Table 2. Effectiveness of Sumagic foliar sprays on flower bud initiation in *Rhododendron catawbiense* 'Roseum Pink'.

Sumagic treatment (ppm)	Flower buds/plant**
0	4 a
12.5	16 b
25.0	17 b
50.0	19 b

** Means within a column followed by the same letter are not significantly different at the 1% level using Duncan's New Multiple Range Test.

CONCLUSIONS

The superphosphate top-dress treatments did not consistently increase the number of flower buds on 'Roseum Pink' hybrid rhododendrons. Sumagic increased the number of flower buds, but increasing the rate from 12.5 to 50.0 ppm had no significant effect on the number of buds. These results are thought to vary from field grown rhododendrons because the rhododendrons in Shelton's field experiments were growing in phosphorus-deficient soils rather than in a container medium with adequate phosphorus nutrition provided by the controlled-release fertilizer.

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Photoperiod and Stock Plant Age Effects on Rhizome, Shoot, and Stolon Initiation From *Achimenes* Leaf-petiole Cuttings©

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INTRODUCTION

Achimenes, commonly known as the hot water plant, magic plant, or monkey faced-pansy, is member of the Gesneriaceae. There are 25 species native to subtropical forest regions of Central America and northern South America (Brickell and Zuk, 1996). Although *Achimenes* have been cultivated since the late 1700s, their popularity has waned and surged. Recently, however, there has been a renewed interest with newer cultivars. *Achimenes* are well suited for use as a pot plant, in mixed containers, and as a hanging basket (De Hertogh and Le Nard, 1993).

Flowers of *Achimenes* develop from the leaf axils and are born singly or in multiples. Flowers can be single or double. *Achimenes* bloom continuously throughout the summer in a wide spectrum of colors; reds, yellows, pinks, blues, violets, and whites. Corollas are five lobed bilaterally symmetric or zygomorphic and are 2 to 5 cm in diameter. Flowers have short peduncles with a wide-spread calyx, and 5 stamens. The long, two-lobed style terminates with a mouth or cup-shaped stigma.

MATERIALS AND METHODS

Stock plants of *Achimenes* 'A09', 'A16', and 'A23' from Oglevee, Inc. were grown in greenhouse conditions at 21 ºC, under two daylengths 16 h or 8 h. Daylengths of 16 h were accomplished by using night interruption lighting with incandescent lighting, while 8-h daylengths were achieved through night shading with black cloth. "Old" stock plants were 27 weeks old from planting (planted 11 Nov. 2002) while "young" stock plants were 13 weeks old from planting (planted on 14 Feb. 2003). Leaf petiole cuttings of uniform size were excised from both young and old stock plants on 21 May 2003 and planted. Three replications of six leaf samples each for each treatment and cultivar were placed into 10-cm plastic pots containing Metro Mix 360 (Scott's Company; Marysville, Ohio) and randomly placed in growth chambers (Percival Scientific; Perry, Iowa) at 20 ºC, under fluorescent lighting.

Photoperiod treatments during propagation remained 8 h and 16 h. The four photoperiodic sequences studied were 16 h to 8 h, 16 h constant, 8 h to 16 h, and 8 h constant. Leaves were evaluated 8 weeks after the cuttings were stuck. Observations were made on rhizome formation, shoot production, and stolon production. Rhizomes were defined as small swelling tissues (>1 mm in diameter) on the petiole or on underground roots and stolons. Shoots were defined as vegetative growth exhibiting a stem with developing leaves. Stolons were defined as an above ground stem with no developing or expanding leaves. Data presented here are on the binary response; a "yes" or "no" the leaf developed at least one rhizome, shoot, or stolon.

The experiment was a three-way factorial with treatments of photoperiod, tissue age, and cultivar. Analysis of Variance was completed using SAS (SAS, 1999). Mean separations were performed using Tukey's method at $P = 0.05$.

RESULTS

Rhizome Response. The age of the leaf tissue used for propagation affected rhizome formation. Old leaf tissue had a greater response to rhizome formation than young tissue. Old leaf cuttings responded with rhizomes 94% of the time, while young leaf cuttings only responded 41% (Fig. 1). There was also a leaf-cutting response to the photoperiod treatment. Leaves that were propagated under 8 h initiated at least one rhizome; more than leaves propagated under 16 h. However, the response was statistically significant for the photoperiod sequence of 16 h to 8 h (Fig. 2).

Shoot and Stolon Response. Shoot response was affected by the age of plant tissue. Young tissue responded 74% of the time with at least one shoot initiated, while old tissue, just 3% (Fig. 3). There was a significant effect on stolon response in young tissue. Eighty eight percent of young leaves responded, while only 25% of old leaves initiated at least one stolon (Fig. 4).

DISCUSSION

Achimenes are easily propagated from leaf cuttings. However, growth responses varied, depending on plant age and photoperiod. This could be advantageous, depending on the desired need. Some leaves only formed rhizomes, shoots, or stolons,

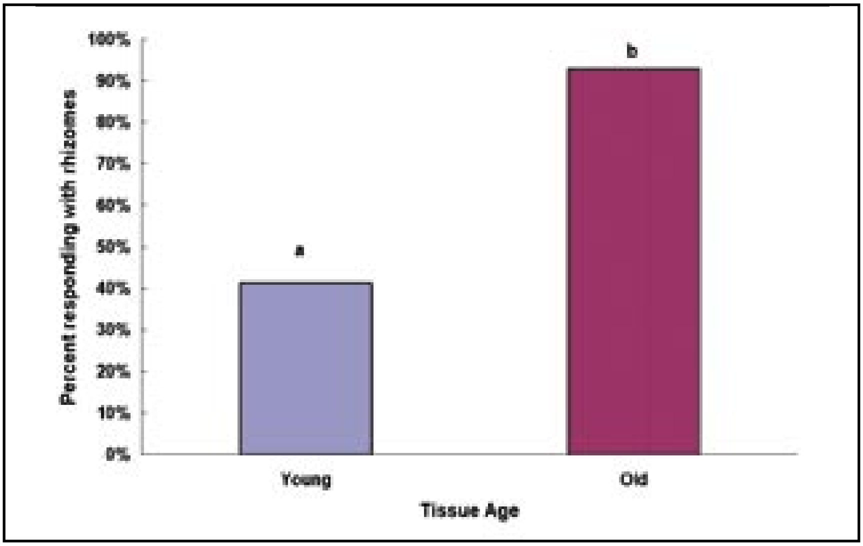

Figure. 1. The percent of young (13 weeks from planting) and old (27 weeks from planting) *Achimenes* leaf petiole cuttings responding with the initiation of rhizomes. Totals are for three cultivars. Mean separations by Tukey's HSD at $P = 0.05$. Values are means of 216 leaves (young) and 212 leaves (old).

while others formed a combination of structures. It is well known that the age of propagation material has an effect on subsequent growth and development (Hartmann, et al., 1997).

The age of propagule had an influence on the response of leaf cuttings. Leaf cuttings from old tissue responded with the production of storage structures (rhizomes). In contrast, young tissue responded with vegetative structures such as shoots and stolons. Little information is known about the specific role and function of the stolons with *Achimenes*.

The initiation of rhizomes on old tissue was more than 2 times greater when compared to young tissue (Fig. 1). Similar rhizome development on leaf cuttings was found by Deutch (1974), Wikesjo (1981), and Vlahos (1989). Vlahos (1989) reported that young leaves produced more shoots and fewer rhizomes in tissue culture.

Shoot formation on young tissue was 25 times greater, and stolon formation from young tissue was 3.5 times greater, than that of old tissue (Figs. 3 and 4, respectively). Similar findings were found in vitro (Vlahos, 1989). The differences between young and old tissue responses could be explained by variations in endogenous hormone levels. The observed responses also suggest a difference in partitioning of carbohydrates. The possibility exists that endogenous hormones as well as light duration and quality, either in combination or individually, play an important role in this portioning and development of rhizomes, shoots, or stolons. Gibberellins are known to adversely affect tuberization, while cytokinins have been shown to be promotive in the process (Deutch, 1974). To date no studies have investigated endogenous hormones in *Achimenes*.

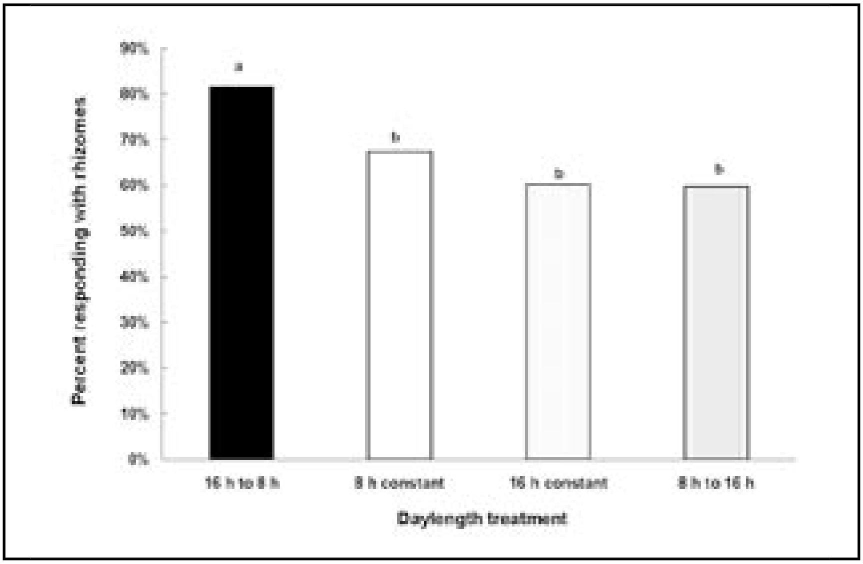

Figure 2. The percent of leaf petiole cuttings initiating rhizomes under various photoperiod treatments in *Achimenes* (initial stock plant daylength and final propagation daylength: 16 h to 8 h (n= 108); 8 h constant (n=106); 16 h constant (n=108); 8 h to 16 h (n=106)). Mean separations by Tukey's HSD at $P = 0.05$.

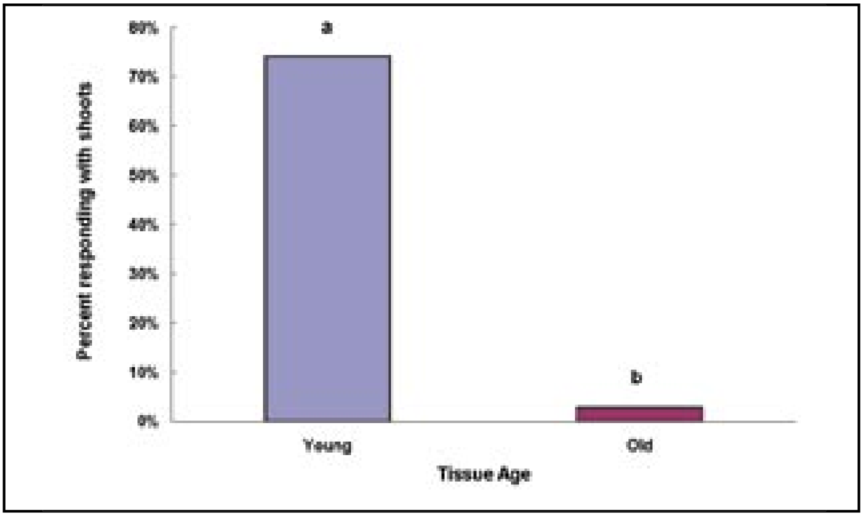

Figure 3. The percent of young (13 weeks from planting) and old (27 weeks from planting) *Achimenes* leaf petiole cuttings responding with the initiation of shoots. Totals are for three cultivars. Mean separations by Tukey's HSD at $P = 0.05$. Values are means of 216 leaves (young) and 212 leaves (old).

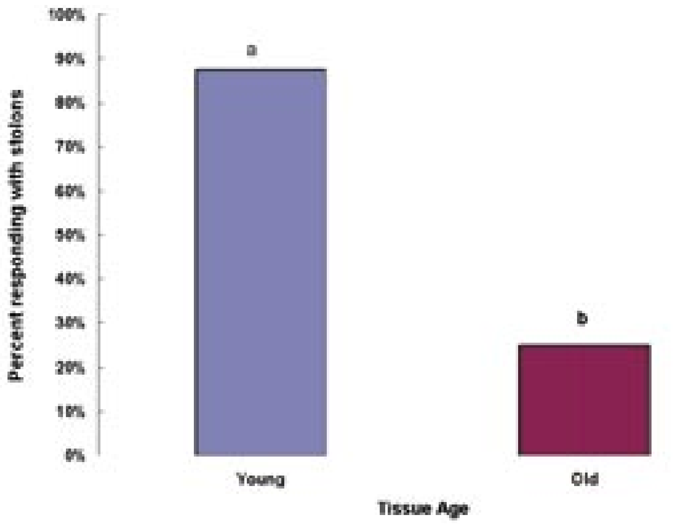

Figure 4. The percent of young (13 weeks from planting) and old (27 weeks from planting) *Achimenes* leaf petiole cuttings responding with the initiation of stolons. Totals are for three cultivars. Mean separations by Tukey's HSD at $P = 0.05$. Values are means of 216 leaves (young) and 212 leaves (old).

The type of morphological structures that are initiated from leaf cuttings can be important for the propagation of *Achimenes*. Increased shoot production is important in subsequent stem-tip cutting propagation from leaf cuttings. *Achimenes* leaf cuttings have the ability to initiate several shoots per leaf. Further experiments would be needed to evaluate the effectiveness of this approach to propagation. Propagation from older leaves could be an alternative and economical method of rhizome production.

Rhizome formation was significantly greater when the leaf cuttings were propagated with a photoperiod ending with 8 h. However, this response was only significant when preceded by 16 h. This is consistent with previous studies that show that shorter photoperiods, depending on cultivar, increased the number of rhizomes in *Achimenes*. No evidence was found that longer photoperiods (16 h) inhibit rhizome formation and development, but the results suggest that long days may suppress rhizome formation. In the current study, a long photoperiod did not suppress rhizome initiation, as was seen in tuber formation in dahlia (Legnani and Miller, 2000), begonia (Fonteno and Larson, 1982), and rhizome formation in lotus (Blumenthal and Harris, 1998). This work suggests that shorter photoperiods stimulate the development of rhizomes, but may not be the primary stimulus for initiation and subsequent development of rhizomes in *Achimenes*. Tuber formation is often a photoperiodic phenomenon, and as such, is important to consider the role of phytochrome and light quality, in relation to endogenous hormones. Deutch (1974) reported that bulblet formation and inhibition was dependent on the quality of light under which the cuttings were propagated. It is important to note that light qualities were not controlled for in this study. Results do not take into account the switch from solar radiation to artificial lighting. Such control of lighting may further explain the results obtained.

This study provides more insight into the little known growth responses of *Achimenes*. Further research should be conducted on hormonal profiles in combination with varied photoperiodic and light quality treatments.

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