with Hormex. There were 34 roots per cutting on average over both Hormex treatments. Statistically, this exceeded the 13 roots that, on average, were present on rooted cuttings in the other treatments. In Florida, an average of 14 roots formed on rooted cuttings in both Hormex treatments. Statistically, that was more than the root number on control cuttings (seven) and on cuttings treated with ISA at 10^{-8} (six), but not more than cuttings treated with ISA at 10^{-7} (nine).

Both the control treatment and ISA at 10^{-8} led to 100% rooting of *M. cerifera* in Iowa in 2004. Hormex at 50% led to statistically poorer rooting (75%), while the other two treatments led to intermediate rooting (both 92%) that did not differ statistically from the other rooting percentages. In Florida, there was 83% rooting among cuttings of *M. cerifera* treated with ISA at 10^{-7}. Cuttings treated as controls and those treated with 50% Hormex rooted at statistically similar percentages (67 and 58, respectively), while ISA at 10^{-8} and 100% Hormex led to statistically lower rooting (42 and 33%, respectively). Treatments did not affect the average number of roots per rooted cutting. In Iowa, the overall mean was 24 roots, while in Florida it was 8.

In 2006, all cuttings of *D.* ×*burkwoodii* 'Carol Mackie' rooted. More roots (24) were present on cuttings treated with Rhizopon than on cuttings in all other treatments (average = 7). Length of the single longest root was 221 mm for cuttings treated with Rhizopon, whereas the average was 116 mm for cuttings in all other treatments. For *M. cerifera*, the three weakest concentrations of ISA maximized rooting at 92%. ISA at 10^{-1} led to 79% rooting, Rhizopon to 63% rooting, and cuttings treated as controls rooted at 54%. Statistically, root number for rooted *M. cerifera* in the six treatments did not vary statistically and averaged six per cutting. Likewise, length of the longest root among rooted cuttings showed no treatment effect and averaged 39 mm. No cuttings of *D. lonicera* rooted.

DISCUSSION

The information we present here is representative of data collected over several years with other woody and herbaceous species, including *Alnus maritima* (Marshall) Muhl. ex Nutt. subsp. *oklahomensis* Schrad. & Graves, *Kolkwitzia amabilis* Graebn., *Tradescantia zebrina* hort. ex Bosse, *Leitneria floridana* Chapman, *Cerastium tomentosum* L., and *Sphaeralcea remota* (Greene) Fernald (syn. *Iliamna* *remota* Greene). Overall, we find little evidence that ISA as we have used it is more effective than auxins now marketed in horticultural commerce. The only instance when some strengths of ISA promoted higher rooting percentages than did the control treatment or other auxins was the trial in 2006 with *M. cerifera*. In that experiment, however, a talc-based auxin (Rhizopon) was the only commercial auxin used. When auxin was applied in liquid to *M. cerifera* in 2004, 50% Hormex led to a rooting percentage similar to the 100% rooting achieved both with ISA at 10^{-8} and with the control treatment.

The case against ISA as a superior rooting agent is strengthened by the fact that we have evaluated taxa that range from easy to difficult to root. Taxa like *D.* ×*burkwoodii* 'Carol Mackie' and *T. zebrina* rooted readily without auxin, and ISA did not promote more or longer roots than did other auxins. The most recalcitrant taxon was *D. lonicera*. While Rhizopan, the commercial auxin used in that trial, was ineffective, so was ISA. The case against ISA is enhanced further by the fact that our trials were done in two disparate regions of the United States; support for ISA as a superior rooting agent was not found despite the range of conditions in Iowa and Florida.

CONCLUSION

We concur with Armstrong et al. (2002) that ISA acts as an auxin. But we were unable to substantiate claims that ISA is an especially potent promoter of rooting. We cannot rule out the possibility that ISA might be superior to auxins now in the marketplace for certain plants under some conditions. Other methods of applying ISA could be attempted. Indeed, Armstrong et al. (2002) kept cut stems in ISA solutions as roots formed. We chose to use methods more like those used in commercial horticultural settings. While our results with a range of taxa at two climatically distinct locations might seem to argue against additional intensive trials with ISA, the superior results reported by Armstrong et al. (2002) are as valid biologically as those we report here. Therefore, additional effort might be focused on defining the conditions under which ISA does promote superior rooting, at least for selections of *Fuchsia*.

LITERATURE CITED

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