Effects of Media PH and Acid/Base Pretreatments on the Rooting of *Gypsophila Paniculata* Cuttings[1]

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Abstract

The greatest rooting of *Gypsophila paniculata* occurred in various propagation media with a pH near, or slightly above, neutrality and poorest rooting in acidic media. Addition of ground limestone to acidic media significantly ($P \geq 5\%$) improved rooting. Basal dipping of cuttings in H_2SO_4 (sulfuric acid), NaOH (sodium hydroxide), and KOH (potassium hydroxide) resulted in improved rooting over nontreated cuttings. Lignin specific phloroglucinol staining of freehand sections revealed the presence of a band of sclerenchyma tissue, external to the vascular region of the stem, that may impede the emergence of newly formed roots.

Index words: plant propagation, herbaceous perennial, calciphilous plant

Introduction

Gypsophila paniculata is a herbaceous perennial important as a cut-flower crop (11), and also as an ornamental landscape plant (3). Unacceptable variability in quality and flower doubleness limits the use of seed-propagated plants (11). Propagation is therefore largely by stem cuttings (1). The most widely grown cultivars for commercial cut-flower production are 'Bristol Fairy' and 'Perfecta.' Both have large, white, fully-double flowers. While propagated by stem cuttings, difficulty is often encountered in achieving satisfactory rooting (personal communications with propagators). Propagators noted low rooting percentages, non-uniform rooting, and losses after transplanting as problems with this species.

The difficulty experienced in the propagation of *Gypsophila* by cuttings may be due, in part, to media-related factors. Studies involving a number of species have shown that the pH of the medium can influence the rooting of cuttings (9, 10). These studies indicate a trend that plants root best in a pH range that most closely approximates that of their native soil. *G. paniculata* is native to calcareous soil and grows best in commercial production in a pH range of 6.5 to 7.5 (11). If rooting of *Gypsophila* is affected by medium pH, it would be expected that optimum rooting would occur at a pH near neutrality and that rooting would be inhibited in acidic media. Recommendations for rooting *Gypsophila* cuttings emphasize the importance of a well-drained

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medium (11), but fail to consider the influence of pH.

Lee *et al.* (8) examined the effects of acid and base pretreatments on the rooting of stem cuttings of a number of species. Generally, they found that dipping the base of stem cuttings in sulfuric acid (H_2SO_4) promoted rooting of plants native to near neutral or alkaline soil, and that the same treatment with sodium hydroxide (NaOH) gave increased rooting for plants native to acidic soil. Such pretreatments might improve rooting in difficult *G. paniculata* cultivars, particularly the acid pretreatment, since this plant is native to alkaline soil. Lee *et al.* (8) also found that the pretreatments plus indole-3-butyric acid (IBA) were more effective in promoting rooting than IBA alone. Treatment with IBA is reported to improve rooting of 'Bristol Fairy' cuttings (5), therefore, pretreatment plus IBA might be even more effective in promoting rooting of *Gypsophila* cuttings.

The present study was undertaken to determine if the rooting of *G. paniculata* cuttings is influenced by media pH. The effects of acid and base treatments were tested as a means of improving the rooting of *Gypsophila* cuttings.

Materials and Methods

Stock plants of 3 *Gypsophila paniculata* cultivars, 'Pink Fairy,' 'Bristol Fairy' and 'Perfecta' were planted in 25 x 25 x 16 cm (10 x 10 x 6.4 in) pots using a 1:2:1 soil, peat, perlite mix (by volume) to which ground limestone was incorporated at the rate of 16.1 kg/m^3 (46 lb/yd^3). These plants were used to supply all cuttings after forcing from dormancy in early January, 1981, under greenhouse temperatures of approximately 27 °C (81 °F) day and 16 °C (61 °F) night.

Media experiments. Sphagnum moss peat, perlite, and vermiculite were used alone, or in combination as rooting media (Table 1). All combinations, such as peat/perlite, were 1:1 (by volume). Ground limestone was incorporated into sphagnum moss peat at rates of 0, 5, 10, 15, and 20 kg/m^3 (0, 14.3, 28.6, 42.9, and 57.2 lb/yd^3).

The media were contained in 17.5 x 10 x 14 cm (7 x 4 x 5.6 in) plastic pots. Each pot contained cuttings of each cultivar. All cuttings were given a basal dip in talc containing IBA at 3000 ppm. The pots were arranged on a mist bench in a randomized complete block design, with 4 blocks. The entire experiment was repeated once, the second time including limed peat III (15 kg lime/m^3 or 42.9 lb/yd^3)/perlite and limed peat IV (20 kg lime/m^3 or 57.2 lb/yd^3)/perlite (Table 1).

Pretreatment experiments. The pretreatment study was conducted in 2 separate experiments. 'Pink Fairy' cuttings were used in the first and 'Bristol Fairy' in the second. Sulfuric acid (H_2SO_4) at 1N, 2N, and 4N, sodium hydroxide (NaOH) at 3.6 x 10^{-3}N (pH 10.5) and 1N, and potassium hydroxide (KOH) at 3.6 x 10^{-3}N (pH 10.5) and 1N were used as pretreatments along with a nontreated control. The basal 3 cm (1.25 in) of the cuttings were dipped for various lengths of time, ranging from 10 seconds to 10 minutes, cuttings were then rinsed for 10 seconds in distilled water and treated with 3000 ppm IBA in talc. Cuttings were rooted in a 1:1 (by volume) perlite and vermiculite medium contained in steam disinfested wooden flats (40 x 60 x 10 cm or 16 x 24 x 4 in). Cuttings were inserted into the flats in a randomized complete block design, with 4 blocks.

Results and Discussion

Media experiments. Analysis of variance revealed no significant interaction between media and cultivars; however, there were significant differences in root ratings among media, with the poorest rooting in media containing peat and no limestone (Fig. 1). A comparison of pH values (Table 1) and mean root ratings (Fig. 1) for each medium indicates a tendency towards higher ratings (more roots) in media with a pH near or above neutral, and generally lower ratings (fewer roots) in more acidic media. Percent rooting was 95.5% in both runs of the experiment, and transplant survival of the rooted cuttings was 92.2%.

The response of *G. paniculata* cuttings to media pH seems to relate to this plant's natural occurrence on

Table 1. Rooting medium pH determined 1 week after start of experiment and at termination.

Medium	Mean pH			
	Experiment I		Experiment II	
	1 week	3 weeks	1 week	3 weeks
A. Sphagnum moss peat (Canadian)	4.7	4.6	4.4	4.5
B. Perlite (+8 horticultural)	7.0	6.8	7.3	7.5
C. Peat/perlite^z	6.8	5.2	5.2	5.1
D. Vermiculite (#2)	7.5	6.9	7.3	7.5
E. Peat/vermiculite	6.5	5.9	5.2	6.1
F. Perlite/vermiculite	6.9	6.8	7.1	7.6
G. Limed peat I (5 kg lime/m^3)	6.5	6.3	6.1	6.6
H. Limed peat I/perlite	7.0	6.2	6.7	6.8
I. Limed peat I/vermiculite	6.8	6.9	6.6	6.9
J. Limed peat II (10 kg lime/m^3)	6.9	6.5	7.3	7.0
K. Limed peat II/perlite	7.1	6.5	7.3	7.1
L. Limed peat II/vermiculite)	6.9	7.0	7.0	7.1
M. Limed peat III (15 kg lime/m^3)/perlite	—	—	7.2	7.1
N. Limed peat IV (20 kg lime/m^3)/perlite	—	—	7.2	7.1

^{z}All media combinations on a 1:1 volume basis.

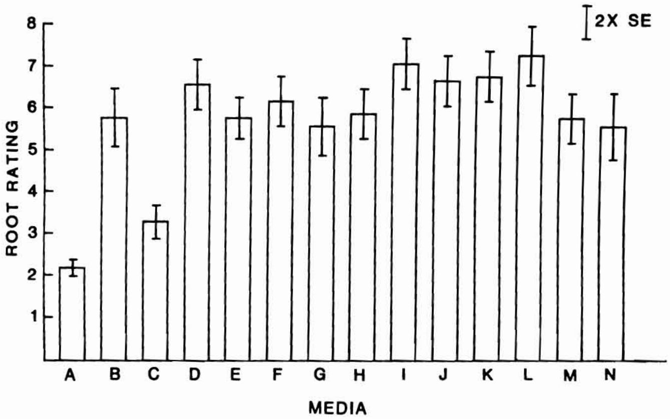

Fig. 1. Effect of media on the rooting of *G. paniculata* cuttings. Each bar represents a mean of 12 replications. I-bar represents 2 times the standard error of the mean. Letters on the X axis are the same as those for media in Table 1. The root ratings were as follows: 1 = no roots, 2 = 1 to 2 roots, 3 = 3 to 5 roots, 4 = 7 to 9 roots, 5 = a root mass 2 to 3 cm wide, 6 = a root mass 3 to 4 cm wide, 7 = a root mass 4 to 5 cm wide, and 8 = a root mass 5 to 6 cm wide.

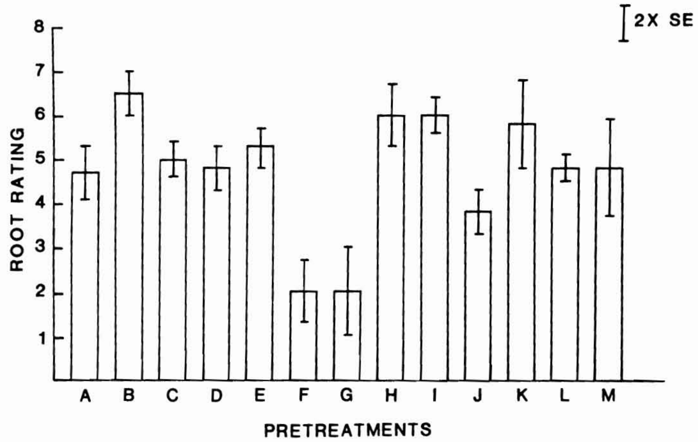

Fig. 2. Effects of pretreatments on the rooting of *G. paniculata* 'Bristol Fairy' cuttings. Each bar represents a mean of 4 replications. I-bar represents 2 times the standard error of the mean. A = untreated control, B = 1N H_2SO_4 at 10 sec, C = 1N H_2SO_4 at 30 sec, D = 1N H_2SO_4 at 1 min, E = 2N H_2SO_4 at 10 sec, F = 2N H_2SO_4 at 30 sec, G = 2N H_2SO_4 at 1 min, H = $3.6x10^{-3}$N NaOH (pH 10.5) at 1 min, I = $3.6x10^{-3}$N NaOH (pH 10.5) at 5 min, J = $3.6x10^{-3}$N NaOH (pH 10.5) at 10 min, K = $3.6x10^{-3}$N KOH (pH 10.5) at 1 min, L = $3.6x10^{-3}$N KOH (pH 10.5) at 5 min, M = $3.6x10^{-3}$N KOH (pH 10.5) at 10 min. The root ratings were the same as in Fig. 1.

calcareous soil. Such soils contain relatively large amounts of Ca^{++} and consequently have a higher pH than others (6). A study involving *Pistacia chinensis,* a plant from a similar soil habitat, found root regeneration of root cuttings to be greatest in media with a high percent Ca^{++} saturation (high pH) (7). The results of Paul and Leiser (9) suggest that Ca^{++} concentration required for normal root growth may be greater for calciphilous plants than acid-loving ones. At low pH, Ca^{++} is replaced by H^+ as the principle exchangeable ion (10), therefore, the apparent inhibition of rooting of *Gypsophila* cuttings at low pH may be due, in part, to lower levels of exchangeable Ca^{++}.

Pretreatment experiments. Pretreatment significantly influenced rooting of 'Pink Fairy' in the first experiment. Four pretreatments in this experiment resulted in root ratings significantly higher than that achieved by nontreated cuttings. These were 1N H_2SO_4 for 10 seconds, 2N H_2SO_4 for 10 seconds, $3.6x10^{-3}$N NaOH for 10 minutes, and $3.6x10^{-3}$N KOH for 10 minutes. No significant differences were found between the root ratings of cuttings dipped in either NaOH or KOH of the same concentration, and at the same dipping time; however, the 1N H_2SO_4 for 1 minute resulted in more roots than either base at the 1N concentration and 1 minute application time.

Certain acid and base concentrations and dipping times were found to be excessive. Cuttings receiving 4N H_2SO_4 treatments were dead or dying the day after the experiment began, as were most receiving the 5 minute acid or 10 minute 1N concentration base dips. Such cuttings were discarded to avoid disease problems. Percent rooting was only 60 percent in this experiment, but this was due primarily to the death of cuttings (those which were discarded) dipped in higher concentrations of acid and bases. Transplant survival was 100% in those treatments which rooted successfully.

In the second experiment, pretreatments again resulted in highly significant differences in rooting. The treatments of 1N H_2SO_4 for 10 seconds gave the highest ratings of all acid pretreatments (Fig. 2). Both the 1 and 5 minute dips of $2.6x10^{-3}$N KOH resulted in higher ratings than the 10 minute dip. There were no signicant differences among dipping times for $3.6x10^{-3}$N KOH pretreatment (1 minute dip) and the corresponding NaOH pretreatment. Percent rooting was 90% in this experiment (averaged across all treatments), with 100% transplant survival of the rooted cuttings.

The observed response of *G. paniculata* cultivars to both acid and base pretreatment was not expected based on the results of Lee *et al.* (8). Their results led them to suggest that an acid pretreatment may break acid-labile linkages in the cell walls of calciphilous plants, resulting in cell wall loosening. The effects of a base on the base-labile linkages of cell walls in acid-loving plants could be similar. Since *G. paniculata* is a calciphilous plant, it would be expected that if rooting was promoted, it would be by acid pretreatment.

The fact that both acid and base-treated *Gypsophila* cuttings achieved higher root ratings than untreated cuttings in the pretreatment experiments suggests that the mode of action by which these treatments improve rooting may be different than the explanation proposed by Lee *et al.* (8). One possible explanation for the effects of these pretreatments on the rooting of *Gypsophila* cuttings is that the corrosive action of the acid and bases is similar to mechnical wounding.

An investigation was made to determine if a band of schlerenchyma tissue which impeded rooting existed in *Gypsophila* stems similar to that found in carnation (12), another member of the Caryophyllaceae. A resemblance between cuttings of both species has been noted (11). Through staining tests of transverse free-hand thin sections using lignin-specific phloroglucinol in 10% hydrochloric acid (HC1), we confirmed the presence of a band of schlerenchyma tissue between the vascular region and the cortex of the stem of all three cultivars. This band is outside of the area where adventitious root initials are normally formed in herbaceous stems (2, 4).

In untreated *Gypsophila* cuttings, we noted that root emergence was generally confined to the very base of the cuttings, similar to that observed in carnation (12), indicating that the schlerenchyma band might resist the penetration of roots. We observed that roots emerged above the base of untreated cuttings only in areas where the removal of leaves had torn the stem tissue. The larger root systems along the treated regions of cuttings receiving an acid or base pretreatment might be due to disruption of the stem tissues such that greater root emergence was possible. Slitting of the base of *Gypsophila* cuttings likewise increased the numbers of emerged roots (unpublished results).

Cultivar differences. Studies of the effects of media pH, acid and base pretreatments, and IBA indicated no significant interaction between cultivars and these variables. (We found that 1000-8000 ppm IBA enhanced rooting more than the control, but there were no differences among IBA levels.) Thus, although each variable caused significant differences in rooting, these results were the same across all 3 cultivars and were not cultivar specific. Differences in cultivar response were expected based on reports from commercial propagators (personal communication). Most growers find 'Perfecta' more difficult to root than 'Bristol Fairy,' while 'Pink Fairy' is reported the easiest to root, but all 3 cultivars rooted well in our studies.

Significance to the Nursery Industry

The choice of a rooting medium influences rooting of *Gypsophila paniculata* cuttings, and for optimum rooting, a well-drained medium with a pH near neutrality is recommended. Among the best choices for propagators are either perlite or vermiculite alone or combined in a 1:1 (by volume) proportion. If sphagnum moss peat is to be used, either alone or in combination with perlite or vermiculite, it should be disinfested and at least 5 kg/lime m^3 (14.3 lb/yd^3) added. The use of IBA is recommended at 1000 ppm (we found this to stimulate better rooting than when no IBA was used, results not presented here). The use of acid and base pretreatments or wounding will also promote rooting.

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