Determining Cold Hardiness of *Heuchera sanguinea* Engelm. 'Chatterbox' Using Dormant Crowns

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Abstract. Dormant, intact crowns were used to determine the cold hardiness of the herbaceous perennial *Heuchera sanguinea* 'Chatterbox'. Crowns were placed in moist cheesecloth, wrapped in aluminum foil, and subjected to -4, -6, -8, -10, -12, -14, -16, or -18°C in a programmable freezer. Regrowth quality ratings and dry-mass measurement decreased linearly with temperature. No regrowth was evident from any crown exposed to -12°C or lower temperatures. Freezing dormant plant crowns proved an efficient and reliable technique for estimating cold hardiness of *Heuchera* 'Chatterbox'.

Researchers studying the effects of low-temperature stress on plant productivity have produced an avalanche of information (Guy, 1990). Still, relatively little is known about low-temperature tolerance of herbaceous perennial landscape plants (Good, 1986). Plant performance of perennial species can be predicted by assigning hardiness-zone ratings (Armitage, 1989; Clausen and Ekstrom, 1989; Still, 1988). However, ratings are based largely on empirical findings and do not reflect results from scientific studies.

Cold hardiness information is vital to growers producing herbaceous perennials in containers. Container culture inevitably means exposing sensitive crowns and root systems to temperature extremes, particularly if plants are held overwinter for sale the next year. Several researchers have described winter protection measures for container-grown perennials (Perry, 1990; Still et al., 1989), but there is little current information describing low-temperature tolerance for specific species. If the herbaceous perennial market is to continue its expansion (Voigt, 1992), growers, retailers, and landscape designers must thoroughly understand how low temperatures affect these popular landscape plants.

The generally accepted laboratory technique for estimating low-temperature hardiness under controlled conditions involves freezing plant tissues to desired temperatures, thawing them, and determining degree of survival

or injury (Ahmedullah and Kawakami, 1986). Lindstrom et al. (1992) recommend examining whole plants because they may respond differently to freezing temperatures than do small leaf sections or disks. Still et al. (1987) exposed 10 species of containerized perennials to a range of freezing temperatures. None of their test species was rated salable after exposure to -12.6°C. However, several species responded differently to low test temperatures. We conducted similar studies (Iles and Agnew, 1993) with containerized perennials and identified lethal low temperatures for five species, but erratic qualitative and quantitative responses were noted after exposing plants to test temperatures well above the identified killing temperature. Therefore, we used dormant, intact crowns instead of containerized plants to determine cold hardiness of the perennial *Heuchera sanguinea* 'Chatterbox'.

On 20 Jan. 1990, dormant crowns of *Heuchera* 'Chatterbox', having an average weight of 76 ± 0.5 g, were obtained from Walters Gardens, Zeeland, Mich., and held at 2 ± 1 °C until freezing tests began on 22 Jan. A randomized complete block design was used with five replications over time. Crowns (24 per replication) were randomly selected, placed in moist cheesecloth, wrapped in aluminum foil (McKenzie and Weiser, 1975), and transferred to a Scientemp programmable freezer (Scientemp Corp., Adrian, Mich.) for exposure to -4, -6, -8, -10, -12, -14, -16, or -18 ± 0.5 °C (three crowns per test temperature). Control plants were kept at 2 ± 1 °C during the freezing test. Test-tube racks were used to suspend plant crowns above the freezer floor to facilitate uniform cooling. Copper-constantan thermocouples (0.02 mm in diameter, 20 gauge; Type T; Omega Engineering, Stamford, Conn.) were attached to three extra crowns to monitor tissue temperature. Thermocouple output was recorded on a Honeywell Electronic 15 multipoint recorder (Honeywell, Fort Washington, Pa.).

Cooling was initiated from the storage temperature (2°C) at a rate of 2 ± 0.5 °C/h. Temperature was lowered to -4°C and held for 12 h, allowing the cheesecloth to freeze and ice to nucleate within the crown tissue. Three randomly chosen crown samples were removed after tissue temperature had stabilized at each treatment temperature, transferred to a cooler, and allowed to thaw for 24 h at 2 ± 1 °C. Each crown then was planted in 3.5-liter (#1) green plastic containers using a medium of 2 Canadian sphagnum peat: 2 perlite: 1 field soil (by volume), and transferred to a 21 ± 3 °C greenhouse for forcing under natural daylength.

After 60 days, plants were rated qualitatively, where 1 = a dead plant, 2 = a live plant with little top growth, and 3 to 5 = a plant of acceptable quality, 5 being the highest rating.

Fig. 1. Relationship between regrowth quality rating and low-temperature exposure for *Heuchera sanguinea* 'Chatterbox'. $Y = 4.9 + 0.22(\text{temp})$, $r = 0.85$. Correlation coefficient is significantly different from zero ($P \leq 0.05$). Data presented are means of three observations $\times$ five replications. Quality ratings were 1 = dead plant; 2 = alive, but little top growth; 3-5 = acceptable, 5 = highest quality. None of the test plants survived exposure to -12°C or lower.

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Fig. 2. Relationship between regrowth dry mass (in grams) and low-temperature exposure for *Heuchera sanguinea* 'Chatterbox'. $Y = 4.4 + 0.18(\text{temp})$, $r = 0.94$. Correlation coefficient is significantly different from zero ($P \leq 0.05$). Data presented are means of three observations $\times$ five replications. None of the test plants survived exposure to -12C or lower.

Shoot regrowth was harvested, dried at 67C for 72 h, and weighed. Quality rating and dry mass data were subjected to analysis of variance procedures and regression analysis.

Relationships between regrowth indices and low temperature were negative and linear. Quality ratings decreased with temperature, falling below an acceptable value after exposure to -10C (Fig. 1). Dry mass measurements also decreased linearly with decreasing temperature (Fig. 2). No regrowth occurred from any crown exposed to -12C or lower. These results agree with findings from a winter-protection study (Iles et al., 1993) in which several cultivars of containerized *H. sanguinea* left unprotected in control treatments failed to resume growth after the medium was below -12C . These results also suggest a gradual transition from viable or undamaged tissue to killed tissue upon exposure to decreasing freezing temperatures. Temperatures at or above -8C did not compromise crown survival and could be termed nonlethal even though quality ratings and dry mass decreased linearly with decreasing temperature. Exposure to sublethal -10C did not cause

visible injury symptoms but apparently injured growing points within the crown, which reduced vegetative regrowth and diminished the ornamental utility of regrowing plants. Temperatures at or below -12C were lethal to *Heuchera* 'Chatterbox'; however, the transition temperature between lethal and sublethal was not determined by our methods. Using a broad range of treatment temperatures with relatively large intervals hinders determining small differences in cold tolerance (Anderson et al., 1988).

We compared our results with hardiness-zone ratings provided in several herbaceous perennial references. Although we found *Heuchera* 'Chatterbox' to be incapable of surviving -12C and lower, *H. sanguinea* is frequently assigned to U.S. Dept. of Agriculture hardiness zone 3 (Armitage, 1989; Clausen and Ekstrom, 1989). While monitoring soil temperatures (15 cm deep) in USDA hardiness zone 4a during a winter with modest snow cover, Wildung et al. (1973) reported temperatures as low as -18C under nonmulched soil, suggesting zone 3 is inappropriate for *H. sanguinea*.

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