IMPROVEMENT OF CUTTING QUALITY BY 4-CHLORORESORCINOL

ALEXANDER E. GAD, IRIS BEN-EFRAIM,
MIRI YAVZURY, CHAVA WEINBERG
AND GAD FRIEDMAN*

Department of Horticulture, The Faculty of Agriculture
The Hebrew University of Jerusalem, P.O. Box 12, Rehovot 76100
Israel

Abstract. Rooting, in cuttings of several plant species, was promoted by 4-chlororesorcinol, a polyphenol oxidase inhibitor, that was applied at mM concentrations before rooting. The subsequent growth of the cutting was also affected by the treatment with 4-chlororesorcinol. Treated cuttings developed greater number of leaves, larger leaves, and produced an overall greater fresh and dry weight. The treatment inhibited, in *Pelargonium peltatum* L'Hér cuttings, flowering during the rooting period. The treatment also inhibited the activity of polyphenol oxidase in the root initiation region of cuttings. The enhanced vegetative growth is attributed to the more developed root system.

REVIEW OF LITERATURE

Rooting of cuttings is still the most common method of vegetative plant propagation. In many instances, the effect of auxin on rooting is enhanced by the addition of phenolics (6). It was suggested that the phenolics affect activity of oxidases, thus elevating auxin concentration in the cuttings. The involvement of the enzyme polyphenol oxidase (PPO) in the rooting process was proposed by Haissig (4). This hypothesis was supported by observations that described correlations between the ease of rooting of woody cuttings and the enzyme's activity (1) and correlations between the location of the enzymatic activity and the tissues that differentiate into roots (1,8). In the present work 4-chlororesorcinol (4-CR), a specific PPO inhibitor (9), was used to study its effect on rooting of several laboratory and commercial species.

MATERIALS AND METHODS

Cuttings of geranium (*Pelargonium peltatum* L'Hér and *P. zonale* L.), silverberry (*Elaeagnus pungens* Thunb. *B.*), and *Tamarix aphylla* (L.) Karst. (Syn. *T. articulata*) were collected from mother plants, grown slightly shaded, at Gillat JNF Nursery. Cuttings of *P. graveolens* L'Hér were prepared from slightly shaded mother plants in the Faculty of Agriculture, Rehovot. Rooting experiments were carried out on location. Plant material was chosen for maximal uniformity according to height and leaf size. Treatments with various concentrations of 4-CR were given to groups of 20 to 35 cuttings for 2 hours. Subsequently, IBA was given to groups of 20 to 35 cuttings for 2 hours. Subsequently, IBA was given as 0.3% powder

*Gillat JNF Nursery, Northern Negev, Israel

(Hormoril T3) to all the cuttings, except for silverberry; that was given 0.8% IBA. The cuttings were then transferred to peat:styrofoam (1:1) and grown unshaded under intermittent mist for 2 to 5 weeks at a 22°C substrate temperature. Cuttings of bean (*Phaseolus vulgaris* L.) and mung bean (*Vigna radiata* Wilcz) were prepared from 7 and 9 day old seedlings grown in growth chambers under white light (80 μ einsteins m^{-2} sec^{-1}) at 25°C. The cuttings were dip-treated for 24 hr. in 2ppm IBA and various concentrations of 4-CR.

The number of roots per cuttings, or the size of the root system, and the extent of flowering were determined at the end of the rooting period. The criterion in some cases was the size of the root system, rather than the actual number of roots, because roots could not be separated satisfactorily from the rooting medium. Polyphenol oxidase activity in mung bean cuttings was measured after extraction. Extracts were dialyzed overnight to see whether the inhibition could be reversed.

Rooted cuttings were transferred for further growth into 1.5 litre soil-filled polyethylene bags and were grown for 10 to 12 weeks. At the end of the growing period the crop yield was estimated measuring: 1) the number of leaves produced, 2) the size of the mature leaf, 3) leaf or shoot fresh weight, and 4) leaf or shoot dry weight. Each experiment was carried out three times and the data were analyzed using Duncan's multiple range test.

RESULTS

The Effect of 4-CR on the Extent of Rooting

Treating freshly-prepared cuttings with 4-CR caused the formation of more adventitious roots (Table 1) and a better developed root system (Table 2, Figure 1). The treatment with 4-CR also promoted in *P. peltatum* L'Hér, at higher frequency, the appearance of roots above the cutting surface (Table 1), which is the normal rooting zone in geranium. In tamarix formation of lateral roots on the adventitious roots was enhanced by 4-CR rather than the number of roots. Rooting percentage was not affected by the treatment. Only in the case of the silverberry rooting percentage increased with 4-CR treatment from 10 to 30% out of the rooting season and from 50 to 80% in season. *P. peltatum* L'Hér cuttings treated with 4-CR flowered less frequently than untreated cuttings (Table 1). Cuttings of bean (Figure 2) and mung bean formed significantly more roots upon treatment with 4-CR. In the rooting zone the measurable activity of PPO decreased after treatment with 4-CR (Table 3). The inhibition of PPO activity was not reversed by dialysis.

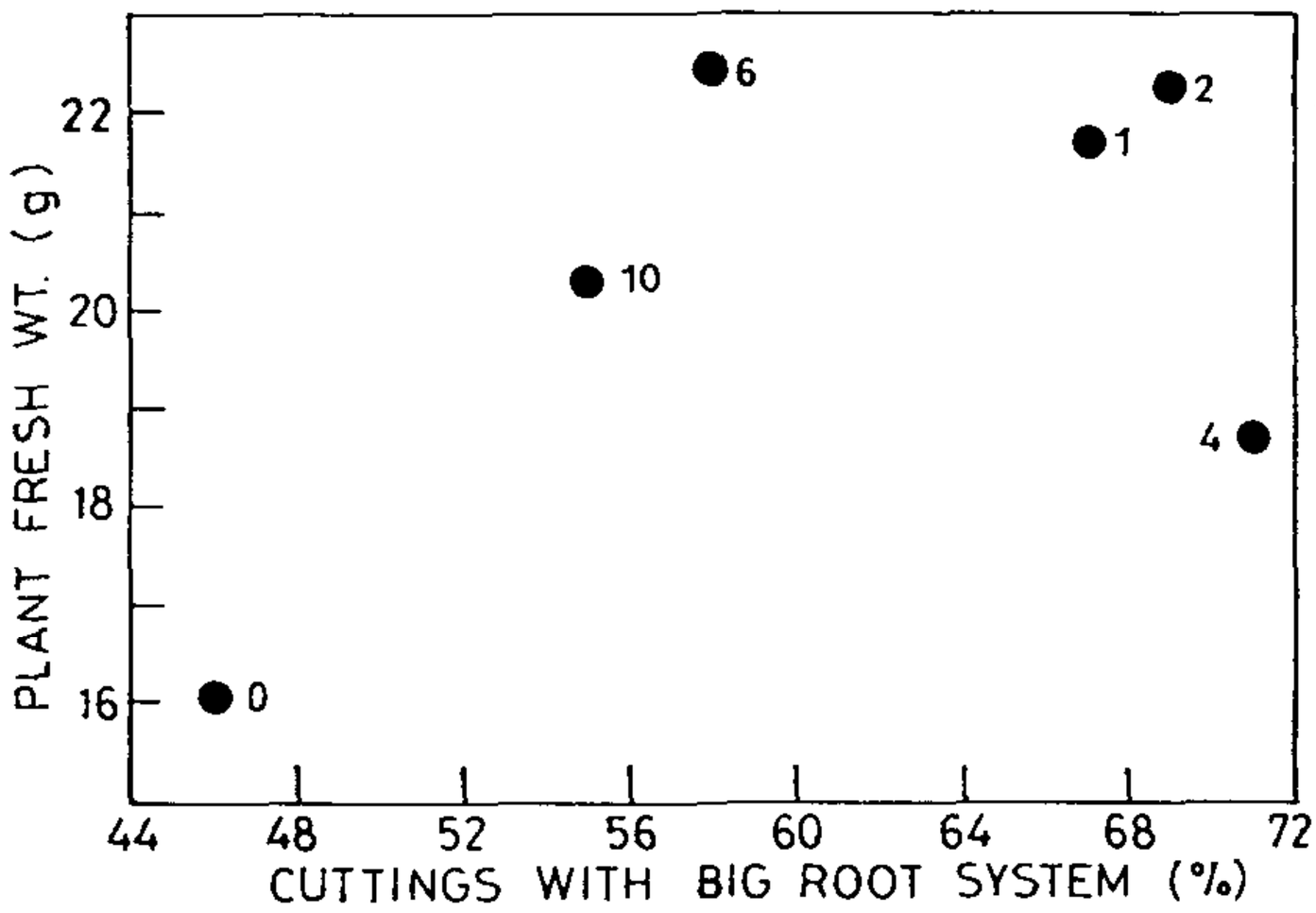

Figure 1. The effect of 4-CR on rooting and vegetative growth of *Pelargonium graveolens* L'Hér cuttings. The numbers in the graph indicate mM 4-CR concentrations applied.

Table 1. The effect of 4-CR on the rooting and vegetative growth of *Pelargonium peltatum* L'Hér [1].

4-CR conc.	Roots per cutting	Flowering cuttings	Leaves per plant	Leaf diameter	Leaf fresh weight	Leaf dry weight
0 mM	30.8a	50%	8.7a	43a(mm)	7.3a	0.85a
0.6	39.4ab	32	8.7a	53.8b	8.7a	0.86a
2	43.8b	28	9.0a	55.8b	10.6a	1.2bc
6	39.6ab	30	11.6b	60.8b	15.7b	1.34c
20	30a	31	8.1	52.1b	8.5a	1.0ab

[1]30 cuttings per treatment.

The Effect of 4-CR on the Quality of the Rooted Cuttings

Cuttings were planted after the extent of rooting had been determined. At the end of a 10 to 12 weeks growth period, the plants were harvested and their crop yield assayed (Table 1, Figure 1). Treated *P. peltatum* L'Hér cuttings developed significantly larger leaves, more leaves, and greater fresh and dry weight (Table 1). The formation of a larger root system in *P. graveolens* L'Hér cuttings enhanced the subsequent vegetative growth as seen by an increase in the plant fresh weight (Figure 1). Treating *P. zonale* L. cuttings with 0.5 to 4 mM 4-CR resulted in the development of more and larger leaves and an overall greater fresh weight (Table 2). The vegetative growth of rooted *P. graveolens* L'Hér and *P. zonale* L. cuttings was consistently greater in 4-CR-treated cuttings, although not always statistically significant.

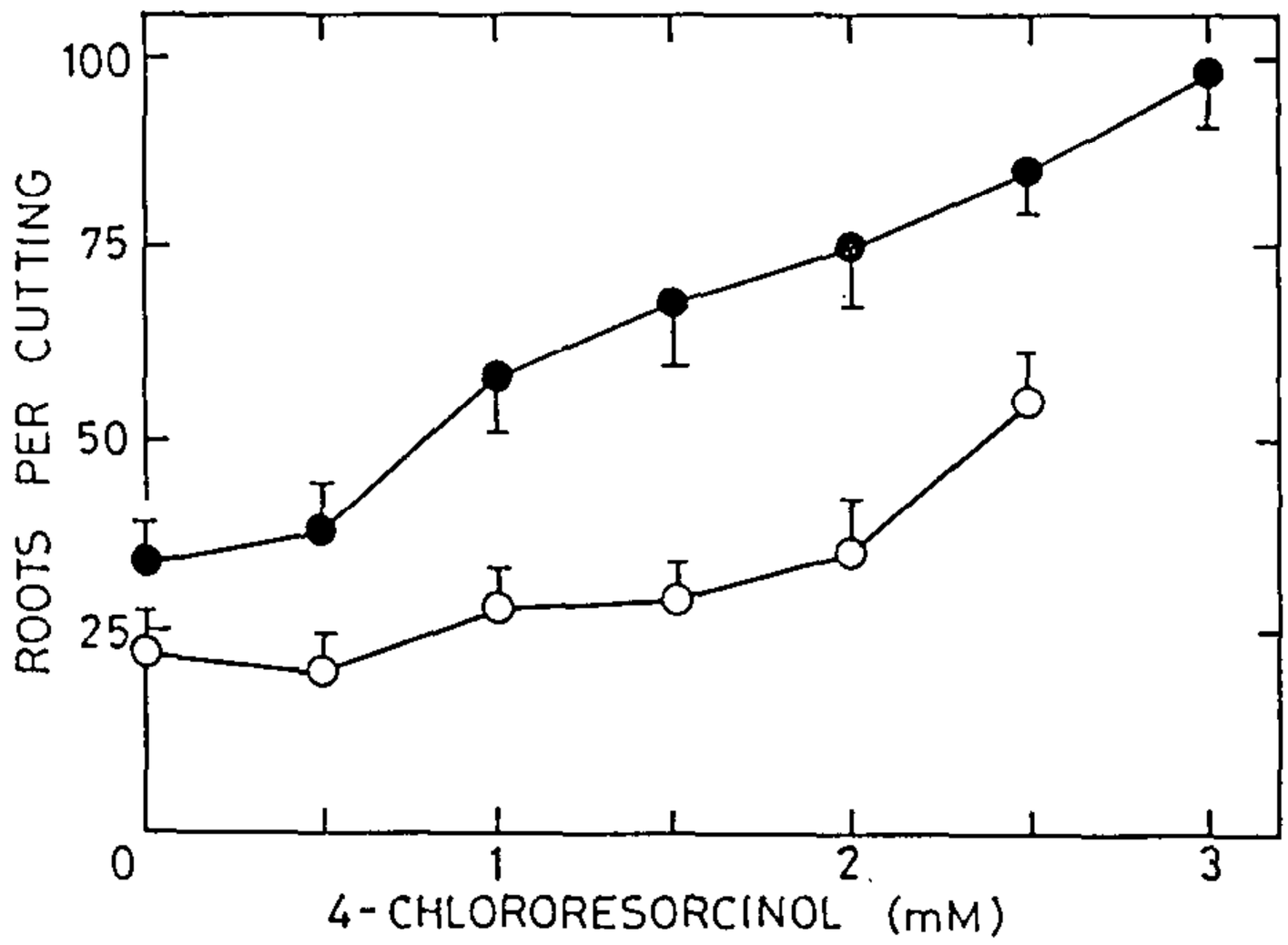

Figure 2. The effect of 4-CR on cuttings of *Phaseolus vulgarus*. Cuttings were dip-treated for 24 hours in various 4-CR concentrations, with (●) or without (○) 2 ppm IBA. The number of roots was counted after 7 days.

Table 2. The effect of 4-CR on the rooting and subsequent vegetative growth of *Pelargonium zonale* L[1].

4-CR *concentration*	Cuttings with a large *root system (percent)*	Fresh weight *of cutting*
0 mM	56	26 ± 11
2	78	33 ± 12
4	70	29 ± 12
10	40	20 ± 10

[1]29 cuttings per treatment.

DISCUSSION

The effect of 4-CR is probably related to its inhibition of polyphenol oxidase (9), which is the only biological activity, so far, attributed to this compound. The plant enzyme was strongly affected by 4-CR. However, we cannot exclude the possibility that it exerted its effect in another way, similar to other phenolics, probably, by inhibiting oxidation of auxin (6).

Table 3. Inhibition of polyphenol oxidase activity in mung bean cuttings by 4-CR[1].

4-CR concentration	Specific/Activity A(410) mg protein^{-1} min^{-1}	Percent inhibition
O mM	1.42a	—
O + dialysis	1.51a	—
1	0.42b	75
3	0.29b	80
10	0.21b	85
10 + dialysis	*0.25b*	84

[1]average of 3 experiments.

The improved vegetative growth and the inhibition of flowering can be explained by the formation of a more developed root system. Richards (12, 13) described the inhibition of vegetative growth by pruning and the promotory effects of cytokinin sprays on the vegetative growth of fruit trees. Treatment with cytokinins promoted branching and thus vegetative growth of geranium (2). The inhibition of flowering during the rooting period and the first growing stage is desired. Flowers, being a strong sink, hinder the plant from developing an appreciable size at a fast rate. By producing greater amounts of cytokinins, a larger root system can also inhibit flowering (10). The appearance of roots outside the normal rooting zone, i.e. above the cut, also improves the quality of the cutting since the formation of a condensed root system is avoided.

In conclusion, 4-CR promoted formation of adventitious roots and improved the subsequent vegetative growth of cuttings. The ability to obtain a bigger plant in a given time implies that plants may be kept less time in the nursery.

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