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NUTRITIONAL EFFECTS ON COLD ACCLIMATION OF *HIBISCUS SYRIACUS*

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Abstract. ***Hibiscus syriacus*** **L. were grown in 3.8 liter containers under natural environmental conditions in Gainesville, Fla. On 1 Oct. 1984 fertilization was discontinued on one-half of the test plants while the other half continued receiving weekly applications of 300 ppm, 20N-8.6P-16K through the experimental period. Freezing tests were conducted and stem apices collected and dried at 2 to 4 week intervals through the fall and winter months of 1984-85. Cold hardiness patterns and tissue nutrient analysis were not significantly different between the fertilized and nonfertilized treatments. Continued fall and winter fertilization does not appear to affect the cold hardiness of *** ***H. syriacus*** **.**

The influence of fertilization practices on cold hardiness of horticultural crops is a subject of considerable economic interest to growers. Although the subject of a number of research investigations, a definitive relationship between nutrition and cold hardiness has yet to be discovered (1, 13, 15). Some of this confusion has been credited to the variability of experimental procedures and interpretation of experimental results (15). However, the complexity of plant cold hardiness physiology must also play a role. Whole plant cold hardiness can be divided into 3 main components: 1) acclimation, the change from a cold-susceptible to a cold-resistant state; 2) ultimate midwinter hardiness, the maximum cold hardiness potential of the plant; and 3) deacclimation, the timing and rate of loss of cold hardiness (9). In addition, cold hardiness is complicated by the fact that adjacent tissues and/or organs of a plant may simultaneously have different hardiness levels (28).

In general, recommendations based on past research discouraged late season fertilization with nitrogen while additions of phosphorus and potassium were thought to increase cold hardiness (5, 10). Early research showed fall nitrogen fertilization of field-grown apples inhibited cold acclimation (7, 23, 27). More recent research indicated fall fertilization of apples with nitrogen, phosphorus, and potassium, while temporarily slowing cold acclimation, produced greater ultimate midwinter hardiness than spring fertilization (12). Similarly, high levels of nitrogen and potassium (250 lbs./acre) inhibited cold acclimation of *Viburnum plicatum tomentosum* in early fall, but did not affect cold hardiness from late fall through early spring (19). Aronsson (2) reported that high nitrogen rates (155 lbs./acre), which resulted in nutrient imbalance, caused a reduction in cold hardiness of *Pinus silvestris,* while Hellergren (8) found high rates of a complete fertilizer only slightly reduced cold hardiness of the same species.

The question most likely to be asked by nursery growers is when to withhold fertilizer to maximize both plant cold hardiness and growth. The objective of this study was to determine effects of fall and winter fertilization on cold hardiness and tissue nutrient levels of *Hibiscus syriacus. H. syriacus,* Rose of Sharon, is a deciduous shrub recommended as far north as USDA Plant Hardiness Zone 5 with winter minimum temperatures down to –29°C (26). Sakai (20), using an artificial hardening regime, has induced a maximum cold hardiness level of –30°C in *H. syriacus.*

Material and Methods

Forty rooted cuttings of a single-white flowered *H. syriacus* genotype were potted in Metro-Mix 500 (W. R. Grace and Co., Cambridge, MA) in 3.8-liter containers during April 1984. Plants were grown under natural temperature and photoperiod in a polypropylene shadehouse (47% light attenuation), watered as needed and fertilized weekly with 300 ppm, 20N-8.6P-16K Peters 20-20-20 (W. R. Grace and Co.). After cold hardiness levels were tested on 1 Oct. 1984, fertilization was discontinued on one-half of the plants for the remainder of the experiment. Fertilization with 300 ppm, 20N-8.6P-16K, at weekly intervals was continued throughout the experiment on the other half of the plants.

Freezing tests were conducted on each treatment at 2 to 4 week intervals from 1 Nov. 1984 through 28 Mar. 1985. On each freezing date, stem samples of consistent caliper from 2 of 3 plants selected at random from each treatment were cut into 3-cm lengths and placed in contact with a moist paper towel in 1500-ml wide-mouthed polyethylene tubes. Copper-constantin thermocouples were inserted 5 to 7 mm into the pith of representative stems. Tissue temperature was monitored using an Esterline Angus PD 2064 data scanner. Tubes were immersed in a Forma Scientific model 2425 bath and circulator containing polyethylene glycol and held at 0°C for 2 hr. The bath temperature was reduced to –2°C and 2 hr later finely crushed ice was added to each tube to ensure freezing of the stems. After exposure to –2°C for an additional 12 hr, the first samples were removed. The temperature was dropped at 2°C per hour and held at each successively lower test temperature (2°±0.5°C intervals) for 2 hr. Samples were thawed at 2°C for 24 hr, removed from the tubes, placed with a moist paper towel in polyethylene bags, and incubated at 25°C and 100% relative humidity for 7 to 10 days. Each treatment was replicated 3 times using 3 stem sections at each test temperature. A control set of samples

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for each treatment was placed directly into a polyethylene bag and incubated without freezing. Sample viability was determined by visual observation of tissue browning (18, 22) using a binocular dissecting microscope. Stem sections killed showed browning and a water-soaked appearance of the phloem and cambial tissue. Stems uninjured by freezing remained green, often developing callus and new shoots. Stem sections were rated from 1 (completely dead) to 3 (alive and uninjured). The percentage of stems surviving each temperature was recorded. From these data a T_{k50}, the freezing temperature required to kill 50% of the samples, was calculated for each treatment (14, 17).

Stem apices were collected for tissue nutrient analysis on 6 of 8 freezing test dates. Samples were dried in a forced draft oven for 48 hr at 70°C, ground in a cyclone mill, ashed at 450°C, then placed into solution for macronutrient and micronutrient analyses according to the procedure described by Chapman (4). Tissue nutrient analyses were conducted by Peters Fertilizer Laboratories, Fogelsville, PA.

The nonparametric Wilcoxon-Mann-Whitney test was used to determine the statistical differences between the seasonal cold acclimation patterns of the 2 treatments (21). One-way analysis of variance was used to compare tissue nutrient levels of the 2 treatments.

Results and Discussion

Wilcoxon-Mann-Whitney analysis of T_{k50} values from 8 freezing test dates, 1 Nov. 1984 through 28 Mar. 1985, showed the cold hardiness patterns of plants in the 2 fertilizer treatments were not significantly different (Fig. 1). In this experiment, continued fertilization with 300 ppm, 20N-8.6P-16K through the fall and winter months did not adversely affect the natural cold acclimation of container-grown *H. syriacus*. Plants cold acclimated down to ultimate midwinter hardiness levels of –22.5°C and –24.5°C in the fertilized and non-fertilized treatments, respectively. These results are in agreement with research using container-grown *Cornus* and *Forsythia* as well as a number of field-grown coniferous species (2, 3, 16).

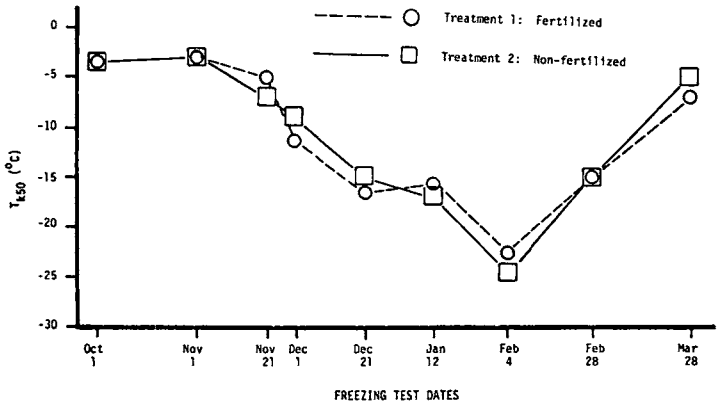

Fig. 1. Natural cold acclimation patterns of fertilized and nonfertilized container-grown *Hibiscus syriacus*.

Mean levels of macronutrients and micronutrients in *H. syriacus* stem tissue were not significantly different between the 2 fertilization treatments (Table 1). Similarly, no differences were found between treatments on individual freezing test dates. Although high nitrogen concentration of leaves was associated with greater winter damage in *Pyracantha coccinea* (11), Christersson (6) found no significant tissue nutrient level or cold hardiness differences between fertilized and unfertilized treatments of *Picea abies* during the winter months. Similar results have been reported for several species of field-grown conifers (3).

The response of *H. syriacus* to continuous fertilization runs contrary to the traditional notion that late season fertilization causes a decrease in cold hardiness (5, 10). It is important when considering results of nutrition-cold hardiness research to keep in mind the nature of the species under study. Photoperiod induces growth cessation (25) and cold acclimation in *H. syriacus* (24). Furthermore, *H. syriacus* is a hardy species when compared to many of the woody ornamentals grown by nurseryman in Florida and the deep South. Cold hardiness of these less hardy species may be more sensitive to late season fertilization. In species with a strong, photoperiodically induced cold acclimation response, fertilization later in the fall could maximize growth without increasing the danger of freeze damage.

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Table 1. Mean tissue levels of fertilized and nonfertilized container-grown *Hibiscus syriacus*.

	Average tissue nutrient levels[z]										
	% Dry weight					PPM					
Treatment	N	P	K	Ca	Mg	Mn	Fe	Cu	B	Zn	Mo
1-Fertilized	2.1	.41	1.31	1.02	.53	90	323	52	39	102	2.5
2-Nonfertilized	1.9	.37	1.42	1.04	.46	91	278	86	36	144	2.8

[z]One way analysis of variance at the 0.05 level showed no significant difference between treatments.

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WOODCHIP SLUDGE COMPOST AS AN INGREDIENT OF POTTING MIXTURES FOR FOLIAGE PLANTS

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Abstract. ***Brassaia actinophylla* Endl., *Chrysalidocarpus lutescens* H. Wendl., *Dieffenbachia maculata* (Lodd.) G. Don 'Camille', and *Peperomia obtusifolia* (L.) A. Dietr. were grown in 3 soil mixes with various levels of a woodchip sludge compost (Compro) incorporated. *Brassaia, Chrysalidocarpus,* and *Peperomia* grew equally in all levels of Compro. Compro did not affect top growth or quality of *Dieffenbachia,* but an increase in Compro decreased root grade. Growth of *Chrysalidocarpus* and *Brassaia* was equal in the 3 mixes, but the 3:1 peat:sand mix was slightly better for *Dieffenbachia* and *Peperomia.* Additions of Compro changed medium physical characteristics, but not to the betterment or detriment of plant growth.**

Many publications have been printed describing effects of potting medium ingredients on growth of a large variety of container grown plants. However, the number of publications describing physical and chemical characteristics of these media and correlation of these characteristics to plant growth is limited. In 1965, Joiner and Conover (6) described the value of expressing cation exchange capacity (CEC) and water holding capacity (WHC) on a volume instead of a weight basis. A few years later, research showed that various amendments added to soil changed both physical characteristics and plant growth (9). Waters et al. (10) showed that changing the ingredients of a container could greatly alter soil physical characteristics. Since then, other publications have related soil physical characteristics to growth responses of plants (2, 3, 4, 5, 7). Suggested standards for potting media used to grow foliage plants were published in 1981 (8). A recent publication indicated Compro (a woodchip sludge compost) could be used as a satisfactory ingredient of potting media (1). Experiments reported here were conducted to determine growth of 4 foliage plants in various potting media with different levels of Compro incorporated and the physical characteristics of these media.

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Materials and Methods

Experiment 1. A 3 x 5 factorial experiment in randomized block design with 6 replications was established 24 June 1982 using rooted *Dieffenbachia maculata* or *Peperomia obtusifolia* in 15-cm pots. The 3 base potting media were: 3 Florida peat:1 builder's sand; 2 Florida peat:1 pine bark:1 cypress shavings; and 1 Florida peat:1 pine bark (v/v). Five woodchip sludge compost levels were 0, 10, 20, 30 and 40% of the above media. The resulting 15 potting media were amended with 1 kg/m^3 MicroMax (Sierra Chemical Co., Milpitas, CA 95035) and 4 kg/m^3 dolomite. A slow release fertilizer (19-3-10, N-P-K, [Sierra Chemical Co., Milpitas, CA 95035]) was surface applied at 2 g/pot for *Peperomia* and 3.3 g/pot for *Dieffenbachia,* 24 June and 26 Sep. 1982. Plants were maintained in a greenhouse receiving 1500 fc maximum light with temper-