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Effect of Some Benzyl Alcohols on Rooting of Bean Cuttings

Adelina Vázquez, Pilar Rodríguez, and Javier C. Torron

Plant Physiology. Instituto de Investigaciones Agrobiológicas de Galicia, C.S.I.C., Santiago de Compostela, Spain

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Abstract. The root differentiating properties of various benzyl alcohols were studied using a bean rooting test. The results showed that the methoxy derivatives enhanced rooting more efficiently than did the hydroxy derivatives. Only 4-hydroxybenzyl alcohol inhibited rooting, but the addition of IAA at 10^{-5}M nullified the inhibition. Root promotion by the alcohols with a hydroxy group in the o- or p- position was increased by the addition of IAA. Auxin did not modify the rooting stimulation caused by the methoxy derivatives. The position of the methoxy group did not influence the rooting activity.

The rooting process involves not only natural plant hormones, but also other compounds, such as phenolics (Basu et al. 1969, Girouard 1969, Hackett 1970, Haissig 1974, Morsink and Smith 1975, Lipecki and Selva 1978). According to Hess (1964) these nonhormonal compounds, called "rooting cofactors," may be responsible for the differential root initiation of easy- and difficult-to-root plants. The type or amount of the rooting cofactors seems to determine in part whether a plant initiates roots easily, with difficulty, or not at all. The induction of roots by the rooting cofactors frequently requires the presence of auxin. Elucidation of the role of such factors in the rooting process and how they interact with auxin in controlling rooting is complicated because of the diversity of these bioactive substances. A greater understanding of their mode of action may have significance for plant development and productivity.

During a study of phenolics in chestnut, Gesto et al. (1981) detected a large amount of vanillyl and salicyl alcohols in a root-stimulating zone of the chromatograms of the extracts from cold-stored cuttings of old plants and also of

juvenile plants (unpublished data). Modification of rooting by hydroxybenzyl alcohols has not yet been studied. It therefore seemed worthwhile to investigate whether these alcohols play a role in the rooting process. This paper reports the rooting effect of vanillyl, salicyl, isovanillyl, veratryl, 4-hydroxybenzyl, 2-methoxybenzyl, 3-methoxybenzyl, and 4-methoxybenzyl alcohols on hypocotyls of bean. The interaction of these alcohols with IAA was also studied.

Materials and Methods

The bean rooting test used was that described by Vázquez (1973). Plants of bean (*Phaseolus vulgaris* L. cv. Contender) were grown in perlite in a growth chamber (12-h day, 25°C days, 18°C nights). Uniform plants were selected 9 days after sowing. Cuttings consisted of epicotyl, a small apical bud, and 3 cm of hypocotyl. Treatment solutions were prepared with distilled water over a concentration range of 25–200 mg/l. When the interaction with the auxin was tested, IAA was added at a concentration of 10^{-5}M. Each cutting was put in a separate vial containing 10 ml of the treatment solution. Ten cuttings were used for each concentration within each experiment, and controls of water and IAA were included. The effect of each alcohol was tested in at least five separate experiments. The cuttings were incubated under the same conditions of growth of the plants and allowed to absorb nearly all of the treatment solution. Distilled water was added, then and thereafter, to maintain the original solution level. After 12 days of treatment, the roots formed on the hypocotyls were counted. The results are presented as the mean of roots formed on each cutting.

Results and Discussion

The rooting of the bean cuttings was modified by the benzyl alcohols tested. Fig. 1 summarizes the response of the cuttings to 100 mg/l. Of the eight compounds tested only 4-hydroxybenzyl alcohol inhibited the formation of roots (Fig. 1H). Vanillyl, veratryl, salicyl, isovanillyl, 2-methoxy-, 3-methoxy-, and 4-methoxybenzyl alcohols significantly enhanced rooting, the number of roots increasing with increasing concentrations. The most effective in promoting rooting were 2-methoxy-, 3-methoxy-, and 4-methoxybenzyl alcohols, there being no significant differences between these three as regards the number of roots (Fig. 1A,B,C). It seems that the position of the methoxy group has no influence on the rooting activity of the monomethoxybenzyl alcohols. An injurious effect was observed in the cuttings treated with 200 mg/l of 4-methoxybenzyl alcohol. The root primordia formed in the basal zone of the hypocotyl did not develop into roots, although an exuberant formation of roots occurred immediately above this region.

The results obtained with vanillyl were very similar to those obtained with veratryl alcohol, both stimulating rooting to a significant degree (Fig. 1D,E). Less marked but still significant promotion of rooting was found in the cuttings treated with isovanillyl alcohol (Fig. 1G). These results evidence the important

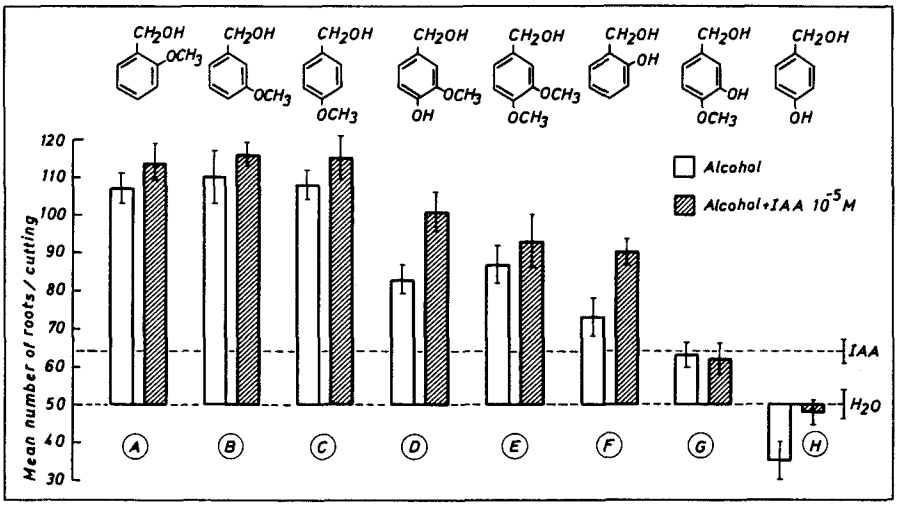

Fig. 1. Histograms showing the root-promoting activity of various benzyl alcohols in hypocotyls of bean. A: 2-methoxybenzyl alcohol. B: 3-methoxybenzyl alcohol. C: 4-methoxybenzyl alcohol. D: vanillyl alcohol. E: veratryl alcohol. F: salicyl alcohol. G: isovanillyl alcohol. H: 4-hydroxybenzyl alcohol. Concentration: 100 mg/l. Activity is expressed as the mean number of roots formed in the cuttings. Vertical bars are the standard errors. Dotted line: Control, IAA (10^{-5}M).

role of the substituents in the biological activity of these compounds. It appears that a hydroxy group at the para-position militates against rooting. However, if the p-hydroxy group is converted into a methoxy group or a methoxy group is placed at a vicinal site, the result is an active molecule stimulating rooting. From these results it seems that the methoxy group may play an important role in the rooting activity of benzyl alcohols. A rooting effect of the methoxy derivatives of cinnamic acid was reported by Poapst and Durkee (1967). The results obtained with vanillyl and isovanillyl alcohols clearly showed the influence of the position of the substituents in the benzyl nucleus. As can be seen in Fig. 1, the root-promoting activity of vanillyl alcohol was about twice that of isovanillyl alcohol.

When the benzyl alcohols under investigation were applied to cuttings together with IAA, an increase in the number of roots was observed in those treated with vanillyl or salicyl alcohol, and the inhibition caused by 4-hydroxybenzyl alcohol was nullified by auxin (Fig. 1D,F,H). The addition of IAA had no effect on the rooting induced by isovanillyl alcohol (Fig. 1G). It seems that the additional increase in rooting when certain of the benzyl alcohols were added with auxin is dependent on the presence of a hydroxy group in the benzyl nucleus in an ortho- or para- position, and that if the hydroxy group is located in a meta- position, there is no IAA-induced increase in root promotion. Further research should determine whether these differences are the results of the phenolic affecting the oxidation of IAA, which according to Hare (1964) can be increased by monophenols.

The addition of IAA to veratryl, 2-methoxy-, 3-methoxy-, and 4-methoxybenzyl alcohols did not modify the rooting response caused by the alcohol

alone (Fig. 1A,B,C,E). From these results, it seems that benzyl alcohols have a specific effect on rooting, but further biological studies are necessary to discover their precise role in the rooting process.

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