Root Applications of Gibberellic Acid Enhance Growth of Seven *Pelargonium* Cultivars

Richard N. Arteca¹, Carl D. Schlagnhauser², and Jeannette M. Arteca³

Department of Horticulture, The Pennsylvania State University, University Park PA 16802

Additional index words. gibberellic acid, GA₃, *Pelargonium × hortorum*, *P. × domesticum*

Abstract. Four concentrations of GA₃ (0.05, 0.5, 5.0, or 50 mg·liter⁻¹) were applied to the root systems of seven hydroponically grown geranium (*Pelargonium × hortorum* cv. Empress Irene, Glacier Crimson, Sincerity, Pink Fiat, Sybil Holmes, and Mrs. Parker and *P. × domesticum* cv. Lavender Grand Slam) cultivars. The relative growth rate of all cultivars tested increased with GA₃ treatments. In conjunction with the increase in growth rate, each of the cultivars showed a reduction in the root : shoot ratio and chlorophyll content per unit leaf area with no change in the percent moisture. These *Pelargonium* cultivars are genetically diverse, showing that GA₃ can stimulate growth over a wide range of cultivars. Chemical name used: gibberellic acid (GA₃).

Foliar applications of GA₃ have been reported to either increase (Bidwell and Turner, 1966) or have no effect (Little and Loach, 1975) on photosynthetic rates. Previous research has shown that a single GA₃ treatment to the roots of hydroponically grown tomato plants can stimulate photosynthesis and plant growth (Arteca and Dong, 1982). Similar GA₃ treatments increased photosynthesis, relative growth rate, and cutting production of two geranium cultivars, regardless of whether they normally grew rapidly or slowly (Arteca et al., 1985). The purpose of this study was to determine if a GA₃ treatment to the roots would stimulate growth and development in seven *Pelargonium* cultivars.

Culture-virus-indexed callused cuttings of *Pelargonium × hortorum* cvs. Empress Irene, Glacier Crimson, Sincerity, Pink Fiat,

Sybil Holmes, and Mrs. Parker and *P. domesticum* cv. Lavender Grand Slam were obtained commercially (Oglevee Associates, Connellsville, Pa.). They were rooted in one-fourth-strength Hoagland solution (Hoagland and Arnon, 1938) under continual aeration and subsequently grown under 14-h days (25C) and 10-h nights (20C) at a photosynthetic photon flux of 300 μmol·s⁻¹·m⁻². Following the 2-week rooting period, GA₃ was added directly to the nutrient solution to obtain concentrations of 0, 0.05, 0.50, 5.0, or 50.0 mg·liter⁻¹. Growth was measured after 4 days of treatment. Each treatment had four single-plant replications, and each experiment was repeated three times. The data from all experiments were pooled for presentation, and regression analysis was performed.

Relative growth rates (RGR) were calculated from the total plant fresh weight recorded when treated and again 4 days later according to the procedure outlined by Collins (1976). At this point, the plants were harvested and the root : shoot ratios determined by separating the roots from stems, petioles, and leaves, followed by fresh weight determination of each. The percent moisture was determined by taking an initial weight, drying the plants at 80C, and calculating the percent change (dry weight/wet weight × 100). Chlorophyll was determined according to the procedure described by Witham et al. (1971).

Chlorophyll content was reduced by GA₃

treatments in all cultivars when expressed on an area basis (Fig. 1), but not on a fresh-weight basis (data not shown). There were no changes in the percent moisture content in any of the cultivars in response to GA₃ treatments (data not shown); however, there was an overall increase in total plant weight. The *Pelargoniums* tested represent a wide range of cultivars, showing that root treatments with GA₃ can effectively and broadly stimulate growth (Fig. 2). This result concurs with other work (Arteca et al., 1985), showing that root applications promote an increase in RGR and enhance the production

Fig. 1. Regression analysis of the effects of varying concentrations of GA₃ on chlorophyll content of *Pelargonium × hortorum* cv. Empress Irene (●) ($R^2 = 0.879$), Glacier Crimson (■) ($R^2 = 0.836$), Mrs. Parker (▲) ($R^2 = 0.951$), Pink Fiat (△) ($R^2 = 0.877$), Sincerity (□) ($R^2 = 0.877$), and Sybil Holmes (+) ($R^2 = 0.929$) and *P. × domesticum* cv. Lavender Grand Slam (○) ($R^2 = 0.823$).

Fig. 2. Regression analysis of the effects of varying concentrations of GA₃ on relative growth rate of *Pelargonium × hortorum* cv. Empress Irene (●) ($R^2 = 0.911$), Glacier Crimson (■) ($R^2 = 0.909$), Mrs. Parker (▲) ($R^2 = 0.919$), Pink Fiat (△) ($R^2 = 0.885$), Sincerity (□) ($R^2 = 0.885$), and Sybil Holmes (+) ($R^2 = 0.970$) and *P. × domesticum* cv. Lavender Grand Slam (○) ($R^2 = 0.914$).

Received for publication 11 Dec. 1990. This work was supported by the Pennsylvania State Univ. Agricultural Experiment Station Project no. 2809, Oglevee Associates, and the American Floral Endowment. This is contribution no. 136 of the Dept. of Horticulture, The Pennsylvania State Univ., and is authorized for publication as no. 8062 in the Journal Series of the Pennsylvania Agricultural Experiment Station. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement solely to indicate this fact.

¹Associate Professor.

²Postdoctoral Scholar.

³Senior Research Aide.

Fig. 3. Regression analysis of the effects of varying concentrations of GA_3 on root : shoot ratio of *Pelargonium* $\times$ *hortorum* cv. Empress Irene (●) ($R^2 = 0.846$), Glacier Crimson (■) ($R^2 = 0.892$), Mrs. Parker (▲) ($R^2 = 0.913$), Pink Fiat (△) ($R^2 = 0.832$), Sincerity (□) ($R^2 = 0.921$) and Sybil Holmes (+) ($R^2 = 0.900$) and *P. x domesticum* cv. Lavender Grand Slam (○) ($R^2 = 0.803$).

of cuttings in two *Pelargonium* cultivars. Our current results also show that GA_3 promoted a general decrease in the root : shoot ratio (Fig. 3), suggesting that the GA_3 -induced increase in RGR was not due to an increase in photosynthetic activity. Instead, it was probably due to a modification in normal partitioning of photosynthate (Little and Loach, 1975). All cultivars treated with GA_3 were visibly larger than nontreated plants. We also observed that the leaves of all cultivars treated with GA_3 were more flexible than nontreated plants, which could possibly reduce damage during shipping and handling operations.

We conclude that root applications of GA_3 have much potential for enhancing cutting production in geraniums, yielding plants less apt to be damaged during shipping and benefits that may possibly apply to other species as well.

Literature Cited

Arteca, R.N. and C.N. Dong. 1982. Increase

photosynthetic rates following gibberellic acid treatments to the roots of tomato plants. *Photosynthesis Res.* 2:243-249.

Arteca, R. N., E.J. Holcomb, C.D. Schlagnhauer, and D.S. Tsai. 1985. Effects of root applications of gibberellic acid on photosynthesis, transpiration, and growth of geranium plants. *HortScience* 20:925-927.

Bidwell, R.G.S. and W.B. Turner. 1966. Effect of growth regulators on CO_2 assimilation in leaves and its correlation with the bud break response in photosynthesis. *Plant Physiol.* 41:257-270.

Collins, W.B. 1976. Effect of carbon dioxide enrichment on growth of the potato plant. *HortScience* 11:467-469.

Hoagland, D.R. and D.I. Arnon. 1938. The water-culture method for growing plants without soil. *Univ. of California Agr. Expt. Circ.* 347.

Little, C.H.A. and K. Loach. 1975. Effect of gibberellic acid on growth and photosynthesis in *Abies balsamea*. *Can. J. Bot.* 53:1805-1810.

Witham, F. H., D.F. Blaydes, and R.N. Devlin. 1971. Experiments in plant physiology. van Nostrand, New York.