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Growth Habit of *Weigela florida* as Affected by Stock Plant Propagation History[1]

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Abstract

The effects of stock plant propagation history on the growth habits of *Weigela florida* (Bunge) A.D.C. 'Red Prince' and '7755' were investigated. The growth habits of cuttings from tissue culture (TC)-propagated and conventionally (CV) propagated plants were compared. In the first vegetative generation, TC-propagated plants of both cultivars exhibited reduced apical dominance and increased branching in comparison with CV propagated plants. In the second vegetative generation, some of the effects of TC-propagation persisted in plants of both cultivars, although TC-propagated plants exhibited fewer differences in growth habit as compared with CV propagated plants. The results of this study indicate that TC-derived stock plants and first-vegetative-generation TC-propagated plants may serve as superior sources of propagation material by providing an increase in both the quantity and quality of cuttings that they produce.

Index words: tissue culture, vegetative propagation, micropropagation, tissue-culture-induced changes

Significance to the Nursery Industry

The growth habits of *Weigela florida* cultivars 'Red Prince' and '7755' were influenced by their propagation history. Plants from rooted cuttings of TC stock plants displayed a more desirable growth habit than that of CV plants. In general, first-vegetative-generation TC plants exhibited less apical dominance and increased branching as compared with CV plants. These improvements in growth habit make TC plants more desirable as a horticultural commodity, and also allow them to serve as improved sources of propagation material by providing an increase in both the quantity and quality of cuttings.

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The effects of TC-propagation diminished noticeably during 2 vegetative generations after TC. The results of this study suggest that nursery growers will maximize the effectiveness of TC-propagation of weigela by using TC plants or first-vegetative-generation TC plants as stock plants for cuttings.

Introduction

The weigela, *Weigela florida* (Bunge) A.D.C., is a popular flowering shrub in Europe and North America. There are many species of weigela, all native to eastern Asia, but most of the cultivars grown today belong to the species *Weigela florida*.

As with most deciduous shrubs, the conventional method of propagation involves the rooting of softwood cuttings. However, this method may be unsuitable for some cultivars, producing plants that display a commercially undesirable growth habit (i.e., a single shoot with little or no branching).

Tissue culture (TC) propagation has produced beneficial

changes in the growth habit of many species. Thornless blackberry plants derived from *in vitro* shoot-tip cultures have displayed a greater degree of shoot growth, cane and lateral branching, and flower production than CV derived plants (7). Similarly, blueberry plants derived from *in vitro* shoot-tip cultures have displayed increased growth rates, basal and lateral branching, and flower bud production over their conventionally derived counterparts (4). The results of these studies indicate that the growth habit of some *Weigela florida* cultivars might be improved through the use of TC propagation.

Before this study, it was observed that TC-derived weigela plants exhibited a visibly superior growth form; i.e., increased branching and reduced apical dominance in comparison with CV derived plants (Dale Siems, Sherman Nurseries, Charles City, IA, personal communication, 1988). In addition to creating a more visibly desirable growth habit, the increased vegetative growth of TC-derived weigela plants may allow them to serve as a superior source of nursery propagation material, increasing both the quantity and quality of cuttings available. In a previous study, it was observed that some of the improved characteristics of TC-derived blueberry plants persisted in their vegetative offspring (3). Plants from rooted cuttings of TC-derived plants had more growing apices and a greater basal branch growth rate than plants from rooted cuttings of CV derived plants. The results of this study suggest the possibility that TC-derived weigela plants might provide superior propagation material should their improved growth characteristics persist, even if only for one or two vegetative generations.

The objective of this study was to determine the effects of stock plant propagation history on the growth habit of *Weigela florida*. Specifically, the persistence of TC-induced changes in growth habit was investigated by comparing the growth habit of plants from rooted cuttings of TC-derived stock plants (the first vegetative generation) with that of CV derived stock plants. A similar comparison was then made for second-vegetative-generation TC and CV plants.

Materials and Methods

Description of cultivars. Two cultivars were used in this study: 'Red Prince' and the Iowa State University selection '7755'. In the past, the range of *Weigela florida* was limited by its lack of cold tolerance, but that range is currently being extended because of the development of winter-hardy cultivars such as 'Red Prince' and '7755'. The cultivar 'Red Prince' has proved hardy as far north as zone 4, reaches a mature, semiupright height of approximately 2 m (6.6 ft), and produces an abundance of crimson, trumpet-shaped flowers from late May until frost (9). The unreleased cultivar '7755', to be released as 'White Knight', has also proved hardy as far north as zone 4, reaches a mature, somewhat weeping height of 2 m (6.6 ft), and produces clusters of near white, often fragrant, trumpet-shaped flowers from late May until frost (J.L. Weigle, personal communication, 1989).

Mother plants. The mother plants used in this study were approximately 1-year-old, greenhouse-grown, CV propagated plants. These mother plants were used to produce both TC- and CV derived stock plants of 'Red Prince' and '7755'.

Propagation of TC-derived stock plants. TC-derived stock plants were produced by first establishing *in vitro* shoot cultures and then rooting shoots harvested from them. *In vitro* shoot cultures were initiated from axillary buds by taking vegetative, softwood cuttings from greenhouse-grown mother plants, removing the leaves, and cutting the remaining stem into 4-cm (1.6 in) sections, each containing an axillary bud. The stem sections were then rinsed in distilled water for 2 min and the surface was disinfested for 20 min in 0.52% sodium hypochlorite (10% commercial bleach) (v/v) containing 4 drops/liter (4 drops/1.1 qt) Tween 20. Finally, the stem sections were rinsed three times for 2 min each in sterile, deionized water. Under aseptic conditions, a thin slice of stem, 1 cm (0.4 in) long and containing the axillary bud, was excised from each stem section and placed on a medium composed of inorganic MS salts (6), with the addition of 100 mg/liter (ppm) *m*-inositol, 0.5 mg/liter (ppm) nicotinic acid, 0.5 mg/liter (ppm) pyridoxine · HCl, 0.1 mg/liter (ppm) thiamine · HCl, 2.0 mg/liter (ppm) glycine, 30 g/liter (30,000 ppm) sucrose, and 5 mg/liter (ppm) benzyladenine (BA). The pH was adjusted to 5.8, 5.0 g/liter (5000 ppm) Difco-Bitek agar was added, and the medium was autoclaved 15 min at 1.1 kg/cm^2 (15 lbs/in^2) and 121°C (250°F). Shoot cultures were transferred to fresh medium every 2 weeks. Shoots, 1–3 cm (0.4–1.2 in) in length, were harvested serially from the fifth, tenth, and thirteenth subcultures and were rooted under mist in a peat moss:vermiculite (1:1 by vol.) soil mix that was pH-adjusted to 6.5, where rooting occurred within 2 weeks. After 3 to 4 weeks, rooted cuttings from each subculture were potted, placed in a greenhouse maintained at 25° ± 3°C (77° ± 5°F), and fertilized weekly with 10-20-10 fertilizer at a rate of 200 ppm nitrogen.

Propagation of CV derived stock plants. CV derived stock plants were produced with each TC subculture by taking vegetative, two node, softwood cuttings from greenhouse-grown mother plants and rooting them in perlite under mist. After rooting, they were cultured in a manner identical to that of TC-derived stock plants.

Experimental design. This study consisted of two experiments. In the first experiment, first-vegetative-generation plants were produced from cuttings of TC and CV stock plants by rooting softwood cuttings in perlite as described previously. Only TC stock plants with superior growth habits (i.e., increased branching and reduced apical dominance) were used as cutting sources to perpetuate these desirable phenotypes should they persist. In the second experiment, cuttings were taken at random from first-vegetative-generation TC and CV plants to produce a second vegetative generation. Figure 1 outlines the propagation history of the plants used in each experiment.

The design of both experiments was a randomized block design involving three blocks (subcultures) and four treatments. In the first experiment, the first block was planted on May 20, 1989, and contained the following treatments: fifth subculture TC-derived 'Red Prince', fifth subculture TC-derived '7755', CV derived 'Red Prince', and CV derived '7755'. The second block was planted on August 28, 1989, and contained the same treatments as the first block except that TC-derived plants were from the tenth subculture. The third block was planted on September 15, 1989, and contained the same treatments as the first block except that TC-derived plants were from the thirteenth subculture. Each TC treatment was replicated an average of 27 times,

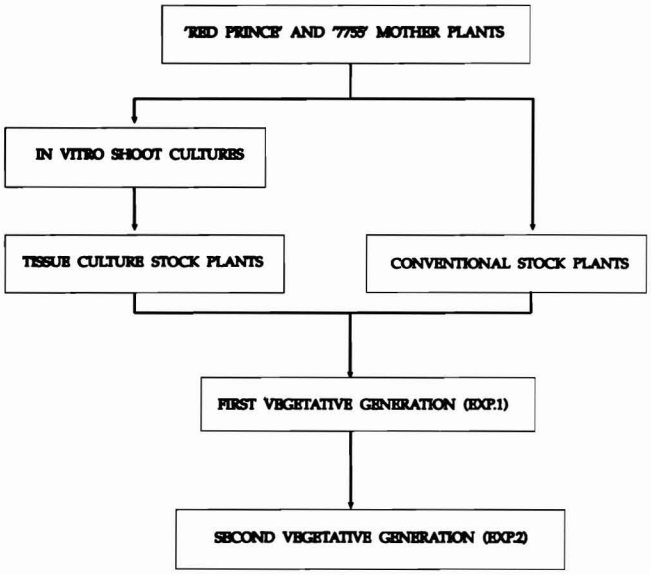

Fig. 1. Schematic diagram outlining the origins of cuttings used in the study of the effects of stock plant propagation history on the growth habit of *Weigela florida* plants.

and each CV treatment was replicated an average of 9 times. The exact number of replications per treatment depended upon the number of rooted cuttings, which was somewhat variable. Smaller numbers of CV plants were used inasmuch as they have proved phenotypically stable in the past. The second experiment was conducted in a manner identical to the first, with the first, second, and third blocks being planted on September 15, 1989, November 27, 1989, and January 10, 1990, resp.

Plant care. Four weeks preceding the planting date of each block, softwood cuttings were taken from the appropriate TC and CV plants, dipped in rooting powder containing 0.7% 1*H*-indole-3-butanoic acid (IBA), and rooted in perlite under mist. After rooting, cuttings were potted, placed randomly in a greenhouse maintained at 25° ± 3°C (77° + 5°F), and fertilized weekly with 10-20-10 fertilizer applied at a rate of 200 ppm nitrogen. During the fall and winter months, a 16-hour photoperiod was maintained by supplementing the natural daylength with incandescent light. The maintenance of long-day conditions was necessary to prevent the induction of dormancy and the suppression of vegetative growth (2).

Data collection and analyses. Methods used in the collection of data and their analyses were identical in the first and second experiments. Approximately 8 weeks after the planting date of each block, the following measurements were recorded: the length of the main shoot, the lengths of the four longest side shoots (branches), and the number of shoots longer than 5 cm (2 in). Hereafter "number of shoots longer than 5 cm" will be stated as "shoot number". Observation of a sample group of plants confirmed that side shoots longer than 5 cm (2 in) continued to grow at a rate similar to that of the main shoot. The average branch length was calculated as the average of the lengths of the four longest side shoots. The apical dominance was then calculated by subtracting the average branch length from the main shoot length.

Statistical analyses were performed using the General Linear Model of the Statistical Analysis System (1).

Results and Discussion

Experiment 1. Significant differences in growth habit between cultivars were observed, so separate analyses were

Table 1. Comparison of conventional vs. tissue culture propagation of stock plants on the growth habit of *Weigela florida* during two consecutive vegetative generations.[z]

		First Vegetative Generation			
Cultivar	Propagation method[y]	Main shoot length (cm)	Average branch length[x] (cm)	Apical dominance[w]	Shoot number[v]
Red Prince	CV	42[ns]	1**	41**	1**
	TC	38	14	24	4
7755	CV	54**	14**	40**	4**
	TC	39	23	16	7
Combined	CV	49**	9**	40**	3**
	TC	39	19	20	6
		Second Vegetative Generation			
Cultivar	Propagation method[y]	Main shoot length (cm)	Average branch length[x] (cm)	Apical dominance[w]	Shoot number[v]
Red Prince	CV	46[ns]	2*	44[ns]	1*
	TC	47	3	44	2
7755	CV	57**	13*	44**	5[ns]
	TC	51	15	36	5
Combined	CV	51[ns]	7*	44*	4[ns]
	TC	49	10	39	4

[z]Significance as determined by single degree-of-freedom F-tests with ** = significance at the 1% level, * = significance at the 5% level, and ns = nonsignificance. Each treatment mean represents the treatment effect averaged over blocks.

[y]CV = conventional; TC = tissue culture.

[x]Average of four longest side shoots.

[w]Apical dominance = main shoot length − average branch length.

[v]Number of shoots longer than 5 cm (2 in).

Table 2. Comparison of conventional vs. tissue culture propagation of stock plants on the growth habit of *Weigela florida* plants between the first and second vegetative generation.[z]

Cultivar	Propagation method[y]	Vegetative generation	Main shoot length (cm)	Average branch length[x] (cm)	Apical dominance[w]	Shoot number[v]
Red Prince	CV	1	42[ns]	1[ns]	41[ns]	1[ns]
		2	46	2	44	2
	TC	1	38**	14**	24**	4**
		2	47	3	44	2
7755	CV	1	54[ns]	14[ns]	40[ns]	4*
		2	57	13	44	5
	TC	1	39**	23**	16**	7**
		2	51	15	36	5

[z]Significance as determined by single degree-of-freedom F-tests with ** = significance at the 1% level, * = significance at the 5% level, and ns = nonsignificance. Each treatment mean represents the treatment effect averaged over blocks.

[y]CV = conventional; TC = tissue culture.

[x]Average of four longest side shoots.

[w]Apical dominance = main shoot length − average branch length.

[v]Number of shoots longer than 5 cm (2 in).

conducted for each cultivar. For 'Red Prince', first-vegetative-generation TC plants were significantly less apically dominant and had significantly more shoots than CV plants (Table 1). The lesser apical dominance observed in TC plants was attributed to a highly significant increase in average branch length rather than to a significantly shorter main shoot because average branch length was significantly different, whereas main shoot length was not (Table 1).

For '7755', first-vegetative generation TC plants were significantly less apically dominant and had significantly more shoots than CV plants (Table 1). However, the lesser apical dominance for '7755' seemed to result from both a significantly shorter main shoot and a significant increase in average branch length (Table 1).

For combined cultivars, TC-propagation of stock plants had a highly significant effect on all four growth measurements in the first vegetative generation from TC (Table 1). This would seem to indicate that, although cultivars may differ somewhat in their response, TC-propagation of stock plants produces plants with less apical dominance and more branching than CV propagation in the first vegetative generation.

Experiment 2. Some of the effects of TC-propagation of stock plants were still present in second-vegetative-generation plants (Table 1). For 'Red Prince', the average branch length and shoot number were significantly greater in TC plants than in CV plants. There was no significant difference in apical dominance between TC and CV plants, most likely due to the inability of the TC treatment to affect the main shoot length after being 2 vegetative generations removed from TC.

For '7755', TC plants still displayed significantly less apical dominance due to a significantly shorter main shoot and significantly longer branches. TC plants, however, did not exhibit significantly more shoots.

For combined cultivars, TC propagation of stock plants produced significantly less apical dominance by causing an increase in the average branch length but did not cause a significant increase in the shoot number. The results of this study show that some of the effects of TC-propagation of stock plants persist into the second vegetative generation, and although these differences are statistically significant, they are probably not of practical significance. That is, by the second vegetative generation from TC, growth habit resembled CV propagated plants quite closely.

Comparison of experiments 1 and 2. The effects of TC propagation on the growth habit of *Weigela florida* diminished noticeably during 2 vegetative generations after TC as evidenced by significant differences between TC plants of the first and second vegetative generation (Table 2). For both cultivars, the effects of TC-propagation in the first vegetative generation were significantly greater than those observed in the second generation for all recorded growth measurements. Differences between vegetative generations may be due to environmental differences resulting from the serial nature of these experiments, or they may be due to a decrease in treatment effectiveness as a function of time removed from culture. It seems most likely that differences between the first and second vegetative generations are the result of a decrease in treatment effectiveness rather than environmental differences because CV plants differed significantly only in shoot number between the first and second vegetative generations for '7755' (Table 2). That is, growth habit of CV plants was quite constant over the time span of these experiments, except for shoot number. The increased shoot number for second-vegetative-generation CV plants may reflect differences in light quantity and quality between generations. Second-generation plants were grown under natural light supplemented by incandescent light, which has been shown to increase lateral branching in previous studies (5, 8).

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Influence of End-of-day Red and Far-red Light on Potted Roses[1]

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Abstract

The effects of end-of-day red and far-red light on postharvest leaf chlorosis of potted roses were investigated. *Rosa* × *hybrida* L. 'Meijikatar' (Tradename: Orange Sunblaze) and 'Confection' plants were treated with 30 minutes of red light (600–700 nm) or far-red light (700–780 nm) at the end of each daily photoperiod throughout production. At harvest, plants were placed in storage for 5 days at 16°C (61°F). 'Meijikatar' plants treated with end-of-day far-red light had more leaf chlorosis than plants treated with end-of-day red light or those which served as controls. 'Confection' plants treated with end-of-day far-red light had more leaf chlorosis than plants treated with end-of-day red light. 'Meijikatar' plants were treated in the greenhouse at the end of each photoperiod with 1 hour of incandescent or fluorescent light, with control plants receiving natural greenhouse end-of-day light, and then placed into storage. Plants treated with end-of-day incandescent light were taller than plants treated with end-of-day fluorescent light or controls. After simulated storage, plants treated with end-of-day incandescent light had the most etiolated shoots. Light treatments had no significant effect on the amount of leaf chlorosis 5 days after removal from simulated storage.

Key Words: chlorosis, phytochrome, postharvest, *Rosa* × *hybrida*, storage.

Significance in the Nursery Industry

The manipulation of light quality during production shows promise as an inexpensive, non-chemical means of regulation of growth responses of plants which are presently controlled by use of chemical growth regulators. In this study, end-of-day red and far-red light treatments given to *Rosa* × *hybrida* 'Meijikatar' and 'Confection' plants in the laboratory had significant effects on postharvest leaf chlorosis. However, when standard light sources with a high amount of red or far-red light (fluorescent and incandescent light) were irradiated on plants at the end of a natural greenhouse photoperiod, there were no effects on postharvest leaf chlorosis. These results indicate that precise alterations of end-of-day light quality must be used to influence leaf chlorosis. These alterations could most easily be obtained with selective light filters such as liquid spectral filters, or light-selective shading materials.

Introduction

Potted roses are a relatively new greenhouse crop for U.S. growers. Recent breeding efforts have resulted in improved pot-forcing cultivars which are easier to grow and have the potential for being mass-marketed to fill consumer demands for roses at Valentine's and Mother's Day. Although potted roses have a promising future, their commercial development is limited by losses encountered during postharvest handling. Because the crop is often shipped in small numbers, it is not always feasible for growers to ship under refrigeration. Adverse storage temperatures and darkness inside storage boxes can lead to crop deterioration. A common postharvest problem with potted roses is leaf chlorosis developing in the lower leaves of plants 3 to 5 days after removal from storage which, subsequently, leads to leaf abscission. Leaf abscission of pot roses was reduced when the cytokinin 6-(benzylamino)-9-(2-tetrahydropyranyl)-9H-purine was sprayed onto plants prior to simulated transport (4). Foliar application of benzyladenine and transzeatin 1 hr prior to storage at 16°C (61°F) reduced lower leaf chlorosis of 'Meijikatar' potted roses 3 and 5 days after removal from storage (1). Presently, there are no chemicals labeled to control leaf chlorosis in potted roses.

Brief end-of-day (EOD) irradiations of tobacco plants with red (R) or far-red (FR) light have been shown to have dramatic morphological effects (6). Plants treated with EOD FR light were more elongated with fewer lateral branches, and had chloroplasts with fewer, smaller starch grains, while plants treated with R light were more compact with more lateral branches and had chloroplasts with more, and larger

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