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Hardening of Herbaceous Perennial
Plugs Prior to Storage at -2.5C

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Beth Etta Engle

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Arthur C Cameron
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USE OF LIGHT AND TEMPERATURE FOR HARDENING OF HERBACEOUS PERENNIAL PLUGS PRIOR TO STORAGE AT -2.5C

BY

BETH ETTA ENGLE

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ABSTRACT

USE OF LIGHT AND TEMPERATURE FOR HARDENING OF HERBACEOUS PERENNIAL PLUGS PRIOR TO STORAGE AT -2.5C

By

BETH ETTA ENGLE

Storage of herbaceous perennial plugs at subfreezing temperatures could be a valuable production tool. Tolerance to subfreezing storage is species dependent and affected by prestorage hardening. In one experiment, 14 species of seed-propagated perennial plugs were pretreated in light at 0 or 5C for zero, two, four, or eight weeks prior to storage at -2.5C. Most species benefited from at least two weeks at a prestorage temperature of 0 or 5C prior to storage. In a second experiment, 16 species were treated at 5C in the light or dark for zero, two, or four weeks prior to -2.5C storage for 0, 6, 12, or 18 weeks. For several species, plugs hardened in the light tolerated storage better than those hardened in the dark. Pretreated plugs performed better than those transferred directly to -2.5C. Regrowth ratings and percent survival for most species declined if storage at -2.5C exceeded six weeks.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Perennials have been gaining in popularity the past several years. This interest on the part of consumers has fueled an equal interest on the part of perennial producers. Traditionally, many perennials have been propagated by division or cuttings, especially once a superior clone had been selected. Because of improved seeding techniques and increased availability of perennial seed, many growers are now producing perennial plugs from seed. Plugs are small transplants grown in trays that usually contain 50-200 cells. Many producers are using techniques first developed by vegetable transplant growers and later adapted by bedding plant producers.

Perennials produced from plugs offer advantages that those field-grown plants do not. Plug-grown plants tend to be less expensive, lend themselves to greenhouse production techniques, and are easier to transplant than field-grown plants.

A drawback to using seedlings is that they are not necessarily phenotypically uniform; it is a function of seed production techniques and breeding efforts. *Campanula* *carpatica* 'Blue Clips' and 'White Clips,' are very uniform phenotypically from seed. However, great seedling variation can be noted with certain species of *Coreopsis* and *Gaillardia*.

Perennial growers of seedling plugs may grow hundreds of different species. In some cases, growers receive orders and sow plugs weekly knowing that in eight to 12 weeks, the seedling will be ready to ship. The growers have little capacity to 'hold' the seedlings once they have reached size. It would be more efficient if the growers were able to sow and grow a species in large numbers simultaneously, even if only on a monthly basis.

To schedule and produce product on a monthly basis, it would be necessary to hold the trays at low temperatures. This would slow growth and reduce watering requirements. This, in some cases, may improve the growth of the plugs by helping to keep the plugs short. There are two possible solutions: (1) hold the trays in a cold greenhouse or cold frame; and (2) hold the trays in controlled temperature storage. Currently, many perennials are overwintered in greenhouses or coldframes, although the space utilized is valuable in the sense that it could be used for producing additional plant material. While the plants are being held in the greenhouse they still require care, particularly watering.

Controlled-temperature storage is currently being used to store field-grown, fall harvested, bare-root plant material. Magbool and Cameron (1994) found that -2.5C storage was preferable for most herbaceous perennial species tested with a few exceptions. During storage, bare-root material is protected from desiccation by wrapping in polyethylene. This has been found to be satisfactory for most, but not all, species. One primary advantage is that no water is required during storage. It could be useful to store plug trays in similar controlled-temperature facilities. Research conducted by Heins et. al. (1992), studied the effect of storage of four species of bedding plants in cell trays at controlled temperatures as low as 0C and as high as 12.5C.

Currently, there is little commercial use of plug storage at controlled temperatures for herbaceous perennial seedlings. Most growers do not have access to the facilities required for this type of storage. Primarily because they can be expensive. There are currently no research recommendations as to prestorage handling techniques, or possible storage duration.

Harvest date is critical for survival in storage. Hanchek and Cameron (1994) observed that the survival of bare-root crowns of several perennials following two to four months storage at -2.0C was very low if the plants were harvested in September. Survival greatly increased when harvested later in the fall. There are two possible reasons for this result, the plants were effected by decreasing temperatures or by shortening daylengths. Hanchek and Cameron (1994) were unable to determine the exact cause of field hardening. Paulsen (1968) showed that temperatures at or below 5C were the most important factor for induction of cold hardening in winter wheat 'Pawnee'. He correlated this with an observed increase in the amount of dry matter, reducing sugars, sucrose, and amino acids with increasing time at cold temperatures. Photoperiod alone had little if any effect on hardening. Olien (1967) suggested that winter cereals held at temperatures above 10C are unable to harden regardless of photoperiod.

It should be possible to hold perennial plugs at below freezing temperatures. However, there are important differences between field-grown and plug-grown material. Plugs are not as large, and will not have the same amount of food reserves as larger plant material. Jung and Smith (1960) pointed out that food reserves for red clover determined the ability of the plants to harden. As the level of available carbohydrates decreased below 14-16%, cold resistance declined. This decline of hardiness with decline of storage reserves may point out the need for light in the hardening process. Plants as small as plugs may require light to produce photosynthates to survive storage. Dexter (1933) found that at 0C, there was no hardening in darkness, less under short-day lengths, and most under long-day lengths. He concluded that the hardening was related to photosynthesis.

Di Sabato-Aust (1987) conducted controlled freezing tests on ten species of herbaceous perennials. She categorized them into three groups, those that were 'hardy', to have a salable plant after freezing to -11.0C, 'intermediate', to have a salable plant from -9.3 to 7.7C , and 'tender' to have a salable plant from -6.0 to -2.7C. In the 'hardy' category were *Achillea filipendulina* 'Parker's Variety', *Gaillardia* x *grandiflora* 'Monarch Strain', and *Lythrum salicaria* 'Robert'. In the 'intermediate' category were *Campanula glomerata* var. *acaulis, and Coreopsis grandiflora* 'Sunray'. In the 'tender' category were *Chrysanthemum coccineum, Erysimum hieraciifolium, Digitalis* x *mertonensis, Geum Quellyon* 'Mrs. Bradshaw' *and Kniphofia Uvaria* 'Pfitzer's hybrids'. The plants used in this study were originally from 70-cell trays, obtained in September and transplanted into quart pots. The plants were hardened outdoors in Ohio until December when the plants were transferred to a walk-in cooler.

The primary objective of the studies I conducted were to determine regrowth and survival of a number of herbaceous perennial plugs following exposure to -2.5C as influenced by pretreatment temperature and irradiance.

LITERATURE REVIEW

1. INTRODUCTION AND DEFINITIONS

Plants must be able to survive the sometimes harsh conditions that are prevalent during the fall, winter, and early spring in temperate climates. How are plants able to survive these conditions? They must have mechanisms that allow some structure in the plant to live throughout the winter until it can grow again in spring. Annuals survive as seeds, while the adult plant usually dies. Perennials, both woody and herbaceous must developed mechanisms to 'cold-harden' and thereby survive direct cold exposure. Levitt (1980) defines cold hardening simply as an increase in freezing tolerance. Other terms used for hardening may include frost or freeze hardening or cold acclimation. It is well-known that most temperate plants have an increased resistance to freezing temperatures in the fall (when growth is slower). Cold hardening and the closely related concept of plant hardiness have been studied by many researchers. Steponkus (1984) noted that there were 3,400 citations from 1830-1935 when Harvey (1935) published an annotated bibliography.

2. ENVIRONMENTAL FACTORS

Alden and Hermann (1971) and Levitt (1980) give excellent reviews of the effect of growth and development on hardening. Alden and Hermann (1971) state, "Environmental factors that depress growth, such as low temperature, insufficient moisture, short photoperiods in plants that accumulate starch, and low nitrogen levels, also enhance the cold tolerance of most plants." They cite numerous references that suggest that during times of active growth, the ability of the plant to harden, even when given the proper conditions, is limited. Levitt (1980) suggested that freezing tolerance is inversely related to growth and development. He listed the following evidence:

1. Rapid spring growth is essentially unable to harden.
2. Preparation for spring growth is accompanied by a loss of freezing tolerance, even at hardening temperatures.
3. Cessation of growth in the fall is accompanied by an increase in freezing tolerance.
4. The relative growth rate of winter annuals in the fall is inversely related to their relative hardiness.
5. Artificial stimulation of growth by excess nitrogen fertilization, long days, vernalization, or growth regulators is accompanied by a loss of cold tolerance and/or of ability to harden. Artificial retardation of growth by wilting or by growth inhibitors is accompanied by an increase in freezing tolerance. The above evidence gives

some conditions under which plants will and will not harden (Levitt, 1980).

A. Temperature

The environmental factor believed to have the greatest influence in the hardening process is low temperature. Paulsen (1968) examined the effect of photoperiod and temperature on 'Pawnee' winter wheat. He demonstrated that temperature alone was more effective than photoperiod, and photoperiod and temperature combined, for hardening this cultivar. Harvey (1930) found that 5C was the threshold for hardening in cabbage. Levitt also suggested that the temperature required for hardening seems to be species, and possibly cultivar, dependent. Plants such as winter cereals held at temperatures above 10C are unable to harden (Olien 1967).

The amount of time that plants remain at a given hardening temperature also affects the hardening process. Harvey (1930) showed that exposure of cabbage to 0C for four hours and 20C for 20 hours a day for five days was enough to harden it against injury at -5C; plants hardened continuously at 0C responded identically. Olien (1967) showed that cereal grains progressively hardened for approximately three weeks when held near 1.6C. After that, there was a gradual decrease of hardiness and the plants degenerated even with normal nutrition and light. The length of time required for hardening was reported as 1.5 days in birch and 24 days for 'Antonovka' apple (reported in Alden and Hermann, 1971). Andrews et al. (1960) showed sprouting winter wheat increased in cold hardiness for the first five weeks at 1.5C in the dark, then decreased between weeks seven and 11. Andrews felt that this response was related to the wheat's being vernalized for seven weeks, which affected the hardiness of the seedlings. Suneson and Peltier (1934), also saw an increase in hardiness for wheat seedlings, up to three weeks, and none from that point to four weeks. Jung and Smith (1960) measured a decline in carbohydrates in red clover and alfalfa when the plants were removed from the field and placed at -2C, but the plants retained a high level of cold resistance until the total available carbohydrates reach 14-16% of the dry weight, at which time the cold resistance declined.

Levitt (1980) and Li (1984) discussed the possibility of 'stages' in the development of hardiness in the hardening process. Some authors have shown that there was an increase in the hardiness of plants when the cold acclimation was given in a stepwise procedure as opposed to administered as a single low temperature. Tumanov and Krasavtsev (1975) separated the two phases of hardening into (1) plants subjected to temperatures just above 0C, and (2) plants subjected to temperatures below 0C. Levitt (1980) suggested that these stages may not be quantitatively different. He cited unpublished (according to Levitt, 1980) work by H. Kohn that showed that there could be many 'stages' in the hardening of cabbage.

The freezing tolerance of chrysanthemum callus cultures increased from -6.6C to -16.1C after acclimation of the cultures at 4.5C for six weeks (Bannier and Steponkus, 1976). The authors found, however, that callus tissues 28 days or older had limited acclimation ability, probably because of substrates in the callus medium and formation of vascular tissue. Reed (1990) showed that hardening could be used as a pretreatment for some species of *Pyrus* prior to immersion in liquid N_2 to improve postimmersion viability.

B. Light

I. Light vs. Dark Hardening

Light is also involved in the cold-hardening process. Levitt (1980) made the blanket statement, "Low temperature by itself is incapable of inducing hardening, at least in the case of winter annuals, biennials and seedlings of perennials." The statement may be too general; it is more likely that some species may require light, while others may not. Most of the literature seems to indicate that the greatest effect of light during the hardening process is through photosynthesis. Dexter (1933) found that alfalfa hardened better at 0C with a constant temperature and seven hours of light than at 0C in the dark. His data suggested that alfalfa did harden in the dark, which he contributed to the storage reserves present in the plant. Winter wheat that was more succulent did not harden in the dark, but did when light was provided. Dexter (1933) also suggested that hardening was favored in the light, especially when CO_2 was present in the air. Dexter (1933) also showed that wheat and alfalfa plants hardened more fully under a long period of light than a short one. Andrews and Pomeroy (1974) showed that seedlings of winter wheat hardened in the dark when grown on moist filter paper for up to five weeks, but declined thereafter. They attributed this decline to the depletion of the endosperm reserves. Seedlings grown in the light continued to harden for up to two weeks. Tumanov et al. (1976) found that winter wheat required as little as five minutes of light per day to survive -20C. Steponkus and Lanphear (1967) found that the killing point of *Hedera helix* leaves was -15.5C in the light and -10.8C in the dark after six weeks of hardening. The killing point for stems was -19.9 in the light and -10.2C in the dark. Steponkus and Lanphear also demonstrated that there seemed to be a translocatable promoter of hardening produced in the light. They showed that darkened receptors that were acropetal to the illuminated donors showed an increase in hardiness. Reversing this treatment did not produce the same hardening of the plant material. Labeling with ^{14}C suggested that the compound was sucrose. Kohn and Levitt (1965) worked with cabbage seedlings and photoperiod. The longer the photoperiod from 8 to 24 hr, the lower the killing temperature. After the first week, though, the pattern was reversed. By the fifth week of hardening, the plants under the 8-hr photoperiod were hardier than the plants at the 24-hr photoperiod.

II. PHOTOPERIOD

Photoperiod may also play a role in the hardening process. Lawrence et al. (1973) discovered that, for *Lolium perenne*, a longer photoperiod as well as higher light intensities both before and during the hardening treatments improved tiller survival.

Aronsson (1975) discovered that seedlings of *Pinus silvestris* L. and *Picea abies* L. would not harden under an 18-hr photoperiod. The seedlings hardened fastest at a photoperiod of 6-12 hr when the day/night temperatures were 20/15C, while at 10/5C, the fastest hardening occurred when the photoperiod was 4-12 hr. Lu and Rieger (1990) measured an increase in hardiness in kiwi vines under an eight-hour photoperiod, not a 16-hr photoperiod.

Species and possibly cultivar may largely determine whether photoperiod is effective in hardening plants. Levitt (1980), stated emphatically that short-day conditions improve hardening in both woody and herbaceous plants (Dexter, 1933). In those plants that respond to photoperiod, he concluded that the short-day conditions improve hardening by controlling growth, food reserves, and tissue hydration. Steponkus (1978) also concluded that the plants' normal photoperiod response determines whether they will respond to photoperiod as a signal for cold hardening. This responsiveness seems to depend on adaptation to the environmental conditions under which the plant grows naturally.

III. Light Quality

Light quality may also be part of the light equation. Kacperska-Palacz et al. (1975) used different light wavelengths on rape seedlings in an attempt to see how light qualities affect hardening. The authors demonstrated that red light alone, followed by white light alone, facilitated the greatest percent frost survival. The authors also tested red and far red effects on the hardening of rape seedlings. They showed that when the seedlings were treated with red light even after being treated with far red, there was an increase in the percent frost survival. The researchers also measured the hypocotyl lengths and discovered that they were shorter in the plants whose last treatment was red light. The authors correlated these shorter hypocotyl lengths under red-light conditions with a decrease of water in the seedlings and an increase of soluble protein, total amount of nucleic acids, and DNA.

C. Water

Alden and Hermann (1971) cited cases of plants hardening better under both dry or moist conditions. There seems to be some disagreement as to which conditions make plants cold harden better. Cox and Levitt (1976) showed that cabbage seedlings were unable to harden when kept at full turgor, even when optimum conditions were given. Steponkus (1978) concluded that a lower water content helps increase hardiness in some plants, although he presented research that contradicts that hypothesis.

3. Hormone and Growth Regulator Effects

In their review on the effect of growth regulators and hardening, Carter and Brenner (1985) cited examples of research that demonstrates that there are factors (both promoters and inhibitors) that can be translocated from one area of a plant to another during the cold acclimation process under inductive and noninductive conditions (Tumanov et al., 1976,). ABA and GA are the plant hormones most implicated in cold acclimation. The majority of the literature cited gave evidence that ABA is a hardening promoter and GA is a hardening inhibitor. Carter and Brenner (1985), Alden and Hermann (1971), and Howell and Dennis (1981) give excellent reviews of the evidence that indicate that GA, when applied in late summer, can improve the bud hardiness of fruit trees in midwinter. Carter and Brenner (1985) suggested that this improvement may be due to the time of year applied more than to the hormone itself. They suggested that not only the hormones themselves, but also the ratio of the hormones to each other, may be important.

GA is known to promote growth in plants and, as previously stated, actively growing plants are not able to cold acclimate easily. Many growth retardants have been tested for their effect on hardening and the hardiness of plant tissues. CCC, AMO, maleic hydrazide, B-Nine, SADH, and other growth regulators have been used in an attempt to improve the hardiness of both woody and herbaceous plants. Levitt (1980), Howell and Dennis (1981), Alden and Hermann (1971), and Carter and Brenner (1985) discuss research in which some growth retardants improved hardening or hardiness of some plants whereas other did not. Chen and Li (1976) found that CCC improved frost hardiness by 1C in two species of *Solanum*, but not in another. Robertson et al. (1987) found that bromegrass cultures treated with ABA and cultured at 3 and 23C developed more freezing resistance than cells cultured at 3C. Tanino et al. (1991) treated bromegrass cell cultures with ABA and saw a 5C increase in hardiness compared to that of the control. They also observed cellular changes that resembled those reported when the cultures were cold acclimated. Brüggemann et al. (1992) found that drought hardening prior to chilling helped ensure survival of tomato plants held at 6C. Perhaps the drought is causing an increase in the ABA levels. Li (1989) reported that mefluidide, a synthetic plant growth regulator, has shown to protect corn and rice seedling from chilling injury in controlled studies.

4. Effect of Age

A. Stage of Development

Age of the plant may or may not be important in determining whether a plant will be able to harden and withstand freezing temperatures. Klages (1926) exposed wheat seedlings at one, two, three, and four weeks of age to -15.6C for 15 and 30 minutes. No plants that were one week old were killed, even after 30 minutes of exposure. All of the other seedlings that were two to four weeks old died after 30 minutes of exposure. When he exposed seedlings 6, 8, and 10 days old to -16.7C for up to two hours, all the six-day-old seedlings survived, while an increasing percentage of older seedlings died with increasing length of exposure. Peltier and Kiesselbach (1934) saw a decrease in percent survival of field-grown oats, barley, and spring wheat with increasing number of leaves. They thought that the reason might have been the exhaustion of the endosperm as the plants grew. Worzella and Cutler (1940) noted an increase in survival with an increase in the number of leaves of wheat seedlings in field tests. However, Suneson and Peltier (1934) concluded from their research that older winter wheat seedlings were less hardy in freezing tests. One problem with comparing the work done by Worzella and

Cutler with that of Suneson and Peltier is that the former did their research in the field and the latter worked in the greenhouse. Andrews et al. (1960) in both field and cold chamber studies showed that the youngest and oldest winter-wheat plants were less cold hardy than those of indeterminate age. Steponkus (1978) suggested that there is confusion among researchers regarding exactly which stage will harden and which will not. The problem may be in part due to different researchers using different plants or conditions. Callus cultures have shown the ability to become hardened to cold temperatures, although there was evidence that older cultures hardened less (Bannier et al., 1976).

5. Tests of Hardening Process

There are many tests that have be used to measure the hardening process and the hardiness of plant material. The tests chosen for hardening and hardiness depend on plant species, type of tissues to be examined, and research objectives. Li (1984) suggested that these tests should be simple, rapid, repeatable, and nondestructive to the intact plant, although he admitted that, to date, there is no method available that meets all of these criteria. Harvey (1918) was the first researcher to use freezing chambers to test hardiness of plants quantitatively.

A. Visual

The visual test after freezing is probably the first ever used for hardiness and is also one of the most subjective. It can be used in either the field or controlled testing and is simple, and rapid. Li (1984) cautions that even plants that have a water-soaked appearance immediately after thawing may be showing injury that is reversible.

B. Regrowth

Stergios and Howell (1973) suggested that growth tests were more reliable than tests based on triphenyl tetrazolium chloride, specific conductivity, or multiple freeze points. Growth tests was used by Di Sabato-Aust (1987) for her work on hardiness of several herbaceous perennials, yielded results.

C. Electrical Conductivity Test

The electrical conductivity (EC) technique has been used by many researchers; Levitt (1980) cites Dexter (1932) as using it first. In this test, the amount of cellular injury is determined by the level of EC that is read. Tissue samples are excised from a thawed frozen sample, then immersed in distilled water. Samples are vacuum infiltrated and shaken for 1 hr or so, after which EC is then measured and tissue is heated to release all the electrolytes, which are then measured. The more damage to the tissue, the higher the EC leakage. The principle of this test is that living cells retain electrolytes better than dead cells. The test can be used on tissues or extracts. Burr et al. (1990) found that freeze-induced electrolyte leakage (FIEL) gave the most precise testing of hardiness of conifer seedlings when compared to whole-plant freeze tests or differential thermal analysis.

D. LD_{50} AND LT_{50}

LD stands for lethal dose; LT, for lethal temperature. These terms, when used for hardening or hardiness tests, represent the temperature at which 50% of the test population is killed. Pomeroy and Fowler (1973) used this test for frost tolerance of wheat that was cold acclimated under controlled and natural environments. The researchers were able to correlate the results from the natural to the controlled tests. Gay and Eagles (1991) used this technique in *Lolium* to test for hardening and dehardening responses. They were able to fit a model for the hardening and dehardening procedure by using this test for *L. perenne*. The LT_{50} test was also used by Gilmour et al. (1988) in their research with *Arabidopsis thaliana* as they studied the genetics of cold hardening.

E. TRIPHENYL TETRAZOLIUM CHLORIDE REDUCTION

This test is based on the reducing ability of living cells. When cells are not injured by cold temperatures, they cause a color change in triphenyl tetrazolium chloride from clear to reddish. The percent difference in reduction between the control and test tissue gives the degree of damage to the tissues. Steponkus and Lanphear (1968) modified this test somewhat and showed that a small amount of tissue could be used for the test (50-100 mg), which allowed precise areas of the plant to be tested. Stergios and Howell (1973), using the modifications by Steponkus and Lanphear, found that the test worked well in hardiness evaluations of grape, but not as reliably in those of cherry, raspberry, and strawberry.

F. Plasmolysis

This test is conducted after freezing and may be done in conjunction with vital staining. Normal, healthy cells will plasmolyze in hypertonic solutions like mannitol. In cells that have been damaged by freezing, the plasma membrane permeability is lost and the cells do not plasmolyze (Li, 1984).

6. Genetic Factors

The physiological changes that take place as plants become hardened must be under genetic control. Roberts (1986) demonstrated that some of the genes that have been implicated in the vernalization process of wheat also seem to be involved in the hardening process. He found that under different hardening conditions, different genes were switched on. Gilmour et al. (1988) found an increase in the production of three different polypeptides during the cold acclimation in *Arabidopsis thaliana*. Cattivelli and Bartels (1990) reported that they were able to isolate five different cDNA clones that were homologous to the cold-regulated mRNAs in barley. From expression studies, they concluded that there were several genes involved in the cold-hardening process, depending on the developmental stage and tissues involved.

SECTION ONE

MATERIALS AND METHODS

Year 1

Seedling perennials in 128-cell trays, (489 plants m^{-2}) were received from Raker's Acres, Litchfield, Michigan, on 6 Nov. 1992. Plants ranged in age from 6 to 13 weeks and had 4 to 28 leaves, depending on species, at the beginning of the experiment (Table 1). Plugs were initially kept in a 16C greenhouse under natural daylengths. On 20 Nov. 1992, the plug trays were transferred to controlled-temperature chambers at continuous 0 or 5C. Lighting was provided for 24 hours per day using cool-white fluorescent bulbs and adjusted to 50 $\mu mol \cdot s^{-1} \cdot m^{-2}$ at the top of the plant canopy. While at 0 or 5C, plugs were subirrigated using deionized water about every other day. After zero, two, four, or eight weeks, plugs were transferred to a -2.5C chamber for two or six weeks, or were transferred directly to a 24C greenhouse. Immediately prior to transfer to -2.5C, 10 plugs of each species were grouped into trays and heat-sealed into 4-mil polyethylene packages. The -2.5C controlled-temperature chamber failed on 1 Dec. 1992 and rose to a high of 17C. Plugs under storage at that time were transferred to 0C until they were transferred to the greenhouse or the chamber was repaired. After each storage period, plugs were removed from packaging and left overnight to warm to 21C before being transferred to the greenhouse. Photographs were taken shortly after plugs were transferred to the greenhouse. Plugs were grouped in trays, then placed on capillary mats and watered as needed. Plugs were fertilized weekly with 3.5 mol/m^3 N, and Compound 111, a micronutrient source (Grace Sierra, Allentown, Pennsylvania) at a rate of 0.14 $g \cdot l^{-1}$ delivered through a 15:1 proportioner. During the regrowth period, plugs were held under natural daylengths.

Year 2

Seedling perennials in 128-cell trays (489 plants m^{-2}) (*V. longifolia* plugs were in 57-cell trays, 380 plants m^{-2}) were received from Raker's Acres, Litchfield, Michigan, on 26 Oct. 1993. Plants ranged in age from 11 to 13 weeks and had 4 to 52 leaves at the beginning of the experiment (Table 2). Plugs were kept in an 18C greenhouse under natural daylengths until the start of the experiment. Because of chlorosis, plugs were fertilized three times with Compound 111, at a rate of 0.14 $g \cdot l^{-1}$ delivered through a 15:1 proportioner prior to the experiment. Otherwise, deionized water was used. On 6 Nov. 1993, the plug trays were transferred to controlled-temperature chambers maintained 5C either under 5 $\mu mol \cdot s^{-1} \cdot m^{-2}$ or in darkness. Lighting was provided for nine hours per day using cool-white fluorescent bulbs. Darkness was ensured by placing plug trays into cardboard boxes. Plugs were subirrigated as necessary using tap water with 3.5 mol/m^3 N and 0.13 $ml \cdot l^{-1}$ sulfuric acid delivered through a 15:1 proportioner. After zero, two, or four weeks, plugs were transferred to -2.5C or to a 20C greenhouse. Immediately prior to transfer to -2.5C, 10 plugs of each species were grouped into trays, then heat-sealed into 4-mil polyethylene packages. *Veronica longifolia* plugs were put into sections of plug trays by themselves, although packaged with other plugs. After six, 12, or 18 weeks, plugs were removed from packaging and left overnight to warm to 21C prior to being taken to the greenhouse. Photographs were taken shortly after plugs were transferred to the greenhouse. Plugs were placed on capillary mats to prevent drying and watered as needed. Plugs were fertilized with potassium nitrate and ammonium nitrate in a 3:2 ratio at a rate of 3.5 mol/m^3 N, and Compound 111, at a rate of 0.14 $g \cdot l^{-1}$ delivered through a 15:1 proportioner. During the regrowth period, plugs received night-interruption (NI) lighting from 2200 HR until 0200 HR from four 60-watt incandescent light fixtures delivering a minimum of 2 $\mu mol \cdot s^{-1} \cdot m^{-2}$. From December until March, supplemental light was provided from HPS lamps at 92 ± 29 $\mu mol \cdot s^{-1} \cdot m^{-2}$ from 0800 HR until 1700 HR. The 5C controlled-temperature chamber failed on 2 Dec. 1993. The temperature went from 5 to 28C during a 6.5-hour period until the failure was noticed. Plugs were immediately transferred into another 5C controlled-temperature chamber until the first chamber was repaired, which took four days.

Experimental design and analysis. Regrowth was evaluated two weeks after placement of plants in the greenhouse using the following rating scale: 4, excellent quality, essentially undamaged; 3, good quality, expected to produce a quality plant; 2, poor quality, unlikely to become a quality plant in a reasonable time; 1, dead. Data on percent survival were calculated from regrowth ratings. For both experiments, data were analyzed using a 3-way ANOVA with missing replications, the data for each species analyzed separately using PC SAS statistical procedures (SAS Institute, North Carolina). Data were not taken from plugs given eight weeks of pretreatment and two weeks of -2.5C storage during year one. *Hibiscus* from year one and *Veronica longifolia* and *Coreopsis grandiflora* from year two contained only five replications; all others contained 10.

Results and Discussion

Year 1

Achillea

All plants transferred directly to the greenhouse survived and were rated 4 (Figure 1). Plugs held first at -2.5C for two or six weeks varied in rating and percent survival even though the plants were the same and had not been placed at 0 or 5C. It is possible that the differences in these treatments were caused by tray placement within the controlled temperature chamber or plug location within the tray. Potentially, plants placed on the sides of the tray might develop more damage than those in the middle of the tray. No obvious differences that would explain this variable response were noted during freezing or in the greenhouse.

Following two-, four-, and eight-week exposure to pretreatment temperatures, nearly all plugs survived (Figure 1). Overall rating average of *Achillea* plugs did not go below 3. There was no obvious difference between 0 and 5C pretreatment temperatures. The pretreatment was successful for *Achillea;* without this pretreatment there was variable response (Table 3).

Aquilegia

All of the plugs survived with a rating of at least a 2 (Figure 1). Statistically, there was no three-way interaction for this species (Table 3). Plants pretreated at 5C performed better than those at 0C (main effect significant <0.001 Table 3). *Aquilegia* plugs improved in regrowth rating with increasing time at the pretreatment temperature (Figure 1). Overall all plugs survived although pretreatment significantly improved regrowth rating.

Astilbe

Control plants responded variably (Figure 1). The rating and percent survival for the 0C plants were lower than those for the 5C treatment, although both pretreatment responses were the same. The phenomenon may have been due to one or more of the causes suggested for *Achillea*. The three-way interaction was highly significant (Table 3), suggesting that all factors influenced response. In general, *Astilbe* regrowth and survival following storage at -2.5C improved with increased time at either hardening temperature. No obvious trend could be detected between pretreatment at 0 or 5C.

Campanula

The survival for *Campanula* was 100% for all treatments (Figure 2). The three-way interaction was not significant, although the two-way interaction of pre- and posttreatment was highly significant (Table 3). The regrowth rating did not fall much below 3 at any time during the entire experiment (Figure 2). All *Campanula* survived, although there was a general reduction in the quality of the seedlings' appearance over time. Campanula would be a good candidate for storage at -2.5C.

Chrysanthemum

The average regrowth rating for *Chrysanthemum* plugs given eight weeks of pretreatment, and six weeks of storage at -2.5C, was 3, with 95% survival (Figure 2). The rest of the data were confounded (Table 3), since plants prior to pretreatment were in less than perfect condition. We have experienced problems with this cultivar and its response to pesticides. It is likely that the plugs came into contact with pesticides prior to the start of the experiment.

Echinacea

Pretreatments improved percent survival and regrowth ratings of *Echinaceae* following storage at -2.5C (Figure 2, Table 3). It is evident that two weeks of pretreatment improved the regrowth rating. Statistically, the 0C pretreatment was better than the 5C pretreatment (Table 3). *Echinacea* is a long-day plant, and it is possible that the regrowth ratings and survival percentages might have been better if the plants had been grown under long days.

Gaillardia

Plugs without pretreatment had lower regrowth ratings and percent survival following storage at -2.5C (Figure 3). Two weeks at the pretreatment temperatures was sufficient to improve survival to 90% or better and significantly improved regrowth ratings (Figure 3, Table 3). *Gaillardia* would be a good candidate for -2.5C storage when given at least two weeks of pretreatment.

Goniolimon

Survival was 100% in all treatments, and the regrowth ratings did not drop below a 3 in any treatments (Figure 3). There were no interactions that were highly significant (Table 3). *Goniolimon* would be a good candidate for -2.5C storage with or without a pretreatment.

Hibiscus

Hibiscus plugs were unable to survive being directly transferred to -2.5C. Regrowth ratings and percent survival were low but improved following pretreatment at 5C (Figure 3, Table 3). *Hibiscus* may require other types of pretreatment to be able to improve survival at -2.5C. It is possible that *Hibiscus* may have suffered during regrowth due to overwatering. Other work with this plant would indicate that it is responsive to long-day conditions and ratings may have been better had the plugs been grown under long-day conditions.

Iberis

Regrowth ratings after storage at -2.5C progressively increased as pretreatment duration increased (Figure 4, Table 3). There was some variability in response when the plugs were transferred directly to -2.5C for six weeks (Figure 4). All plugs receiving pretreatment survived -2.5C storage. *Iberis* would be a good candidate for storage after at least two weeks of pretreatment.

Lavandula

Regrowth ratings following direct transfer to -2.5C varied (Figure 4). Although percent survival was slightly variable for those plugs pretreated at 0 or 5C, it never went below 90%. Plugs pretreated at 0C performed slightly better than those treated at 5C following storage at -2.5C (Figure 4). These data suggest that *Lavandula* would be a good nominee for -2.5C storage after pretreatment.

Oenothera

There was a slight decrease in regrowth rating with increasing time at the pretreatment temperature (Figure 4). Percent survival was 90% or better except for eight weeks of 0C pretreatment and six weeks of -2.5C storage (Figure 4). Overall *Oenothera* regrowth ratings and percent survival were good when given either a two or four week pretreatment prior to -2.5C storage.

Primula

Primula exhibited good regrowth ratings after two weeks of pretreatment (Figure 5). The plugs stored for six weeks at -2.5C improved with increasing time at the pretreatment temperatures. Temperature did not significantly affect regrowth ratings (Table 3).

Rudbeckia

Percent survival increased with increasing time at the pretreatment temperatures (Figure 5). The percent survival for the four or eight weeks of pretreatment was 100% (Figure 5). Based on these results, *Rudbeckia* is one that, with pretreatment, could tolerate storage at freezing temperature.

The ratings might have been greater if the plants had been given long-day conditions during the regrowth period. Other research has shown that Rudbeckia is long-day responsive.

Year 2

Alcea

Plugs transferred directly to -2.5C had poor percent survival and regrowth ratings (Figure 6). Percent survival and regrowth rating increased with increased time at the pretreatment temperature (Figure 6, Table 4). Plugs pretreated for four weeks in the light outperformed those pretreated in the dark. The survival percentage and the rating decreased sharply with storage at -2.5C beyond 12 weeks. Performance after 12 weeks at -2.5C was unsatisfactory.

Armeria

There was an unexplained variation in response for plugs transferred directly to -2.5C for 12 or 18 weeks. The rest of the treatments showed a general decline in regrowth ratings and percent survival with increased storage duration. One hundred percent of Armeria plugs survived six weeks at -2.5C after two or four weeks of pretreatment with regrowth ratings of approximately 3. The presence of light did not significantly affect survival or regrowth (Figure 6, Table 4).

Asclepias

It was difficult to assign a rating to *Asclepias* after storage. It has a tuberous root and regrows very slowly.

Most species experience incomplete dieback of the stem. However, the stem of *Asclepias* dies back and new growth must start with the lateral bud(s) at the top of the tuberous root. This process in a slow growing species may take longer than the two weeks allotted for the regrowth period. When the plugs were rated 1, it was because of the death of the tap root. Some of the plants had regrown more than others and were given a higher rating accordingly. There was a general decrease in the rating for plugs stored (Table 4). Although there was 100% survival of plugs given two and four weeks of pretreatment, then stored at -2.5C for six weeks, regrowth ratings were poor because of the small size of the regrowth at the time of rating (Figure 6). The plugs may have received better ratings given more time to regrow. Few plants survived -2.5C storage past six weeks.

Coreopsis

Coreopsis did not survive direct transfer to -2.5C without hardening. The ratings and percent survival were high for plugs that had been given four weeks of pretreatment in the light followed by six weeks at -2.5C (Figure 7). Two weeks of pretreatment were not enough to allow survival at -2.5C.

Delphinium

Delphinium plugs survived six weeks at -2.5C after two weeks of pretreatment at 5C (Figure 7). The regrowth ratings for those treatments, though, were less than or equal to 3, which would indicate that *Delphinium* would be a poor candidate for freezing storage.

Dianthus

Overall, *Dianthus* stored well at -2.5C. There was no statistical difference between pretreatments conducted in light or darkness (Table 4). There was some increase in percent survival and regrowth rating when the plugs were given a two-week pretreatment, then stored for up to 12 weeks (Figure 7). The ratings for this treatment were ≈ 3 and the survival was 100%. *Dianthus* is a good candidate for storage for up to at least 12 weeks.

Gypsophila

When directly transferred to -2.5C, *Gypsophila* survived poorly (Figure 8). There was some improvement in regrowth rating with two or four weeks' pretreatment for six weeks of storage (Table 4). Ratings and percent survival for more than six weeks of storage were poor. The use of freeze storage would be questionable for *Gypsophila*.

Heuchera

When directly transferred to -2.5C percent survival and regrowth were reduced (Figure 8). The three-way interaction was not significant (Table 4). In all cases, increased with pretreatment and decreased after -2.5C storage. *Heuchera* would be a good candidate for up to 18 weeks of storage with two or four weeks of pretreatment.

Lavandula

Four weeks of pretreatment in the light were necessary to store *Lavandula* at -2.5C for six weeks with a regrowth rating of 3 and a survival of 100%. Other treatments ended with a rating of 1 and a 0% survival.

In year one, we were able to store *Lavandula* with only two weeks' pretreatment, whereas in year two *Lavandula* plugs required four weeks (Figure 4 and Figure 8). The difference may have been caused by decreased light levels and lighting hours in the 1993-1994 experiment. Plug quality in 1992-1993 was better than in 1993-1994, which might have contributed to the difference in results.

Linum

Linum seedlings pretreated for two or four weeks had higher percent survival and regrowth rating (Figure 9) over those put directly to -2.5C. Light as a main effect was highly significant and improved the rating and percent survival for those plants pretreated for four weeks (Table 4, Figure 9).

Lobelia

Except for the zero-week controls, the plugs given light during pretreatment had higher regrowth ratings following six weeks storage at -2.5C than those kept in the dark (Figure 9, Table 4). The responses were similar throughout the pretreatment weeks. There was a decrease in regrowth rating and percent survival with increased duration of freeze storage. This species of *Lobelia* would not be a good candidate for storage with these pretreatments.

Lupinus

Although it was possible to store the plugs at 5C for up to four weeks with 100% survival and regrowth, exposure to -2.5C caused excessive plant death. We do not suggest storing *Lupinus* at -2.5C under these conditions.

Papaver

It was possible to freeze-store *Papaver* for six weeks with a rating of ≈ 2.5 and a survival of ≈ 95% (Figure 10). There was some indication that light was beneficial prior to storage, especially after four weeks of pretreatment. It survived well, although regrowth was slow and overwatering may have been a problem.

Salvia

Direct transfer to storage at -2.5C decreased percent survival and regrowth dramatically for this species of *Salvia*. The treatments given light tended to have either equal or higher regrowth ratings and percent survival, especially after four weeks of pretreatment, than those kept in the dark (Figure 10). There was a general decline in percent survival and regrowth ratings with increased weeks of storage at -2.5C. The best response was after two weeks of pretreatment and six weeks of storage: ratings were between 3 and 4, and percent survival was 100.

Veronica spicata

Veronica spicata survived direct transfer to -2.5C without much decrease in vigor or percent survival (Figure 10) and would be an excellent candidate for long-term storage. Light was significantly beneficial in the fourth week of pretreatment (Table 4). There was some decrease with time in regrowth rating, although no treatment dropped much below a rating of 3.

Veronica longifolia

Plugs kept in light during pretreatment had significantly higher regrowth ratings and percent survival than plugs kept in the dark (Figure 11, Table 4). Pretreatment with light improved storage survival at -2.5C (Figure 11). *Veronica longifolia* performed poorly following direct transfer to -2.5C. Plants given two weeks of pretreatment in the light and six weeks of storage had 100% survival and received a rating of 4, following regrowth. *Veronica longifolia* would be a candidate for limited storage at -2.5C.

SUMMARY

A list of all species worked with in this study is included in Tables 5 and 6 with recommendations for pretreatments prior to storage and storage duration at -2.5C.

Species that could be stored at -2.5C for at least six weeks without a pretreatment were:

Campanula, Dianthus, Goniolimon, and Veronica spicata.

Species that benefited from at least a short pretreatment exposure to 0 or 5C with supplemental light:

Achillea, Alcea, Aquilegia, Armeria, Echinacea, Delphinium, Gaillardia, Heuchera, Iberis, Linum, Lavandula, Oenothera, Papaver, Salvia, and Veronica longifolia.

Species required increased time in pretreatment or could be stored for very limited periods:

Astilbe, Chrysanthemum, Coreopsis, Gypsophila, Species that stored very poorly were as follows:

Asclepias, *Hibiscus*, *Lobelia*, and *Lupinus*.

It may be that those species that did not store well, even after a longer pretreatment duration, require some other stimuli to survive freezing storage. Johnson and Havis (1977) showed that shortening photoperiod and cool temperatures are required for maximal rates of cold acclimation of roots of *Picea* and *Potentilla*. *Hibiscus* and certain other LD plants may require short-day conditions to slow growth and increase cold hardiness. In Michigan, *Hibiscus* is a perennial, although it initiates growth late in the spring compared to most other herbaceous perennials.

Note that species tested the first year were regrown during the time of year when daylengths were shortest. Many of these plants are long-day responsive, and it may be that the regrowth ratings and percent survival would have been higher if grown under long-day conditions. The second years' regrowth period was given with a night interruption.

Some seeds of herbaceous perennials may germinate in the spring, overwinter naturally as larger plants. The carbohydrates produced and stored over the summer may help the plant survive winter conditions. The shortening daylength in fall may also help to mobilize and conserve carbohydrates as a survival mechanism. Since the plugs stored in these studies were small, those that could not survive for long periods at

-2.5C may have depleted their food reserves and been damaged by the low temperatures.

Research has shown that growth regulators and hormones may successfully be used to induce hardening in seedlings (Li, 1989; Tanino, 1991). Growers could potentially apply a chemical to induce hardening prior to freezing storage, which might be easier than trying to use lights and controlled temperatures. Growth regulators would of course need to be tested and labeled for the species prior to actual use commercially.

The use of hardening temperatures prior to freezing storage has commercial potential. These tests support prior research that, for most species, light and a short time at the pretreatment temperatures between 0 and 5C is important prior to freeze storage.

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Table 1. Plants used in Experiment 1 (1992), and in forcing experiments (see Appendix). Leaf counts taken on similar size/age plugs when plants transplanted in greenhouse for experiments described in the Appendix.

Species	**Cultivar**	**Age of[Y] Plugs (weeks)**	**Age of[z] Plugs (weeks)**	**Leaf[Y] Counts**	**Leaf[z] Counts**
Achillea filipendulina Lam.	Cloth of Gold	10	---	7	---
Aquilegia L.	Music Mixed	11	---	7	---
Aquilegia L.	Dragon Fly	---	22	---	11
Asclepias tuberosa L.		---	21	---	45
Astilbe X *Arendsii* Arends.		13		5	---
Campanula carpatica Jacq.	Blue Clips	12	22	9	14
Chrysanthemum X *superbum* Bergmans ex J. Ingram	Snow Lady	10	19	10	13
Echinacea purpurea (L.) Moench	Bravado	10	---	6	---
Echinacea purpurea (L.) Moench	Ovation Pink	---	21		6
Gaillardia X *grandiflora* Van Houtte	Goblin	10	20	8	9
Goniolimon tatarica (L.) Boiss.		11	21	12	16
Hibiscus Moscheuros L.	Disco Belle Mixed	6	---	6	---
Hibiscus Moscheuros L.	Disco Belle White	---	21	---	8
Iberis sempervirens L	Snowflake	10	20	23	36
Lavandula angustifolia Mill.	Munstead Dwarf	12	21	28	40
Oenothera missouriensis Sims.		10	21	6	7
Primula veris L.	Pacific Giants Mixed	12	20	9	10
Rudbeckia fulgida Ait.	Goldsturm	10	21	4	8

[Y]=plugs were grown in 128-cell trays.
[z]=plugs were grown in 50-cell trays.

Table 2. Plants used in Experiment 1 (1993), and in forcing experiments (see Appendix). Leaf counts taken on similar size/age plugs when plants transplanted in greenhouse for experiments described in the Appendix.

Species	**Cultivar**	**Age of[Y] Plugs (weeks)**	**Age of[z] Plugs (weeks)**	**Leaf[Y] Counts**	**Leaf[z] Counts**
Alcea rosea L.	Chater's Double Mixed	4	20	4	4
Armeria maritima (Mill.) Willd.	Dwarf Ornament Mix	10	---	19	---
Armeria pseudarmeria (J. Murr.) Mansf.		---	20	---	18
Asclepias tuberosa L.		9	22	19	28
Coreopsis grandiflora Hogg ex Sweet	Sunray	9	18	10	12
Delphinium X elatum L.	Magic Fountains Sky Blue	8	20	4	6
Dianthus deltoides L.	Brilliant	8	20	22	30
Gypsophila paniculata L.	Double Snowflake	8	21	23	26
Heuchera sanguinea Engelm.	Bressingham Hybrids	10	22	7	14
Lavandula angustifolia Mill.	Munstead Dwarf	11	21	23	47
Linum perenne-nanum L.	Sapphire	7	20	52	71
Lobelia X speciosa Sweet	Queen Victoria	10	---	8	---
Lobelia X speciosa Sweet	Compliment Scarlet	---	18	---	15
Lupinus hybrida L.	Minarette Mix	4	19	5	11
Papaver orientale L.	Brilliant	9	20	8	12
Salvia X superba Stapf.	Blue Queen	8	20	10	17
Veronica spicata L.	Blue	7	19	8	12
Veronica longifolia L.	Sunny Border Blue[x]	7	11	12	12

[x]=*V. longifolia* plugs vegetatively propagated, and were grown in 50-cell tray and 55-cell trays.
[Y]=plugs were grown in 128-cell trays.
[z]=plugs were grown in 50-cell trays.

Table 3. Analysis of variance for year 1992-1993.

Species	Cultivar	temp (t)	pretrt (pr)	posttrt (po)	t*pr	t*po	pr*po	t*pr*po
Achillea	Cloth of Gold	ns	***	***	ns	***	***	***
Aquilegia	Music Mixed	***	***	**	ns	ns	***	ns
Astilbe		ns	***	***	*	***	***	***
Campanula	Blue Clips	ns	***	***	*	**	***	ns
Chrysanthemum x superba	Snow Lady	ns	***	***	***	ns	***	**
Echinacea	Bravado	ns	***	***	***	ns	***	*
Gaillardia	Goblin	ns	***	***	ns	ns	***	ns
Goniolimon		*	**	ns	ns	ns	**	ns
Iberis	Snowflake	ns	***	***	***	ns	***	***
Hibiscus	Disco Belle Mixed	***	***	***	***	***	***	***
Lavandula	Munstead	**	**	***	**	ns	***	***
Oenothera		ns	*	**	***	ns	ns	*
Platycodon	Sentimental Blue	ns	***	***	ns	ns	***	ns
Primula	Pacific Giants	ns	**	***	***	**	***	**
Rudbeckia	Goldsturm	***	ns	***	*	ns	***	***

ns, *, **, ***Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001 respectively.
temp=Either 0 or 5C pretreatment.
pretrt=pretreatment for either 0, 2, 4, or 8 weeks.
posttrt=storage for either 0, 2, or 6 weeks at -2.5C.

Table 4. Analysis of variance for year 1993-1994.

Species	Cultivar	light (l)	pretrt (pr)	posttrt (po)	l*pr	l*po	pr*po	l*pr*po
Alcea	Chater's Double Mix	***	***	***	***	ns	***	***
Armeria	Dwarf Ornament Mix	ns	ns	***	***	*	***	ns
Asclepias		*	**	***	*	ns	***	ns
Coreopsis	Sunray	*	***	***	ns	***	***	*
Delphinium	Magic Fountains Sky Blue	ns	*	***	*	ns	*	**
Dianthus	Brilliant	ns	***	***	ns	ns	***	ns
Gypsophila	Double Snowflake	ns	***	***	*	ns	***	ns
Heuchera	Bressingham Hybrids	**	***	***	ns	ns	***	ns
Lavandula	Munstead	***	***	***	***	***	***	***
Linum	Sapphire	***	***	***	ns	ns	**	*
Lobelia	Queen Victoria	***	ns	***	***	***	ns	***
Lupinus	Minarette Mix	***	***	***	***	***	***	***
Papaver	Brilliant	**	***	***	ns	ns	***	*
Salvia	Blue Queen	*	***	***	ns	***	***	ns
Veronica spicata		ns	***	***	ns	***	***	***
Veronica longifolia	Sunny Border Blue	*	ns	***	*	***	**	ns

ns, *, **, ***Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001 respectively.
light=Either lighted or dark pretreatment.
pretrt=pretreatment for either 0, 2, or 4 weeks.
posttrt=storage for either 0, 6, 12, or 18 weeks at -2.5C.

Table 5. Recommendations for minimum length of pretreatment with supplemental lighting at 50 $\mu mol \cdot s^{-1} \cdot m^{-2}$ for 128-cell trays prior to storage at -2.5C.

Species	Weeks of storage at -2.5C	
	2	6
Achillea filipendulina	2	2
Aquilegia	0	2
Astilbe X *Arendsii*	4	8
Campanula carpatica	0	0
Chrysanthemum X *superbum*	4	8
Echinacea purpurea	2	2
Gaillardia X *grandiflora*	0	0
Goniolimon tatarica	0	0
Hibiscus moscheuros	4	a
Iberis sempervirens	0	2
Lavandula angustifolia	a	4
Oenothera missouriensis	0	0
Primula veris	0	0
Rudbeckia fulgida	0	2

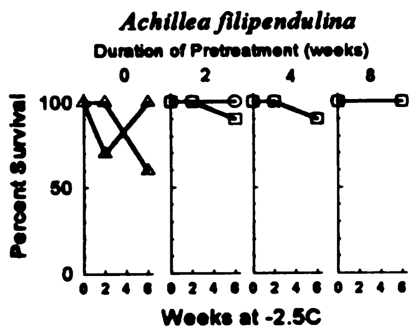
a=Did not survive -2.5C for this length of time.

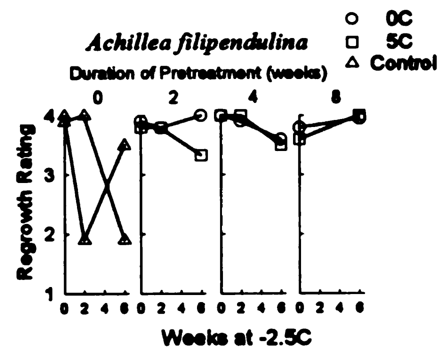
Table 6. Recommendations for minimum length of pretreatment with supplemental lighting at 5 $\mu mol \cdot s^{-1} \cdot m^{-2}$ or in dark, for 128-cell trays prior to storage at -2.5C.

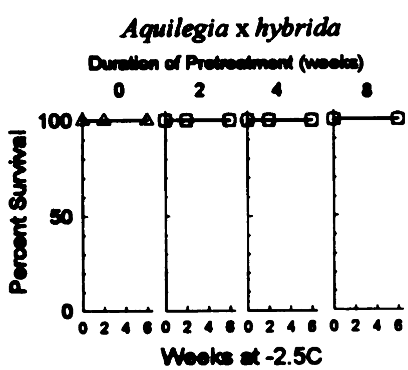
Species	Light	Dark	Weeks of storage at -2.5C		
			6	12	18
Alcea rosea	X		2	2	a
Armeria maritima	X		0	2	2
Asclepias tuberosa	X		a	a	a
Coreopsis grandiflora	X		2	a	a
Delphinium X elatum	X		2	a	a
Dianthus deltoides	X	X	0	0	0
Gypsophila paniculata	X		2	a	a
Heuchera sanguinea	X		2	2	2
Linum perenne-nanum	X		2	2	2
Lobelia X speciosa	X	X	a	a	a
Lupinus hybrida	X	X	a	a	a
Papaver orientale	X		2	2	a
Salvia X superba	X		2	a	a
Veronica spicata	X	X	0	0	0
Veronica longifolia	X		2	2	a

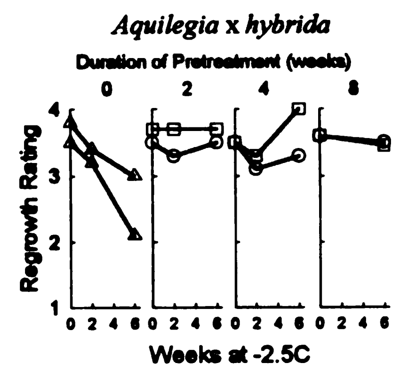
a=Did not survive at -2.5C for this length of time.

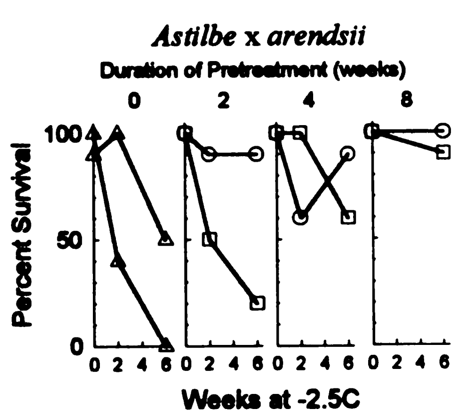
Figure 1. Percent survival and regrowth ratings following storage at -2.5C for *Achillea*, *Aquilegia*, and *Astilbe*. Plugs pretreated at 0 and 5C for 0, 2, 4, and 8 weeks prior to being transferred to -2.5C for 0, 2, or 6 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.


Achillea filipendulina
Duration of Pretreatment (weeks)
0 2 4 8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Achillea filipendulina
Duration of Pretreatment (weeks)
0 2 4 8
OC
5C
Control
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Aquilegia x hybrida
Duration of Pretreatment (weeks)
0 2 4 8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Aquilegia x hybrida
Duration of Pretreatment (weeks)
0 2 4 8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Astilbe x arendsii
Duration of Pretreatment (weeks)
0 2 4 8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

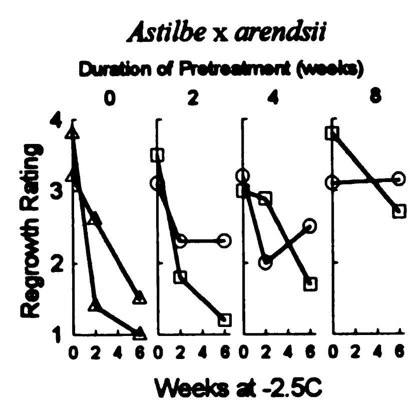
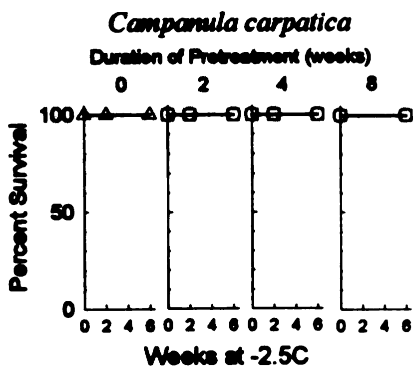
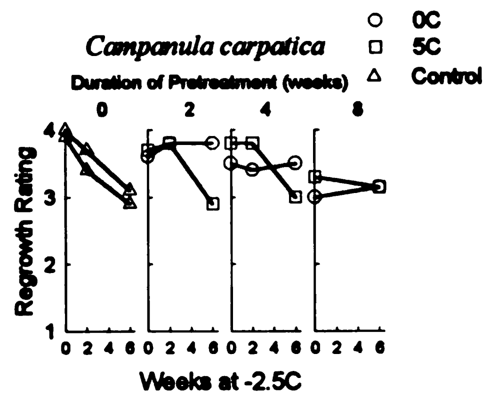

Astilbe x arendsii
Duration of Pretreatment (weeks)
0 2 4 8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

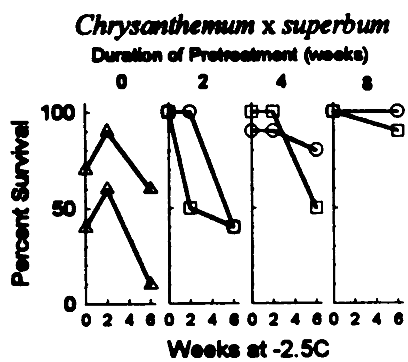
Figure 2. Percent survival and regrowth ratings following storage at -2.5C for *Campanula*, *Chrysanthemum*, and *Echinacea*. Plugs pretreated at 0 and 5C for 0, 2, 4, and 8 weeks prior to being transferred to -2.5C for 0, 2, or 6 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.



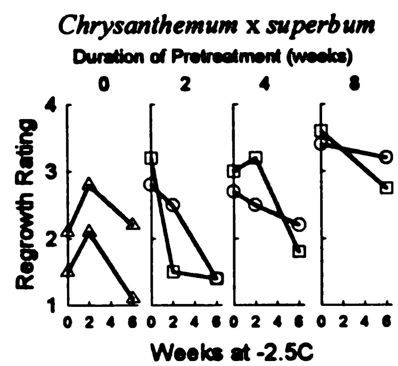
Campanula carpatica
Duration of Pretreatment (weeks)
0
2
4
8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C



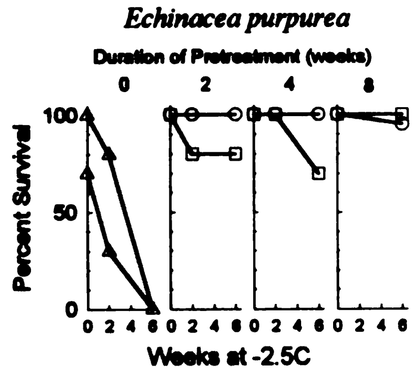
Campanula carpatica
0C
5C
Control
Duration of Pretreatment (weeks)
0
2
4
8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C



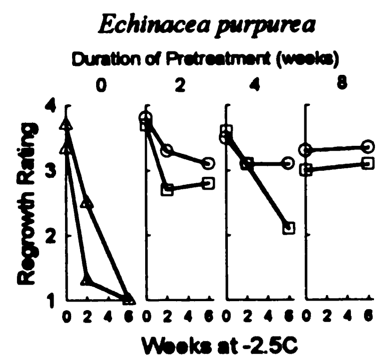
Chrysanthemum x *superbum*
Duration of Pretreatment (weeks)
0
2
4
8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C



Chrysanthemum x *superbum*
Duration of Pretreatment (weeks)
0
2
4
8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

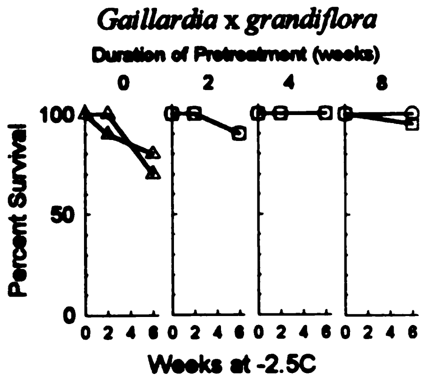


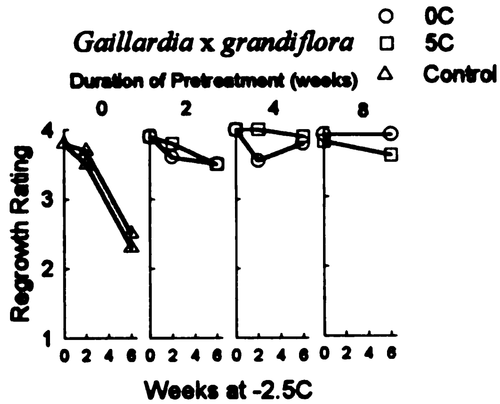
Echinacea purpurea
Duration of Pretreatment (weeks)
0
2
4
8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

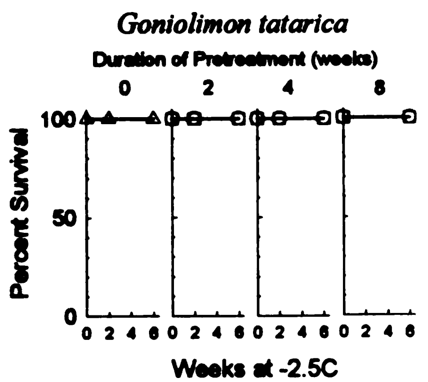


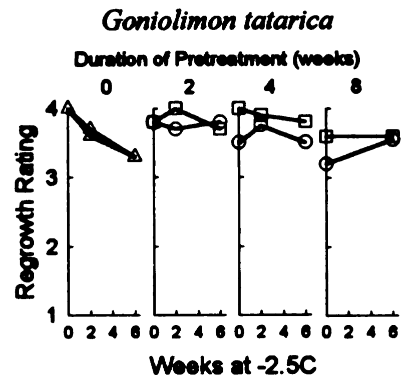
Echinacea purpurea
Duration of Pretreatment (weeks)
0
2
4
8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

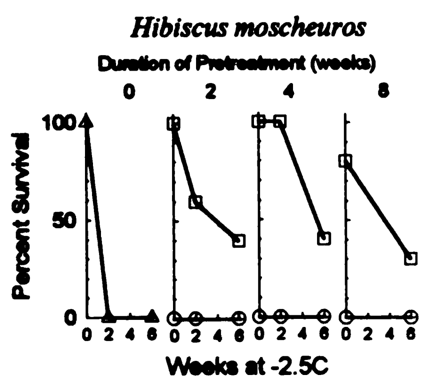
Figure 3. Percent survival and regrowth ratings following storage at -2.5C for *Gaillardia*, *Goniolimon*, and *Hibiscus*. Plugs pretreated at 0 and 5C for 0, 2, 4, and 8 weeks prior to being transferred to -2.5C for 0, 2, or 6 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.


Gaillardia x grandiflora
Duration of Pretreatment (weeks)
0 2 4 8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


0C
5C
Control
Gaillardia x grandiflora
Duration of Pretreatment (weeks)
0 2 4 8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Goniolimon tatarica
Duration of Pretreatment (weeks)
0 2 4 8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Goniolimon tatarica
Duration of Pretreatment (weeks)
0 2 4 8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Hibiscus moscheuros
Duration of Pretreatment (weeks)
0 2 4 8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

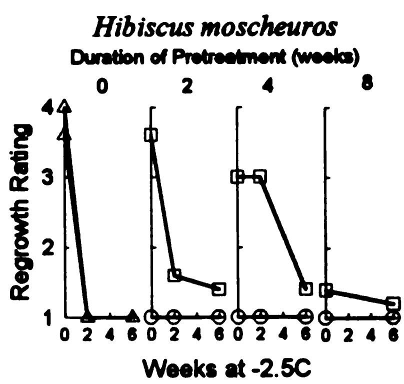
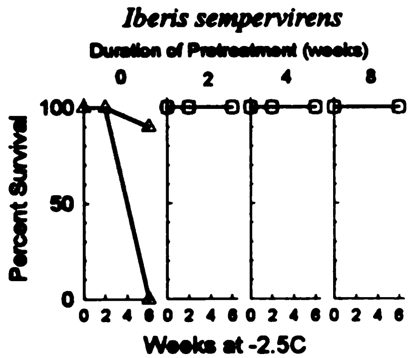
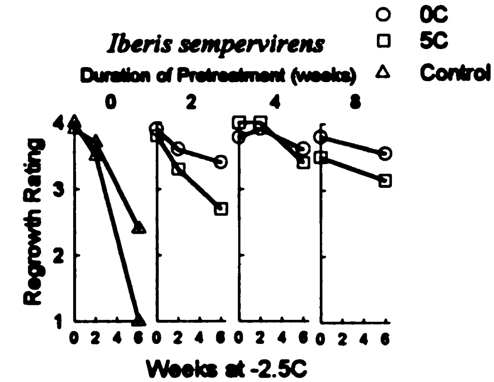
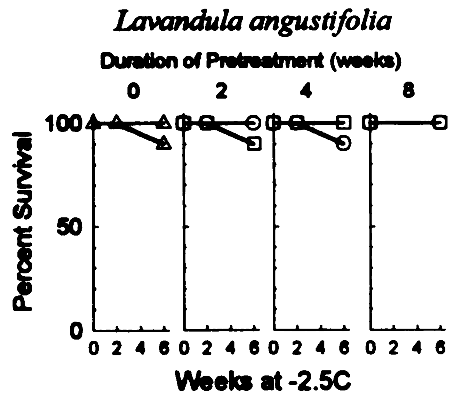
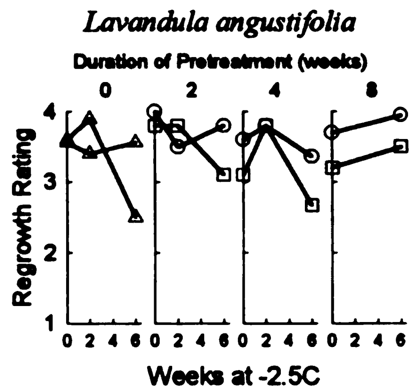

Hibiscus moscheuros
Duration of Pretreatment (weeks)
0 2 4 8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

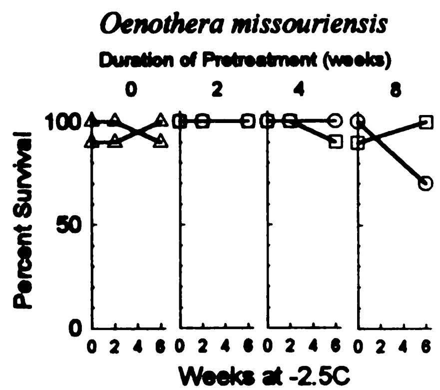
Figure 4. Percent survival and regrowth ratings following storage at -2.5C for *Iberis*, *Lavandula*, and *Oenothera*. Plugs pretreated at 0 and 5C for 0, 2, 4, and 8 weeks prior to being transferred to -2.5C for 0, 2, or 6 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.


Iberis sempervirens
Duration of Pretreatment (weeks)
0
2
4
8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


0C
5C
Control
Iberis sempervirens
Duration of Pretreatment (weeks)
0
2
4
8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Lavandula angustifolia
Duration of Pretreatment (weeks)
0
2
4
8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Lavandula angustifolia
Duration of Pretreatment (weeks)
0
2
4
8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Oenothera missouriensis
Duration of Pretreatment (weeks)
0
2
4
8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

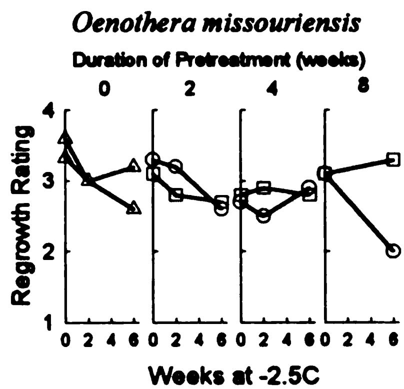
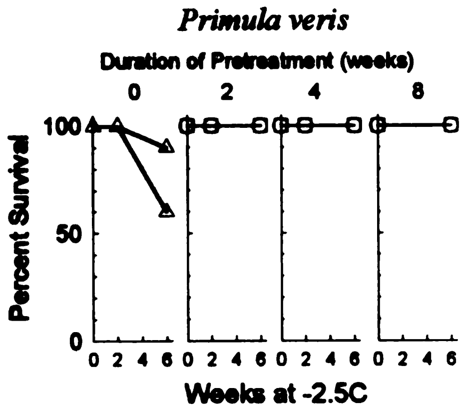
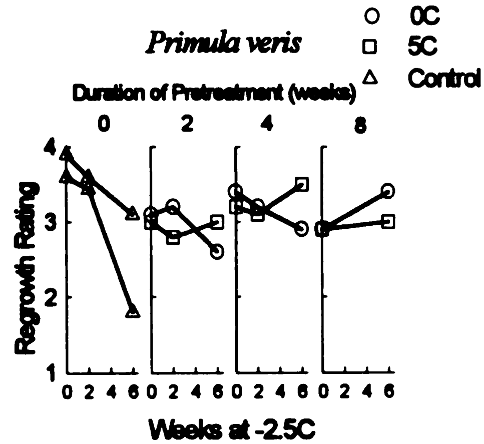
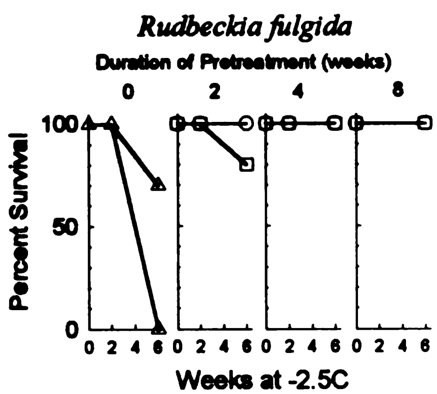

Oenothera missouriensis
Duration of Pretreatment (weeks)
0
2
4
8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

Figure 5. Percent survival and regrowth ratings following storage at -2.5C for *Primula* and *Rudbeckia*. Plugs pretreated at 0 and 5C for 0, 2, 4, and 8 weeks prior to being transferred to -2.5C for 0, 2, or 6 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.


Primula veris
Duration of Pretreatment (weeks)
0 2 4 8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Primula veris
0C
5C
Control
Duration of Pretreatment (weeks)
0 2 4 8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C


Rudbeckia fulgida
Duration of Pretreatment (weeks)
0 2 4 8
Percent Survival
100
50
0
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

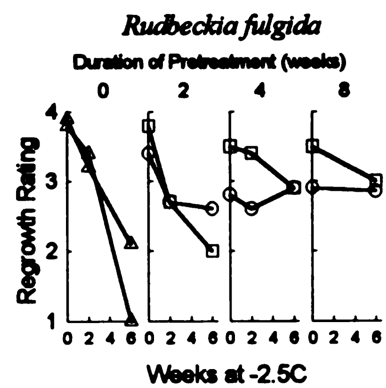
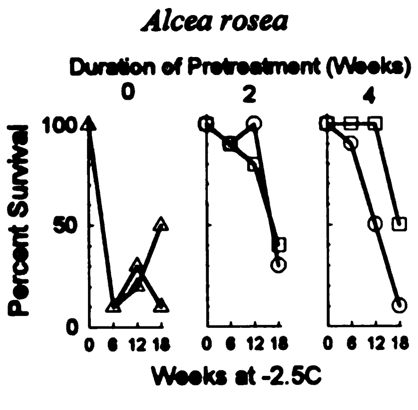
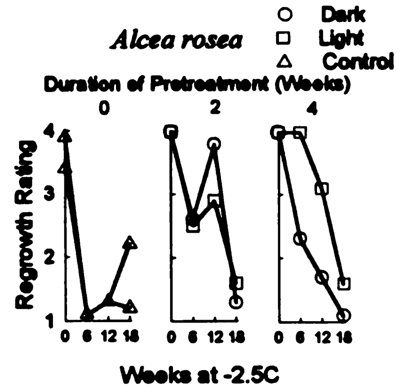
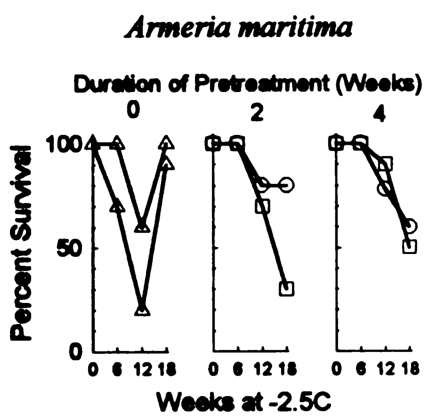
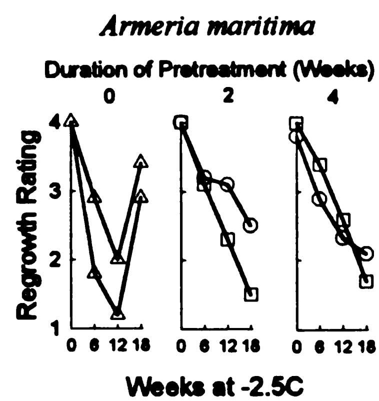

Rudbeckia fulgida
Duration of Pretreatment (weeks)
0 2 4 8
Regrowth Rating
4
3
2
1
0 2 4 6 0 2 4 6 0 2 4 6 0 2 4 6
Weeks at -2.5C

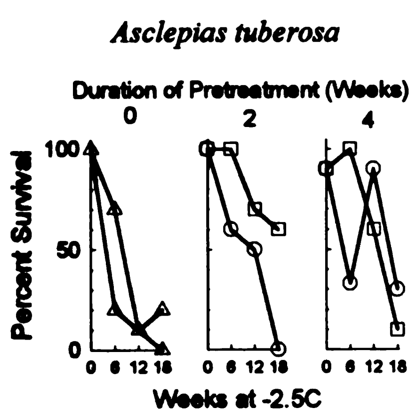
Figure 6. Percent survival and regrowth ratings following storage at -2.5C for *Alcea*, *Armeria*, and *Asclepias*. Plugs pretreated at 5C in light or dark for 0, 2, 4 weeks prior to being transferred to -2.5C for 0, 6, 12, or 18 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.


Alcea rosea
Duration of Pretreatment (Weeks)
0
2
4
Percent Survival
100
50
0
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C


Alcea rosea
Dark
Light
Control
Duration of Pretreatment (Weeks)
0
2
4
Regrowth Rating
4
3
2
1
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C


Armeria maritima
Duration of Pretreatment (Weeks)
0
2
4
Percent Survival
100
50
0
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C


Armeria maritima
Duration of Pretreatment (Weeks)
0
2
4
Regrowth Rating
4
3
2
1
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C


Asclepias tuberosa
Duration of Pretreatment (Weeks)
0
2
4
Percent Survival
100
50
0
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C

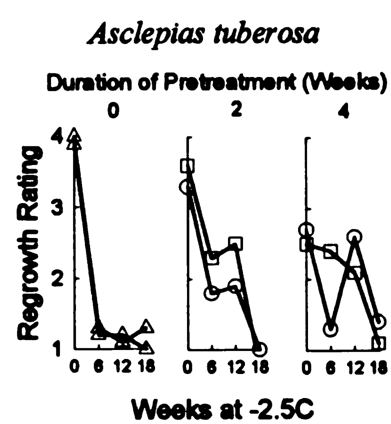

Asclepias tuberosa
Duration of Pretreatment (Weeks)
0
2
4
Regrowth Rating
4
3
2
1
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C

Figure 7. Percent survival and regrowth ratings following storage at -2.5C for *Coreopsis*, *Delphinium*, and *Dianthus*. Plugs pretreated at 5C in light or dark for 0, 2, 4 weeks prior to being transferred to -2.5C for 0, 6, 12, or 18 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.

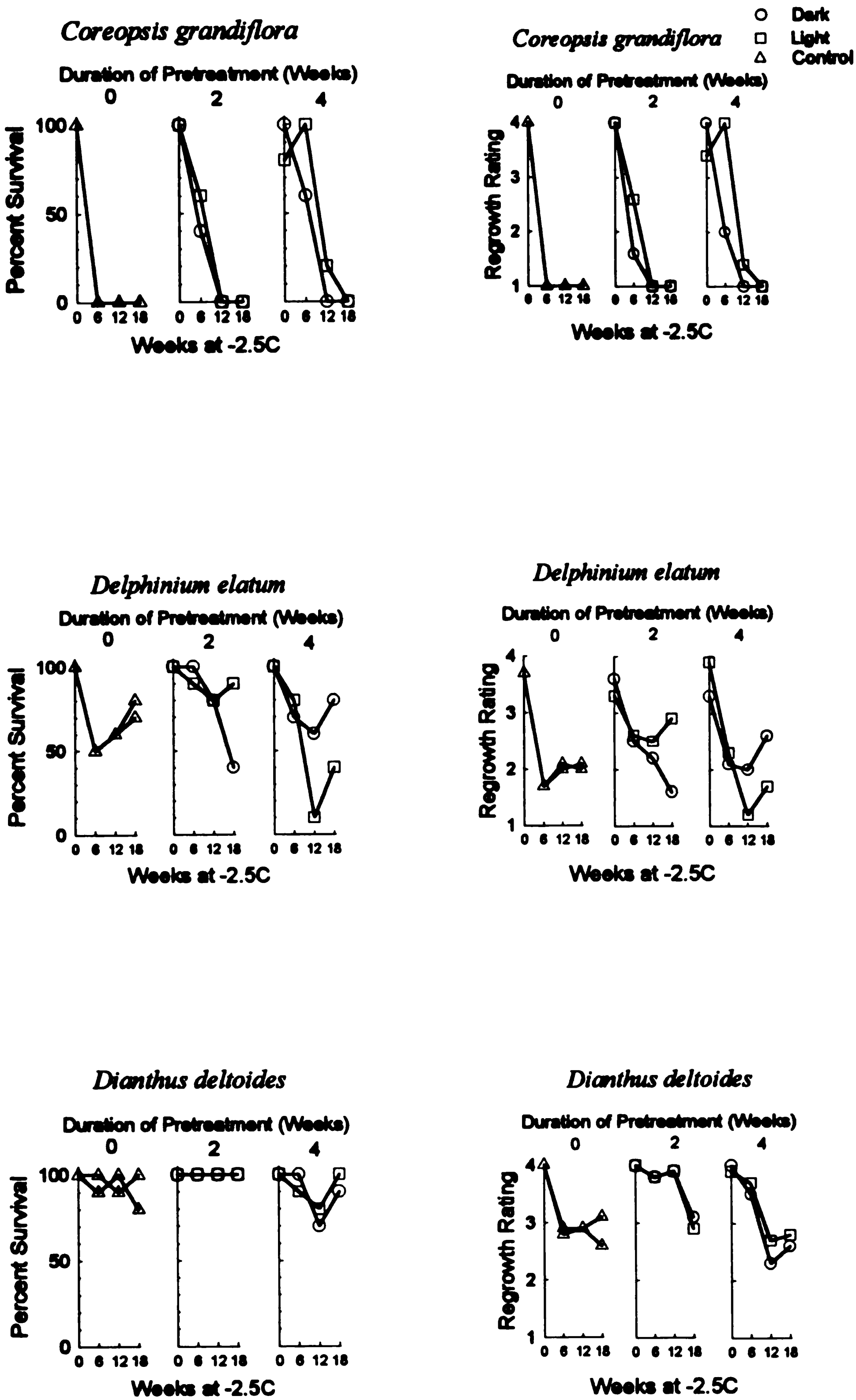
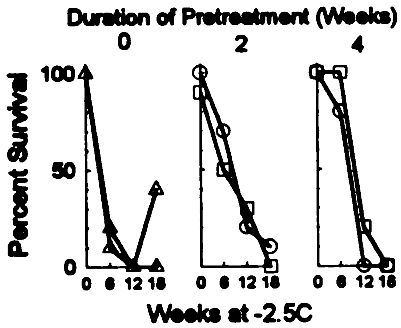
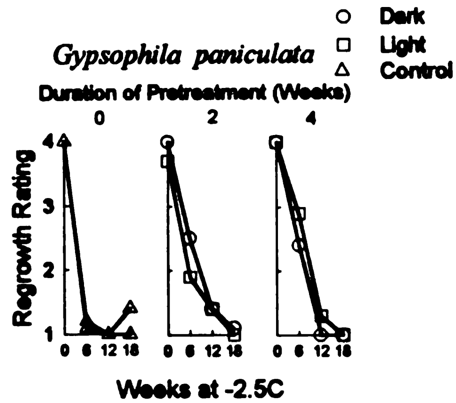

Coreopsis grandiflora
Duration of Pretreatment (Weeks)
0 2 4
Percent Survival
100
50
0
0 6 12 18
Weeks at -2.5C
Dark
Light
Control
Regrowth Rating
4
3
2
1
Delphinium elatum
Dianthus deltoides

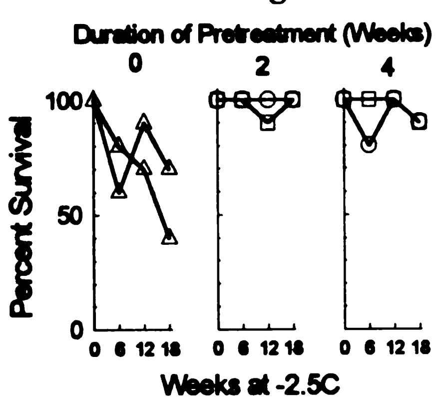
Figure 8. Percent survival and regrowth ratings following storage at -2.5C for *Gypsophila*, *Heuchera*, and *Lavandula*. Plugs pretreated at 5C in light or dark for 0, 2, 4 weeks prior to being transferred to -2.5C for 0, 6, 12, or 18 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.

Gypsophila paniculata

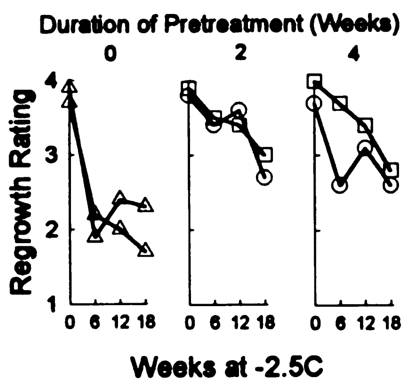




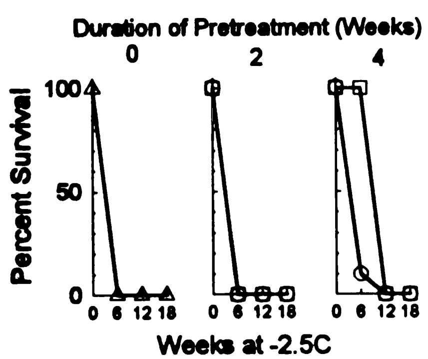
Heuchera sanguinea



Heuchera sanguinea



Lavandula angustifolia



Lavandula angustifolia

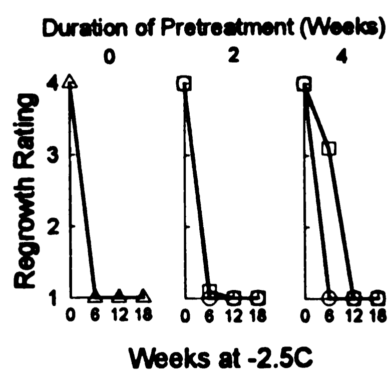
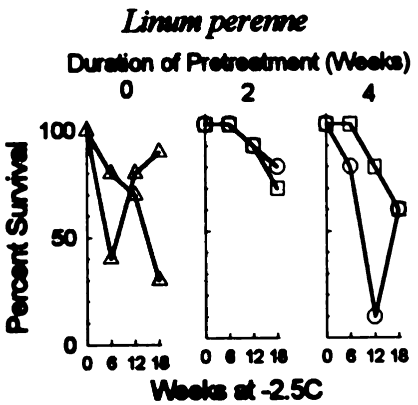
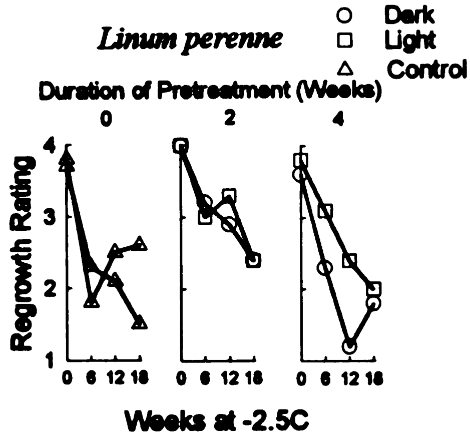
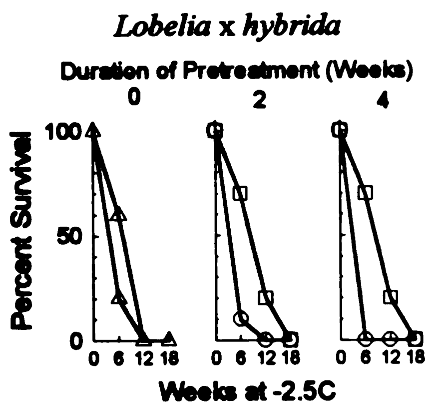
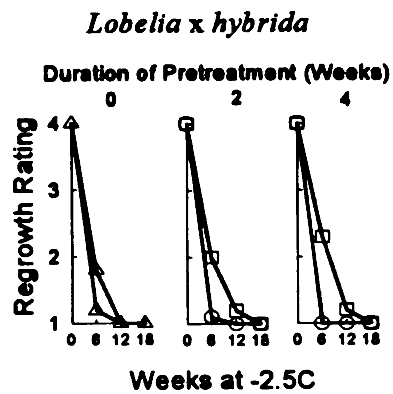


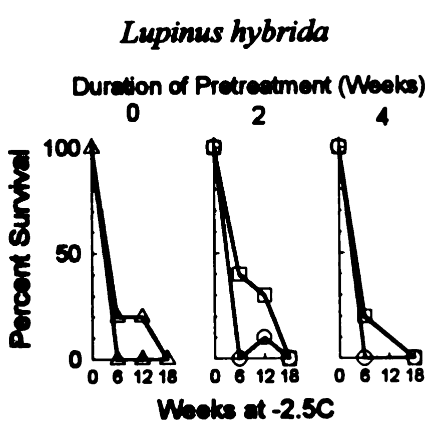
Figure 9. Percent survival and regrowth ratings following storage at -2.5C for *Linum*, *Lobelia* and *Lupinus*. Plugs pretreated at 5C in light or dark for 0, 2, 4 weeks prior to being transferred to -2.5C for 0, 6, 12, or 18 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.


Linum perenne
Duration of Pretreatment (Weeks)
0 2 4
Percent Survival
100
50
0
0 6 12 18
Weeks at -2.5C


Linum perenne
Dark
Light
Control
Duration of Pretreatment (Weeks)
0 2 4
Regrowth Rating
1 2 3 4
0 6 12 18
Weeks at -2.5C


Lobelia x hybrida
Duration of Pretreatment (Weeks)
0 2 4
Percent Survival
100
50
0
0 6 12 18
Weeks at -2.5C


Lobelia x hybrida
Duration of Pretreatment (Weeks)
0 2 4
Regrowth Rating
1 2 3 4
0 6 12 18
Weeks at -2.5C


Lupinus hybrida
Duration of Pretreatment (Weeks)
0 2 4
Percent Survival
100
50
0
0 6 12 18
Weeks at -2.5C

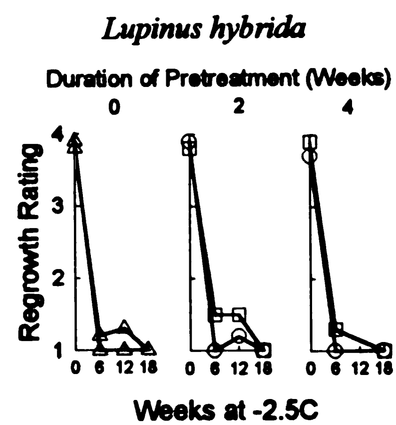
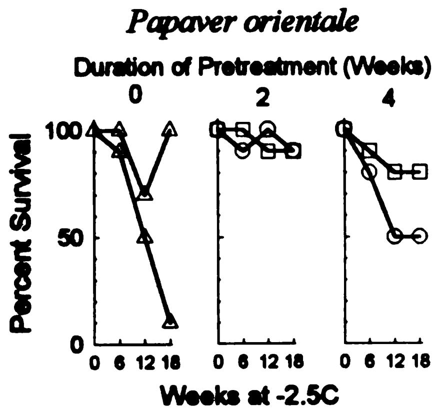
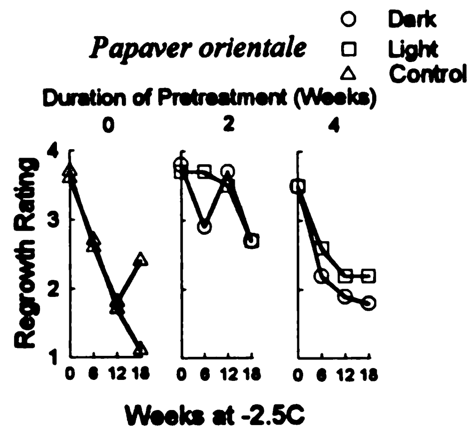
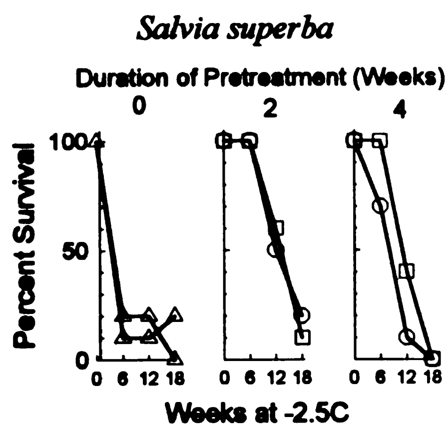
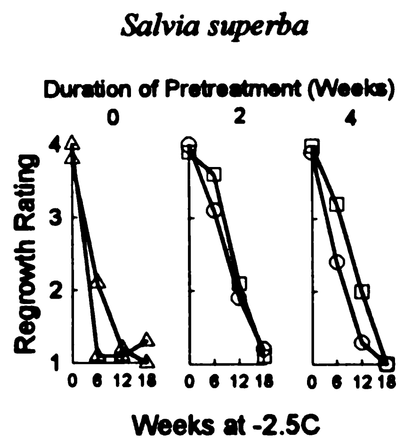

Lupinus hybrida
Duration of Pretreatment (Weeks)
0 2 4
Regrowth Rating
1 2 3 4
0 6 12 18
Weeks at -2.5C

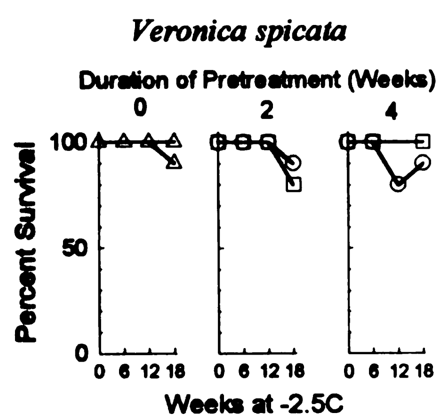
Figure 10. Percent survival and regrowth ratings following storage at -2.5C for *Papaver*, *Salvia*, and *Veronica spicata*. Plugs pretreated at 5C in light or dark for 0, 2, 4 weeks prior to being transferred to -2.5C for 0, 6, 12, or 18 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.


Papaver orientale
Duration of Pretreatment (Weeks)
0
2
4
Percent Survival
100
50
0
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C


Papaver orientale
Dark
Light
Control
Duration of Pretreatment (Weeks)
0
2
4
Regrowth Rating
4
3
2
1
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C


Salvia superba
Duration of Pretreatment (Weeks)
0
2
4
Percent Survival
100
50
0
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C


Salvia superba
Duration of Pretreatment (Weeks)
0
2
4
Regrowth Rating
4
3
2
1
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C


Veronica spicata
Duration of Pretreatment (Weeks)
0
2
4
Percent Survival
100
50
0
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C

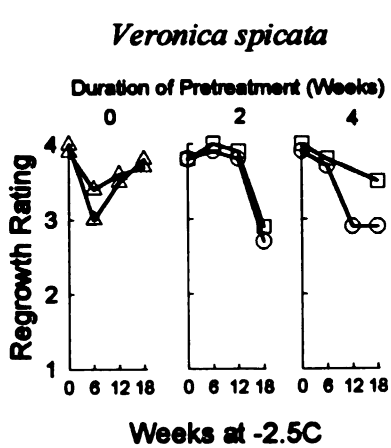
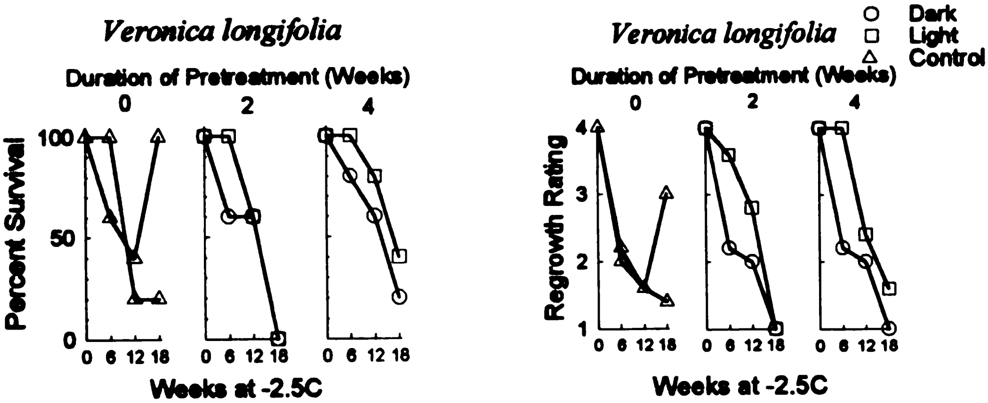

Veronica spicata
Duration of Pretreatment (Weeks)
0
2
4
Regrowth Rating
4
3
2
1
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C

Figure 11. Percent survival and regrowth ratings following storage at -2.5C for *Veronica longifolia*. Plugs pretreated at 5C in light or dark for 0, 2, 4 weeks prior to being transferred to -2.5C for 0, 6, 12, or 18 weeks. Regrowth ratings taken after two weeks. Ratings based on a 4 (excellent) to 1 (dead) scale.



Veronica longifolia
Duration of Pretreatment (Weeks)
0
2
4
Percent Survival
100
50
0
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C
Veronica longifolia
Dark
Light
Control
Duration of Pretreatment (Weeks)
0
2
4
Regrowth Rating
4
3
2
1
0 6 12 18
0 6 12 18
0 6 12 18
Weeks at -2.5C

APPENDIX

THE EFFECT OF DAYLENGTH AND CHILLING ON 33 SPECIES OF PLUG-GROWN HERBACEOUS PERENNIALS

MATERIALS AND METHODS

Year 1

Seedling perennial plugs in 128-cell trays, (489 plants m^{-2}) were received from Raker's Acres, Litchfield, Michigan, on 6 Nov. 1992. Seedling perennial plugs in 50-cell trays, (177 plants m^{-2}) were received from Swift Greenhouses, Gilman, Iowa, on 3 Nov. 1992. Plants from Raker's ranged in age from 6 to 13 weeks and had 4 to 28 leaves, species dependent, at the beginning of the experiment (Table 1, pg. 47). Plants from Swift ranged in age from 18 to 22 weeks and had 7 to 45 leaves, species dependent, at the beginning of the experiment (Table 1, pg. 47). Plugs were initially kept in a 16C greenhouse under natural daylengths. On 10 Nov. 1992, the plug trays were transferred to controlled-temperature chambers maintained at 5C. Lighting was provided for 8 hours per day by cool-white fluorescent bulbs and adjusted to approximately 5 $\mu mol \cdot s^{-1} \cdot m^{-2}$. While at 5C, plugs were subirrigated as needed using distilled water about every other day for 128-cell plugs and twice a week for 50-cell plugs. After 0, 2, 4, 6, 8, and 10 weeks, 20 plugs of each species from each source were transferred to a 21C greenhouse. Photographs were taken just prior to plugs being transplanted.

Plugs were transplanted into 10-cm plastic pots containing Metro Mix 510 medium (Grace Sierra, Allentown, Pennsylvania). Once transplanted, 10 plants of each species from each source were placed under short-day night-interruption conditions. Short days (9 hours) were provided by blackcloth between at 1700 HR and 0800 HR. Night interruption was provided with 60-watt incandescent lights (approximately 6 ± 4 $\mu mol \cdot s^{-1} \cdot m^{-2}$) from 2200 HR to 0200 HR. Plants were grouped by species and source. Pots were overhead watered individually, although they did absorb some water through subirrigation because they were on a solid bench surface. Chrysanthemum plants were damaged, sometimes severely, presumable due to phytotoxicity caused by insecticides. *Hibiscus* plugs in storage from Raker's became drought stressed after the sixth week of storage; they did not recover properly.

Year 2

Seedling perennial plugs in 128-cell trays, (489 plants m^{-2}); (*Veronica longifolia* plugs were in 55-cell trays, 380 plants m^{-2}) were received from Raker's Acres, Litchfield, Michigan, on 26 Oct. 1993. Seedling perennial plugs in 50-cell trays, (177 plants m^{-2}) from Swift Greenhouses, Gilman, Iowa, on 2 Nov. 1993. Plants from Raker's ranged in age from 3 to 11 weeks and had 4 to 52 leaves, species dependent, at the beginning of the experiment (Table 2, pg. 48). Plants from Swift ranged in age from 18 to 22 weeks and had 4 to 71 leaves at the beginning of the experiment (Table 2, pg. 48). Plugs were initially kept in an 18C greenhouse under natural daylengths. Because of chlorosis, the Raker's plugs were fertilized three times with Compound 111, a micronutrient source (Grace Sierra, Allentown, Pennsylvania) at a rate of 0.14 $g{\cdot}l^{-1}$ delivered through a 15:1 proportioner, prior to the experiment. Otherwise, distilled water was used. On 11 Nov. 1993, the plug trays were transferred to 5C controlled-temperature chambers. Lighting was provided for 9 hours per day by cool-white fluorescent bulbs. The initial light level was approximately 100 $\mu mol{\cdot}s^{-1}{\cdot}m^{-2}$ after eight days. Cheesecloth was placed on top of plug trays to adjust light to 5 $\mu mol{\cdot}s^{-1}{\cdot}m^{-2}$. While at 5C, plugs were subirrigated as needed (about every other day for 128-cell plugs and twice a week for 50-cell plugs) using tap water containing 3.5 mM N, Compound 111, at a rate of 0.14 $g{\cdot}l^{-1}$ and 22 ml SO_4 to adjust pH, delivered through a 15:1 proportioner. After 0, 5, 10, and 15 weeks, 20 plugs of each species from each source were transferred to a 20C greenhouse. One of the controlled-temperature rooms cooling units failed on 2 Mar. 1994, and went from 7C to 26C in six hours, at which time the failure was discovered. All plug trays in that chamber were moved into another chamber set at 5C. Plug trays were transferred back to the original chamber after one day, when the temperature returned to 5C. Photographs were taken just prior to plugs being transplanted. Plugs were transplanted into 10-cm plastic pots containing Metro Mix 510 medium (Grace Sierra, Allentown, Pennsylvania). Once plants were transplanted, 10 plants from each species from each source were placed under short-day and night-interruption conditions as described previously. From December until March, supplemental light was provided by HPS lamps at approximately $92 \pm 29\ \mu mol \cdot s^{-1} \cdot m^{-2}$ from 0800 HR until 1700 HR. Plants species were randomized within each size. Pots were overhead watered individually, although they did absorb some water through subirrigation because of the solid bench surface. Species photographs were taken 10 weeks after planting. Banrot® at a rate of $10.6\ g \cdot l^{-1}$ delivered through a 15:1 proportioner, was applied at planting. After the five weeks of growth in the greenhouse *Alcea* plants grew too large for the pots they were growing in and were transplanted into 15-cm standard plastic pots. On 27 Feb. all *Lupines* in greenhouse, and those to be transferred there later, were transplanted into 15-cm plastic pots containing 50% Metro Mix 510 and 50% coarse sand to reduce plant loss caused by overwatering. *Asclepias* plugs (128-cell) were difficult to water in storage because of the lack of root development and the roots' inability to hold onto the soil. These plugs were eventually put on capillary mats during storage. Photographs were taken after 10 weeks after transplant. After photographs were taken, plants that flowered were removed. Plants were removed from the greenhouse after 120 days from planting if they had not flowered.

Experimental design and analysis. Data collected in year 1 were beginning leaf count after planting, date of first visible bud, date of first flower, leaf count at flowering, percent mortality, and regrowth rating. Regrowth was rated on a 1.0 (dead) to 4.0 (excellent) scale, similar to that used in plug regrowth ratings. Ratings were given approximately six weeks after planting. A rating of 4 does not necessarily infer that the plants were in flower. Data types collected for year 2 were the same as those for year 1, although regrowth rating was not taken. Addition data were taken on total bud count and total plant height at flowering. Data on total bud count (including open flower and all subsequent visible buds), and heights were taken on date of first open flower. Heights were taken with a ruler by measuring from the base of the pot (pots measure 8.0 cm tall). For both experiments, data were analyzed as 3-way ANOVA and general linear means with missing replications, the data for each species analyzed separately using PC SAS statistical procedures (SAS Institute, North Carolina).

RESULTS

Means and statistical analysis presented in Tables 7 to 41.

Table 7. Regrowth and flowering response of *Achillea* plugs after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING
SPECIES: *Achillea filipendulina* Cloth of Gold

WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	Days VB	Days FLW	Days VB to FLW	RATING
.	128	.	4	7	53	146	178	31	3.8
0	128	.	10	7	58	174	206	32	3.9
2	128	.	5	6	51	156	186	30	3.7
4	128	.	5	6	44	127	158	31	3.6
6	128	.	0	7	.	.	.	.	3.9
8	128	.	0	7	.	.	.	.	3.9
10	128	.	5	7	55	101	133	32	4.0
.	128	NI	8	7	53	146	178	31	3.9
.	128	SD	0	7	.	.	.	.	3.7
0	128	NI	20	7	58	174	206	32	3.9
2	128	NI	10	5	51	156	186	30	3.9
4	128	NI	10	6	44	127	158	31	4.0
6	128	NI	0	8	.	.	.	.	3.8
8	128	NI	0	6	.	.	.	.	4.0
10	128	NI	10	8	55	101	133	32	4.0
0	128	SD	0	7	.	.	.	.	3.9
2	128	SD	0	7	.	.	.	.	3.5
4	128	SD	0	6	.	.	.	.	3.1
6	128	SD	0	7	.	.	.	.	4.0
8	128	SD	0	7	.	.	.	.	3.9
10	128	SD	0	7	.	.	.	.	4.0

Significance	LEAVES Planting	LEAVES Final	VB	FLW	VB to FLW	RATING
weeks (w)	**	NS	NS	NS	***	**
size (s)	z	z	z	z	z	z
(w) x (s)	z	z	z	z	z	z
photoperiod (p)	NS	*	z	z	z	**
(p) x (w)	NS	NS	z	z	z	***
(p) x (s)	z	z	z	z	z	z
(p) x (w) x (s)	z	z	z	z	z	z

z = F-test not possible due to missing data from lack of flowering
n=119

Table 8. Regrowth and flowering response of *Aquilegia* plugs of two cultivars (different sizes) after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING — 128 Cell—Music Mixed a

SPECIES: *Aquilegia x hybrida* — 50 Cell—Dragon Fly a

WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	128	.	7	7	40	133	147	12	3.7
.	50	.	15	11	34	68	79	11	3.8
0	128	.	32	7	39	129	145	12	3.6
2	128	.	10	6	44	141	154	13	3.4
4	128	.	0	6	.	.	.	.	3.8
6	128	.	0	8	.	.	.	.	3.7
8	128	.	0	8	.	.	.	.	3.8
10	128	.	0	8	.	.	.	.	3.9
0	50	.	30	10	42	109	118	9	3.5
2	50	.	11	10	32	58	69	11	3.7
4	50	.	26	11	28	47	60	12	4.0
6	50	.	5	12	31	45	58	13	3.7
8	50	.	10	13	29	37	50	13	3.8
10	50	.	10	12	28	49	60	12	3.8
.	128	NI	0	7	.	.	.	.	3.8
.	50	NI	8	11	29	47	59	12	3.8
.	128	SD	14	7	40	133	147	12	3.6
.	50	SD	23	11	35	76	86	11	3.7
0	128	NI	0	7	.	.	.	.	3.7
2	128	NI	0	6	.	.	.	.	3.7
4	128	NI	0	6	.	.	.	.	3.6
6	128	NI	0	8	.	.	.	.	3.8
8	128	NI	0	8	.	.	.	.	3.8
10	128	NI	0	8	.	.	.	.	3.9
0	50	NI	0	9	.	.	.	.	3.6
2	50	NI	10	10	35	56	66	10	3.9
4	50	NI	10	10	24	44	58	14	4.0
6	50	NI	0	12	.	.	.	.	3.7
8	50	NI	10	14	30	37	50	13	3.8
10	50	NI	20	12	28	49	60	12	3.7
0	128	SD	67	6	39	129	145	12	3.6
2	128	SD	20	6	44	141	154	13	3.1
4	128	SD	0	6	.	.	.	.	4.0
6	128	SD	0	8	.	.	.	.	3.5
8	128	SD	0	8	.	.	.	.	3.9
10	128	SD	0	7	.	.	.	.	3.8
0	50	SD	60	11	42	109	118	9	3.4
2	50	SD	13	9	28	60	71	11	3.5
4	50	SD	44	11	30	48	60	12	4.0
6	50	SD	10	11	31	45	58	13	3.8
8	50	SD	10	12	27	37	50	13	3.8
10	50	SD	0	12	.	.	.	.	3.9
Significance									
weeks (w)				***	NS	*	*	NS	*
size (s)				***	NS	***	***	NS	NS
(w) x (s)				NS	NS	*	*	NS	NS
photoperiod (p)				NS	NS	NS	NS	NS	NS
(p) x (w)				NS	NS	NS	NS	NS	NS
(p) x (s)				NS	z	z	z	z	NS
(p) x (w) x (s)				*	z	z	z	z	NS

z = F-test not possible due to missing data from lack of flowering

n=235

a=Statistical analysis performed on cultivars together

Table 9. Regrowth and flowering response of *Asclepias* plugs after 0 and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING
SPECIES: *Asclepias tuberosa*

WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	50	.	40	45	84	51	79	27	3.2
0	50	.	35	49	70	47	54	18	2.9
10	50	.	45	41	86	54	83	28	3.5
.	50	NI	70	46	84	52	79	27	3.5
.	50	SD	10	45	.	45	.	.	2.9
0	50	NI	10	50	70	48	54	18	3.5
10	50	NI	80	39	86	56	83	28	3.5
0	50	SD	0	48	.	37	.	.	2.2
10	50	SD	0	42	.	53	.	.	3.5

Significance

weeks (w)	*	NS	NS	NS	NS	NS
size (s)	z	z	z	z	z	z
(w) x (s)	z	z	z	z	z	z
photoperiod (p)	NS	*	NS	z	z	NS
(p) x (w)	NS	*	NS	z	z	NS
(p) x (s)	z	z	z	z	z	z
(p) x (w) x (s)	z	z	z	z	z	z

z = F-test not possible due to missing data from lack of flowering
n=40

Table 10. Regrowth and flowering response of *Astilbe* plugs after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent.

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING										
SPECIES *Astilbe arendsii*										
WEEKS	Plug	Photo-	FLOWERING	LEAVES		DAYS				
of 5C	Size	period	(%)	Planting	Final	VB	FLW	VB to FLW		RATING
.	128	.	7	5	12	103	127	27		3.4
0	128	.	0	6	.	.	.	.		3.2
2	128	.	15	5	13	95	119	24		3.6
4	128	.	10	5	12	121	150	30		3.5
6	128	.	5	4	9	105	133	28		3.1
8	128	.	5	3	12	100	127	27		3.1
10	128	.	5	4	14	67	96	29		3.6
.	128	NI	15	4	12	102	127	27		3.6
.	128	SD	3	5	14	107	.	.		3.1
0	128	NI	0	5	.	.	.	.		3.3
2	128	NI	30	5	13	95	119	24		3.7
4	128	NI	20	5	12	122	150	30		3.7
6	128	NI	10	4	9	105	133	28		3.5
8	128	NI	10	4	12	100	127	27		3.6
10	128	NI	10	3	13	67	96	29		4.0
0	128	SD	0	6	.	.	.	.		3.1
2	128	SD	0	6	.	.	.	.		3.6
4	128	SD	0	6	.	.	.	.		3.3
6	128	SD	0	4	.	.	.	.		2.6
8	128	SD	0	3	.	.	.	.		2.6
10	128	SD	0	4	.	.	.	.		3.3
			Significance							
			weeks (w)	***	NS	NS	NS	NS		*
			size (s)	z	z	z	z	z		NS
			(w) x (s)	z	z	z	z	z		z
			photoperiod (	NS	NS	NS	z	z		***
			(p) x (w)	**	z	NS	z	z		NS
			(p) x (s)	z	z	z	z	z		z
			(p) x (w) x (s)	z	z	z	z	z		z

z = F-test not possible due to missing data from lack of flowering
n=120

Table 11. Regrowth and flowering response of *Campanula* plugs of two sizes after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING

SPECIES: ***Campanula carpatica*** **Blue Clips**

WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	.	.	49	11	30	49	71	23	3.4
0	.	.	45	11	30	71	94	23	3.0
2	.	.	53	9	32	69	93	25	3.1
4	.	.	48	11	28	42	65	23	3.5
6	.	.	50	11	30	46	68	22	3.6
8	.	.	49	13	29	34	55	21	3.7
10	.	.	50	13	29	33	54	25	3.8
.	128	.	47	9	25	57	80	22	3.3
.	50	.	51	14	34	41	64	24	3.6
0	128	.	40	8	25	95	118	23	2.3
2	128	.	50	8	28	80	101	21	2.9
4	128	.	46	9	24	46	70	24	3.5
6	128	.	50	8	28	56	77	22	3.5
8	128	.	47	11	25	40	61	21	3.7
10	128	.	50	10	24	33	55	22	3.9
0	50	.	50	14	35	51	75	24	3.8
2	50	.	55	11	37	60	88	28	3.2
4	50	.	50	13	32	38	61	23	3.5
6	50	.	50	14	33	36	58	22	3.7
8	50	.	50	15	32	29	50	21	3.7
10	50	.	50	16	34	33	53	26	3.7
.	.	NI	97	12	29	48	71	23	3.5
.	.	SD	1	11	82	101	161	49	3.4
0	.	NI	90	11	30	71	94	23	3.2
2	.	NI	100	9	29	67	89	23	3.1
4	.	NI	95	11	28	42	65	23	3.7
6	.	NI	100	12	30	46	68	22	3.8
8	.	NI	100	14	29	34	55	21	3.7
10	.	NI	100	15	29	30	54	25	3.8
0	.	SD	0	12	.	.	.	.	2.9
2	.	SD	5	9	82	112	161	49	3.1
4	.	SD	0	12	.	.	.	.	3.4
6	.	SD	0	11	.	.	.	.	3.4
8	.	SD	0	12	.	.	.	.	3.7
10	.	SD	0	11	.	89	.	.	3.8
.	128	NI	95	9	25	57	80	22	3.3
.	50	NI	100	15	33	39	62	24	3.7
.	128	SD	0	9	.	.	.	.	3.3
.	50	SD	2	13	82	101	161	49	3.4
0	128	NI	80	8	25	95	118	23	2.6
2	128	NI	100	8	28	80	101	21	2.7
4	128	NI	90	10	24	46	70	24	3.4
6	128	NI	100	8	28	56	77	22	3.6
8	128	NI	100	11	25	40	61	21	3.5
10	128	NI	100	11	24	33	55	22	3.8
0	50	NI	100	13	35	51	75	24	3.7
2	50	NI	100	11	33	55	77	25	3.4
4	50	NI	100	13	32	38	61	23	3.9
6	50	NI	100	16	33	36	58	22	3.9
8	50	NI	100	17	32	29	50	21	3.8
10	50	NI	100	19	34	27	53	26	3.7
0	128	SD	0	8	.	.	.	.	2.0
2	128	SD	0	8	.	.	.	.	3.1
4	128	SD	0	9	.	.	.	.	3.6
6	128	SD	0	8	.	.	.	.	3.3
8	128	SD	0	11	.	.	.	.	3.8
10	128	SD	0	9	.	.	.	.	3.9
0	50	SD	0	16	.	.	.	.	3.8
2	50	SD	10	11	82	112	161	49	3.0
4	50	SD	0	14	.	.	.	.	3.1
6	50	SD	0	13	.	.	.	.	3.4
8	50	SD	0	12	.	.	.	.	3.6
10	50	SD	0	13	.	.	.	.	3.7

Significance	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
weeks (w)	***	NS	***	***	NS	***
size (s)	***	***	***	***	NS	***
(w) x (s)	NS	NS	***	***	NS	***
photoperiod (p)	*	***	***	***	***	NS
(p) x (w)	**	NS	NS	z	z	NS
(p) x (s)	NS	NS	z	z	z	*
(p) x (w) x (s)	*	NS	z	z	z	**

z = F-test not possible due to missing data from lack of flowering

n=239

Table 12. Regrowth and flowering response of *Chrysanthemum* plugs of two sizes after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING

SPECIES: ***Chrysanthemum superbum*** **Snow Lady**

WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	.	.	42	11	25	33	64	34	3.0
0	.	.	43	12	26	42	68	34	3.6
2	.	.	45	10	26	36	65	34	4.1
4	.	.	54	11	27	39	74	36	3.7
6	.	.	30	12	.	26	.	.	1.9
8	.	.	25	12	26	31	63	30	1.7
10	.	.	57	12	24	23	56	34	2.9
.	128	.	31	10	23	41	67	31	3.0
.	50	.	53	13	27	28	62	36	3.0
0	128	.	20	11	28	56	93	29	3.4
2	128	.	40	10	27	51	88	33	3.9
4	128	.	42	9	25	42	66	31	3.7
6	128	.	15	10	.	36	.	.	1.8
8	128	.	30	9	26	44	63	30	2.2
10	128	.	40	9	19	23	54	31	2.9
0	50	.	65	13	25	38	61	35	3.8
2	50	.	50	11	25	25	59	36	4.3
4	50	.	65	13	29	38	81	42	3.7
6	50	.	45	13	.	22	.	.	2.0
8	50	.	20	14	.	10	.	.	1.2
10	50	.	75	14	32	23	56	38	2.9
.	.	NI	71	12	24	31	63	34	3.0
.	.	SD	13	11	38	44	79	40	2.9
0	.	NI	70	12	26	34	68	34	3.7
2	.	NI	90	11	26	36	65	34	4.4
4	.	NI	90	11	25	35	69	35	3.7
6	.	NI	60	12	.	26	.	.	2.0
8	.	NI	30	12	23	33	56	28	1.5
10	.	NI	85	12	21	21	53	32	3.0
0	.	SD	15	11	.	77	.	.	3.6
2	.	SD	0	10	.	.	.	.	3.8
4	.	SD	16	10	37	64	97	40	3.7
6	.	SD	0	11	.	.	.	.	1.9
8	.	SD	20	12	31	28	73	33	1.8
10	.	SD	30	11	47	28	67	48	2.8
.	128	NI	58	10	23	41	67	31	3.0
.	50	NI	83	14	26	24	60	36	3.1
.	128	SD	3	9	31	49	73	33	3.0
.	50	SD	23	12	42	43	82	44	2.8
0	128	NI	40	11	28	56	93	29	3.4
2	128	NI	80	9	27	51	88	33	3.8
4	128	NI	80	9	25	42	66	31	3.7
6	128	NI	30	10	.	36	.	.	1.6
8	128	NI	40	10	23	42	58	28	1.8
10	128	NI	80	10	19	23	54	31	3.3
0	50	NI	100	13	25	26	61	35	3.9
2	50	NI	100	13	25	25	59	35	4.9
4	50	NI	100	14	26	30	73	43	3.7
6	50	NI	90	14	.	22	.	.	2.3
8	50	NI	20	14	.	14	.	.	1.2
10	50	NI	90	15	27	20	53	34	2.6
0	128	SD	0	11	.	.	.	.	3.4
2	128	SD	0	10	.	.	.	.	4.0
4	128	SD	0	9	.	.	.	.	3.8
6	128	SD	0	10	.	.	.	.	2.1
8	128	SD	20	8	31	49	73	33	2.9
10	128	SD	0	8	.	.	.	.	2.4
0	50	SD	30	12	.	77	.	.	3.7
2	50	SD	0	10	.	.	.	.	3.6
4	50	SD	30	12	37	64	97	40	3.7
6	50	SD	0	12	.	.	.	.	1.6
8	50	SD	20	15	.	7	.	.	1.1
10	50	SD	60	13	47	28	67	48	3.2
			Significance						
			weeks (w)	*	*	***	***	NS	***
			size (s)	***	***	***	***	***	NS
			(w) x (s)	***	NS	***	***	NS	*
			photoperiod (p)	**	***	***	***	NS	NS
			(p) x (w)	NS	***	***	NS	*	NS
			(p) x (s)	NS	NS	NS	z	z	NS
			(p) x (w) x (s)	*	***	z	z	z	*

z = F-test not possible due to missing data from lack of flowering

n=239

Table 13. Regrowth and flowering response of *Echinacea* plugs of two cultivars (different sizes) after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING 128 Cell--Bravado a

SPECIES: *Echinacea purpurea* 50 Cell--Ovation Pink a

WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	.	.	46	6	21	99	134	36	3.4
0	.	.	48	6	24	129	165	36	3.1
2	.	.	38	6	21	108	145	36	2.6
4	.	.	40	7	22	108	136	37	3.3
6	.	.	50	6	21	108	139	34	3.7
8	.	.	50	6	20	77	114	37	3.7
10	.	.	51	6	21	73	107	34	3.8
.	128	.	48	6	23	108	139	35	3.6
.	50	.	43	6	20	92	128	36	3.1
0	128	.	45	7	25	130	165	35	3.5
2	128	.	47	6	21	104	141	37	3.3
4	128	.	50	6	24	120	151	37	3.8
6	128	.	50	6	22	112	142	33	3.8
8	128	.	50	6	23	90	125	35	3.7
10	128	.	53	6	24	82	116	34	3.8
0	50	.	50	6	22	127	165	37	2.8
2	50	.	30	6	20	115	150	36	2.0
4	50	.	30	7	20	87	126	38	2.8
6	50	.	50	6	20	101	136	35	3.7
8	50	.	50	6	18	65	104	39	3.6
10	50	.	50	6	19	64	97	33	3.8
.	.	NI	92	6	21	99	134	36	3.5
.	.	SD	2	6	24	102	132	32	3.2
0	.	NI	95	6	24	129	165	36	3.6
2	.	NI	79	6	21	108	145	36	3.1
4	.	NI	80	6	22	108	136	37	3.2
6	.	NI	95	6	21	108	139	34	3.7
8	.	NI	100	6	20	77	114	37	3.8
10	.	NI	100	7	21	72	105	34	3.9
0	.	SD	0	6	.	.	.	.	2.7
2	.	SD	0	6	.	.	.	.	2.2
4	.	SD	0	7	.	.	.	.	3.4
6	.	SD	5	6	14	103	132	.	3.7
8	.	SD	0	6	.	.	.	.	3.5
10	.	SD	5	5	33	100	132	32	3.7
.	128	NI	96	6	23	108	139	35	3.8
.	50	NI	85	6	20	92	128	36	3.3
.	128	SD	2	6	33	100	132	32	3.5
.	50	SD	2	6	14	103	132	.	2.9
0	128	NI	90	7	25	130	165	35	3.7
2	128	NI	100	7	21	104	141	37	3.8
4	128	NI	100	6	24	120	151	37	3.7
6	128	NI	100	6	22	112	142	33	3.7
8	128	NI	100	6	23	90	125	35	4.0
10	128	NI	100	7	23	80	114	34	4.0
0	50	NI	100	6	22	127	165	37	3.5
2	50	NI	60	6	20	115	150	36	2.5
4	50	NI	60	7	20	87	126	38	2.6
6	50	NI	90	7	21	101	136	35	3.7
8	50	NI	100	6	18	65	104	39	3.6
10	50	NI	100	7	19	64	97	33	3.8
0	128	SD	0	7	.	.	.	.	3.3
2	128	SD	0	6	.	.	.	.	2.9
4	128	SD	0	6	.	.	.	.	3.8
6	128	SD	0	6	.	.	.	.	3.8
8	128	SD	0	6	.	.	.	.	3.4
10	128	SD	10	5	33	100	132	32	3.6
0	50	SD	0	6	.	.	.	.	2.0
2	50	SD	0	7	.	.	.	.	1.4
4	50	SD	0	8	.	.	.	.	3.0
6	50	SD	10	6	14	103	132	.	3.6
8	50	SD	0	6	.	.	.	.	3.6
10	50	SD	0	5	.	.	.	.	3.8
			Significance						
			weeks (w)	NS	**	***	***	NS	***
			size (s)	NS	*	**	*	NS	***
			(w) x (s)	NS	NS	NS	NS	NS	***
			photoperiod (p)	NS	***	NS	NS	NS	***
			(p) x (w)	*	**	z	z	z	***
			(p) x (s)	NS	*	z	z	z	NS
			(p) x (w) x (s)	NS	NS	z	z	z	*

z = F-test not possible due to missing data from lack of flowering

n=237

a=Statistical analysis performed on cultivars together

Table 14. Regrowth and flowering response of *Gaillardia* plugs of two sizes after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING

SPECIES: *Gaillardia x grandiflora* Goblin

WEEKS of 5C	Plug Size	Photo period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	.	.	30	8	53	123		32	3.9
0	.	.	31	9	53	147	177	30	3.9
2	.	.	30	7	46	135	168	33	3.7
4	.	.	25	7	55	134	171	37	3.9
6	.	.	30	9	52	115	146	31	3.9
8	.	.	26	10	56	101	132	31	3.9
10	.	.	35	9	58	107	140	33	3.9
.	128	.	29	8	60	130	161	31	3.9
.	50	.	30	9	47	116	149	33	3.8
0	128	.	37	8	62	156	182	26	3.8
2	128	.	25	8	45	143	174	31	3.9
4	128	.	20	7	57	128	165	37	3.8
6	128	.	25	8	66	127	157	30	3.9
8	128	.	25	8	64	109	143	33	3.9
10	128	.	45	8	62	116	150	34	3.9
0	50	.	25	9	41	134	170	36	3.9
2	50	.	35	6	46	130	164	35	3.5
4	50	.	30	7	53	138	175	37	4.0
6	50	.	35	10	40	106	138	32	4.0
8	50	.	30	11	49	94	123	30	4.0
10	50	.	25	10	52	92	123	31	3.9
.	.	NI	47	9	53	123	156	33	3.8
.	.	SD	13	8	57	121	152	31	3.9
0	.	NI	40	9	49	138	166	29	3.7
2	.	NI	60	8	46	135	168	33	3.7
4	.	NI	45	7	54	137	174	38	3.9
6	.	NI	35	9	53	120	150	31	4.0
8	.	NI	35	10	53	101	135	34	4.0
10	.	NI	65	9	60	107	140	32	3.9
0	.	SD	21	9	61	165	198	33	4.0
2	.	SD	0	6	.	.	.	.	3.7
4	.	SD	5	8	64	113	141	28	4.0
6	.	SD	25	9	49	108	139	31	3.9
8	.	SD	20	9	62	100	127	27	3.8
10	.	SD	5	8	43	107	147	40	3.9
.	128	NI	42	8	57	132	164	33	3.9
.	50	NI	52	9	49	116	149	33	3.8
.	128	SD	17	8	67	125	154	29	3.9
.	50	SD	8	9	32	113	149	36	3.9
0	128	NI	40	9	56	146	173	27	3.7
2	128	NI	50	8	45	143	174	31	4.0
4	128	NI	30	7	54	133	173	39	3.8
6	128	NI	30	8	62	139	168	28	3.9
8	128	NI	20	8	58	119	162	44	4.0
10	128	NI	80	8	64	117	150	33	3.9
0	50	NI	40	9	43	129	159	30	3.7
2	50	NI	70	7	46	130	164	35	3.4
4	50	NI	60	8	53	138	175	37	3.9
6	50	NI	40	10	47	105	138	33	4.0
8	50	NI	50	12	51	94	125	30	4.0
10	50	NI	50	10	52	92	123	31	3.8
0	128	SD	33	8	71	169	193	24	4.0
2	128	SD	0	7	.	.	.	.	3.9
4	128	SD	10	8	64	113	141	28	3.9
6	128	SD	20	8	71	108	141	33	3.9
8	128	SD	30	8	68	103	130	26	3.7
10	128	SD	10	8	43	107	147	40	3.9
0	50	SD	10	10	31	153	212	59	4.0
2	50	SD	0	6	.	.	.	.	3.5
4	50	SD	0	7	.	.	.	.	4.0
6	50	SD	30	9	28	108	139	30	3.9
8	50	SD	10	11	42	89	117	28	3.9
10	50	SD	0	9	.	.	.	.	3.9
			Significance						
			weeks (w)	***	NS	**	***	NS	NS
			size (s)	***	NS	NS	NS	NS	NS
			(w) x (s)	***	NS	NS	NS	NS	**
			photoperiod (p)	NS	***	NS	NS	NS	NS
			(p) x (w)	NS	**	NS	NS	NS	NS
			(p) x (s)	NS	NS	NS	NS	NS	NS
			(p) x (w) x (s)	NS	NS	NS	NS	NS	NS

z = F-test not possible due to missing data from lack of flowering
n=239

Table 15. Regrowth and flowering response of *Goniolimon* plugs of two sizes after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING										
SPECIES:	*Goniolimon tatarica*									
WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING	
.	.	.	0	14	.	.	.	.	3.9	
0	.	.	0	14	.	.	.	.	3.8	
2	.	.	0	14	.	.	.	.	3.8	
4	.	.	0	14	.	.	.	.	4.0	
6	.	.	0	15	.	.	.	.	3.9	
8	.	.	0	15	.	.	.	.	4.0	
10	.	.	0	15	.	.	.	.	3.9	
.	128	.	0	12	.	.	.	.	3.8	
.	50	.	0	16	.	.	.	.	4.0	
0	128	.	0	13	.	.	.	.	3.7	
2	128	.	0	12	.	.	.	.	3.7	
4	128	.	0	12	.	.	.	.	4.0	
6	128	.	0	13	.	.	.	.	3.9	
8	128	.	0	12	.	.	.	.	3.9	
10	128	.	0	13	.	.	.	.	3.8	
0	50	.	0	16	.	.	.	.	4.0	
2	50	.	0	16	.	.	.	.	4.0	
4	50	.	0	15	.	.	.	.	4.0	
6	50	.	0	17	.	.	.	.	4.0	
8	50	.	0	18	.	.	.	.	4.2	
10	50	.	0	16	.	.	.	.	4.0	
.	.	NI	0	15	.	.	.	.	3.9	
.	.	SD	0	14	.	.	.	.	3.9	
0	.	NI	0	14	.	.	.	.	3.8	
2	.	NI	0	14	.	.	.	.	3.9	
4	.	NI	0	14	.	.	.	.	4.0	
6	.	NI	0	15	.	.	.	.	4.0	
8	.	NI	0	16	.	.	.	.	3.9	
10	.	NI	0	17	.	.	.	.	4.0	
0	.	SD	0	15	.	.	.	.	3.9	
2	.	SD	0	14	.	.	.	.	3.8	
4	.	SD	0	13	.	.	.	.	4.0	
6	.	SD	0	15	.	.	.	.	3.9	
8	.	SD	0	14	.	.	.	.	4.2	
10	.	SD	0	13	.	.	.	.	3.8	
.	128	NI	0	13	.	.	.	.	3.9	
.	50	NI	0	17	.	.	.	.	4.0	
.	128	SD	0	12	.	.	.	.	3.8	
.	50	SD	0	16	.	.	.	.	4.1	
0	128	NI	0	12	.	.	.	.	3.6	
2	128	NI	0	12	.	.	.	.	3.8	
4	128	NI	0	12	.	.	.	.	4.0	
6	128	NI	0	15	.	.	.	.	4.0	
8	128	NI	0	12	.	.	.	.	3.8	
10	128	NI	0	14	.	.	.	.	4.0	
0	50	NI	0	16	.	.	.	.	4.0	
2	50	NI	0	15	.	.	.	.	3.9	
4	50	NI	0	16	.	.	.	.	3.9	
6	50	NI	0	16	.	.	.	.	4.0	
8	50	NI	0	19	.	.	.	.	4.0	
10	50	NI	0	20	.	.	.	.	4.0	
0	128	SD	0	14	.	.	.	.	3.7	
2	128	SD	0	12	.	.	.	.	3.5	
4	128	SD	0	12	.	.	.	.	4.0	
6	128	SD	0	12	.	.	.	.	3.7	
8	128	SD	0	11	.	.	.	.	4.0	
10	128	SD	0	13	.	.	.	.	3.7	
0	50	SD	0	15	.	.	.	.	4.0	
2	50	SD	0	17	.	.	.	.	4.0	
4	50	SD	0	15	.	.	.	.	4.0	
6	50	SD	0	19	.	.	.	.	4.0	
8	50	SD	0	16	.	.	.	.	4.3	
10	50	SD	0	13	.	.	.	.	4.0	
			Significance							
			weeks (w)	NS	z	z	z	z	*	
			size (s)	***	z	z	z	z	***	
			(w) x (s)	NS	z	z	z	z	NS	
			photoperiod (p)	*	z	z	z	z	NS	
			(p) x (w)	**	z	z	z	z	NS	
			(p) x (s)	NS	z	z	z	z	*	
			(p) x (w) x (s)	***	z	z	z	z	NS	

z = F-test not possible due to missing data from lack of flowering

n=240

Table 16. Regrowth and flowering response of *Hibiscus* plugs of two sizes after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING

SPECIES: Hibiscus x hybrida Disco Belle

WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	.	.	48	7	34	109	182	73	2.8
0	.	.	50	8	32	127	200	71	3.1
2	.	.	47	7	37	129	206	76	3.1
4	.	.	50	6	32	108	187	84	2.1
6	.	.	48	7	29	89	138	48	2.5
8	.	.	50	7	33	93	160	67	2.9
10	.	.	45	7	39	74	161	91	3.2
.	128	.	56	6	33	131	196	66	3.0
.	50	.	46	8	34	100	175	76	2.7
0	128	.	61	7	32	132	198	66	3.9
2	128	.	44	7	34	132	191	59	3.8
4	128	.	75	5	30	119	208	107	2.3
6	128	.	50	7	39	138	176	38	1.5
8	128	.	0	6	.	.	.	.	1.0
10	128	.	0	5	.	.	.	.	2.0
0	50	.	39	9	33	120	204	81	2.5
2	50	.	50	8	40	127	224	96	2.4
4	50	.	44	6	33	104	182	78	2.0
6	50	.	47	7	28	84	133	50	2.9
8	50	.	50	8	33	93	160	67	3.2
10	50	.	45	8	39	74	161	91	3.3
.	.	NI	95	7	33	108	182	73	2.7
.	.	SD	5	7	40	129	184	60	2.8
0	.	NI	88	8	31	128	202	72	3.2
2	.	NI	94	7	37	128	206	76	3.1
4	.	NI	100	6	32	108	187	84	1.8
6	.	NI	100	7	29	89	138	48	2.8
8	.	NI	100	7	33	93	160	67	2.9
10	.	NI	90	8	39	74	161	91	3.1
0	.	SD	16	8	40	126	184	60	3.1
2	.	SD	5	8	.	139	.	.	3.1
4	.	SD	0	6	.	.	.	.	2.5
6	.	SD	0	7	.	.	.	.	2.1
8	.	SD	0	7	.	.	.	.	2.9
10	.	SD	0	7	.	.	.	.	3.3
.	128	NI	100	6	32	131	197	67	2.6
.	50	NI	93	7	34	99	175	76	2.8
.	128	SD	14	6	40	126	184	60	3.3
.	50	SD	2	8	.	139	.	.	2.6
0	128	NI	100	7	31	134	201	67	3.6
2	128	NI	100	6	34	132	191	59	3.9
4	128	NI	100	5	30	119	208	107	1.9
6	128	NI	100	7	39	138	176	38	1.5
8	128	NI	0	6	.	.	.	.	1.0
10	128	NI	0	6	.	.	.	.	.
0	50	NI	78	9	33	120	204	81	2.9
2	50	NI	90	7	40	126	224	96	2.4
4	50	NI	100	6	33	104	182	78	1.7
6	50	NI	100	7	28	84	133	50	3.3
8	50	NI	100	8	33	93	160	67	3.3
10	50	NI	90	8	39	74	161	91	3.1
0	128	SD	30	8	40	126	184	60	4.0
2	128	SD	0	7	.	.	.	.	3.8
4	128	SD	0	5	.	.	.	.	3.0
6	128	SD	0	6	.	.	.	.	1.5
8	128	SD	0	5	.	.	.	.	1.0
10	128	SD	0	4	.	.	.	.	2.0
0	50	SD	0	9	.	.	.	.	2.2
2	50	SD	10	9	.	.	.	.	2.3
4	50	SD	0	6	.	.	.	.	2.2
6	50	SD	0	7	.	.	.	.	2.4
8	50	SD	0	8	.	.	.	.	3.1
10	50	SD	0	8	.	.	.	.	3.4

Significance	Planting	Final	VB	FLW	VB to FLW	RATING
weeks (w)	***	***	NS	**	**	NS
size (s)	***	***	**	NS	NS	NS
(w) x (s)	NS	***	NS	NS	***	NS
photoperiod (p)	NS	***	NS	NS	NS	NS
(p) x (w)	NS	**	z	z	z	NS
(p) x (s)	NS	*	z	z	z	NS
(p) x (w) x (s)	NS	***	z	z	z	NS

z = F-test not possible due to missing data from lack of flowering

n=212

Table 17. Regrowth and flowering response of *Iberis* plugs of two sizes after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING

SPECIES: *Iberis sempervirens* Snowflake

WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	.	.	21	29	47	54	68	12	3.8
0	.	.	25	29	49	112	107	11	3.6
2	.	.	23	27	49	65	90	14	3.7
4	.	.	18	28	44	53	65	12	3.9
6	.	.	17	28	52	65	79	12	3.8
8	.	.	21	31	37	16	26	11	3.8
10	.	.	21	34	48	18	32	13	3.8
.	128	.	7	23	47	121	129	9	3.7
.	50	.	36	36	47	42	56	13	3.8
0	128	.	10	24	47	134	146	12	3.6
2	128	.	5	21	45	95	120	12	3.6
4	128	.	5	20	41	116	122	6	3.8
6	128	.	10	21	53	122	129	7	3.8
8	128	.	0	25	.	.	.	.	3.7
10	128	.	0	27	.	.	.	.	3.9
0	50	.	40	33	49	103	98	10	3.7
2	50	.	30	33	51	60	75	15	3.8
4	50	.	30	35	45	43	56	13	4.0
6	50	.	23	35	52	37	59	15	3.8
8	50	.	42	36	37	16	26	11	3.8
10	50	.	50	41	48	18	32	13	3.8
.	.	NI	9	30	45	35	42	13	3.8
.	.	SD	33	28	47	57	74	12	3.8
0	.	NI	15	30	53	162	75	11	3.7
2	.	NI	10	28	41	12	28	16	3.8
4	.	NI	10	28	45	22	31	9	4.0
6	.	NI	0	28	.	.	.	.	3.7
8	.	NI	11	34	42	8	22	15	3.7
10	.	NI	5	34	34	.	29	.	3.8
0	.	SD	35	27	47	103	121	11	3.6
2	.	SD	35	26	51	87	108	14	3.7
4	.	SD	25	27	44	66	79	13	3.8
6	.	SD	28	29	52	65	79	12	3.9
8	.	SD	30	28	36	18	28	10	3.8
10	.	SD	40	33	50	18	32	13	3.8
.	128	NI	0	23	.	.	.	.	3.7
.	50	NI	17	38	45	35	42	13	3.8
.	128	SD	13	23	47	121	129	9	3.7
.	50	SD	53	34	47	44	61	13	3.8
0	128	NI	0	26	.	.	.	.	3.7
2	128	NI	0	21	.	.	.	.	3.7
4	128	NI	0	19	.	.	.	.	3.9
6	128	NI	0	21	.	.	.	.	3.6
8	128	NI	0	24	.	.	.	.	3.6
10	128	NI	0	29	.	.	.	.	3.8
0	50	NI	30	35	53	162	75	11	3.7
2	50	NI	20	35	41	12	28	16	3.8
4	50	NI	20	38	45	22	31	9	4.0
6	50	NI	0	35	.	.	.	.	3.7
8	50	NI	22	43	42	8	22	15	3.9
10	50	NI	11	41	34	.	29	.	3.9
0	128	SD	20	23	47	134	146	12	3.4
2	128	SD	30	21	45	95	120	12	3.5
4	128	SD	10	22	41	116	122	6	3.6
6	128	SD	20	22	53	122	129	7	3.9
8	128	SD	0	25	.	.	.	.	3.8
10	128	SD	0	25	.	.	.	.	3.9
0	50	SD	50	31	47	88	111	10	3.7
2	50	SD	40	31	56	85	99	14	3.8
4	50	SD	40	33	45	54	69	15	4.0
6	50	SD	50	36	52	37	59	15	3.9
8	50	SD	60	30	36	18	28	10	3.8
10	50	SD	80	41	50	18	32	13	3.7
			Significance						
			weeks (w)	***	NS	**	NS	NS	NS
			size (s)	***	***	**	*	NS	*
			(w) x (s)	NS	NS	NS	NS	NS	NS
			photoperiod (p)	**	*	NS	NS	NS	NS
			(p) x (w)	NS	NS	NS	NS	NS	NS
			(p) x (s)	*	NS	z	z	z	NS
			(p) x (w) x (s)	*	NS	z	z	z	NS

z = F-test not possible due to missing data from lack of flowering

n=237

Table 18. Regrowth and flowering response of *Lavandula* plugs of two sizes after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING
SPECIES: ***Lavandula angustifolia*** **Munstead**

WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	.	.	24	34	61	40	74	34	3.8
0	.	.	8	34	63	144	179	35	3.8
2	.	.	8	30	62	81	113	32	3.8
4	.	.	10	34	61	45	73	31	3.8
6	.	.	28	34	66	42	79	37	3.9
8	.	.	32	35	62	30	65	35	3.9
10	.	.	59	38	58	25	57	32	3.9
.	128	.	11	28	54	38	70	33	3.8
.	50	.	37	40	63	41	75	34	3.9
0	128	.	5	29	60	141	176	35	3.7
2	128	.	0	26	.	.	.	.	3.7
4	128	.	0	26	.	.	.	.	3.6
6	128	.	5	27	52	30	60	30	3.7
8	128	.	15	29	59	44	78	33	3.9
10	128	.	40	33	51	24	56	32	4.0
0	50	.	10	38	64	146	181	35	4.0
2	50	.	16	34	62	81	113	32	3.9
4	50	.	20	42	61	45	73	31	4.0
6	50	.	50	42	67	43	81	37	4.0
8	50	.	50	41	62	25	61	36	3.9
10	50	.	79	43	61	25	58	32	3.8
.	.	NI	36	35	62	42	76	35	3.9
.	.	SD	12	33	58	34	66	31	3.8
0	.	NI	15	34	63	144	179	35	3.9
2	.	NI	15	32	82	81	113	32	3.9
4	.	NI	17	33	61	41	69	33	4.0
6	.	NI	35	36	65	38	76	38	3.9
8	.	NI	56	36	62	30	67	37	3.8
10	.	NI	84	40	57	25	58	32	4.0
0	.	SD	0	33	.	.	.	.	3.8
2	.	SD	0	28	2	.	.	.	3.7
4	.	SD	5	35	60	60	83	23	3.6
6	.	SD	20	33	69	50	84	34	3.8
8	.	SD	10	34	58	28	54	27	4.0
10	.	SD	35	36	59	24	56	32	3.8
.	128	NI	20	29	54	39	72	33	3.8
.	50	NI	53	41	65	43	78	35	4.0
.	128	SD	2	28	54	26	58	32	3.7
.	50	SD	22	39	58	35	66	31	3.9
0	128	NI	10	31	60	141	176	35	3.8
2	128	NI	0	25	.	.	.	.	3.8
4	128	NI	0	26	.	.	.	.	4.0
6	128	NI	10	27	52	30	60	30	3.8
8	128	NI	30	31	59	44	78	33	3.7
10	128	NI	70	35	51	23	56	32	4.0
0	50	NI	20	36	64	146	181	35	4.0
2	50	NI	30	39	82	81	113	32	3.9
4	50	NI	30	40	61	41	69	33	4.0
6	50	NI	60	44	67	39	79	40	4.0
8	50	NI	88	43	64	24	63	38	4.0
10	50	NI	100	46	62	27	59	33	4.0
0	128	SD	0	27	.	.	.	.	3.7
2	128	SD	0	27	.	.	.	.	3.6
4	128	SD	0	26	.	.	.	.	3.2
6	128	SD	0	27	.	.	.	.	3.6
8	128	SD	0	28	.	.	.	.	4.0
10	128	SD	10	31	54	26	58	32	3.9
0	50	SD	0	40	.	.	.	.	3.9
2	50	SD	0	28	2	.	.	.	3.9
4	50	SD	10	43	60	60	83	23	4.0
6	50	SD	40	39	69	50	84	34	4.0
8	50	SD	20	39	58	28	54	27	3.9
10	50	SD	60	41	60	24	56	32	3.7
			Significance						
			weeks (w)	***	***	***	***	NS	NS
			size (s)	***	***	NS	NS	NS	***
			(w) x (s)	*	*	NS	NS	NS	NS
			photoperiod (p)	**	***	NS	NS	NS	*
			(p) x (w)	NS	NS	NS	NS	NS	NS
			(p) x (s)	NS	NS	NS	NS	NS	NS
			(p) x (w) x (s)	*	NS	z	z	z	*

z = F-test not possible due to missing data from lack of flowering
n=236

Table 19. Regrowth and flowering response of *Oenothera* plugs of two sizes after 0 and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING
SPECIES: Oenothera missouriensis

WEEK of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	.	.	39	6	26	53	80	34	3.4
0	.	.	35	6	30	69	99	36	3.5
10	.	.	43	7	22	39	65	32	3.4
.	128	.	43	6	25	62	85	34	3.4
.	50	.	35	7	27	40	74	34	3.4
0	128	.	35	5	28	81	103	29	3.5
10	128	.	50	6	23	46	72	37	3.4
0	50	.	35	6	33	52	94	42	3.4
10	50	.	35	7	21	28	54	26	3.5
.	.	NI	75	7	25	46	77	33	3.5
.	.	SD	3	6	49	103	174	43	3.4
0	.	NI	65	6	29	61	93	35	3.5
10	.	NI	85	8	22	32	65	32	3.5
0	.	SD	5	5	49	139	174	43	3.5
10	.	SD	0	6	.	79	.	.	3.3
.	128	NI	80	7	23	51	79	33	3.5
.	50	NI	70	7	27	40	74	34	3.5
.	128	SD	5	5	49	103	174	43	3.4
.	50	SD	0	6	.	.	.	.	3.4
0	128	NI	60	6	24	69	92	27	3.6
10	128	NI	100	8	23	36	72	37	3.4
0	50	NI	70	7	33	52	94	42	3.3
10	50	NI	70	8	21	28	54	26	3.7
0	128	SD	10	5	49	139	174	43	3.4
10	128	SD	0	5	.	79	.	.	3.3
0	50	SD	0	6	.	.	.	.	3.5
10	50	SD	0	6	.	.	.	.	3.3

Significance						
weeks (w)	NS	NS	***	***	NS	NS
size (s)	NS	NS	***	NS	NS	NS
(w) x (s)	NS	NS	NS	*	**	NS
photoperiod (p	*	***	***	***	NS	NS
(p) x (w)	NS	NS	*	z	z	NS
(p) x (s)	NS	NS	z	z	z	NS
(p) x (w) x (s)	NS	*	z	z	z	NS

z = F-test not possible due to missing data from lack of flowering
n=79

Table 20. Regrowth and flowering response of *Platycodon* cv. Sentimental Blue plugs after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent.

Leaves were counted at planting. Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING

SPECIES: *Platycodon grandiflorus* Sentimental Blue

WEEKS OF 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	128	.	41	7	66	90	26	2.6
0	128	.	35	8	80	97	25	2.6
2	128	.	40	8	62	91	29	2.0
4	128	.	55	8	72	100	28	2.5
6	128	.	25	8	71	100	28	2.0
8	128	.	40	7	54	76	22	3.0
10	128	.	50	5	58	78	22	3.4
.	128	NI	38	7	62	86	25	2.4
.	128	SD	43	8	70	93	26	2.7
0	128	NI	30	7	60	75	25	3.2
2	128	NI	10	8	67	101	34	1.3
4	128	NI	50	8	73	99	27	2.3
6	128	NI	30	7	68	101	33	1.7
8	128	NI	50	7	54	75	22	3.5
10	128	NI	60	5	57	79	22	3.1
0	128	SD	40	8	105	114	26	2.0
2	128	SD	70	8	61	89	28	2.7
4	128	SD	60	8	71	100	29	2.6
6	128	SD	20	8	76	98	22	3.0
8	128	SD	30	8	54	77	23	2.5
10	128	SD	40	6	59	78	24	3.8
			Significance					
			weeks (w)	***	**	**	NS	**
			photoperiod (p)	NS	NS	NS	NS	NS
			(p) x (w)	NS	NS	*	NS	**

z = F-test not possible due to missing data from lack of flowering

n=120

Table 21. Regrowth and flowering response of *Platycodon* cv. Maresii Blue plugs after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting. Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING

SPECIES: *Platycodon grandiflorus* Maresii Blue

WEEKS OF 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	50	.	63	11	66	94	28	3.3
0	50	.	5	12	126	203	29	2.9
2	50	.	65	13	88	113	25	2.6
4	50	.	80	13	72	104	32	3.8
6	50	.	75	12	64	96	31	3.3
8	50	.	65	9	52	76	24	3.5
10	50	.	85	9	47	75	28	3.6
.	50	NI	62	11	66	94	30	3.4
.	50	SD	63	12	66	94	27	3.2
0	50	NI	0	11	.	.	.	2.7
2	50	NI	50	11	84	108	28	2.8
4	50	NI	80	12	80	120	39	3.7
6	50	NI	80	.	61	87	26	3.1
8	50	NI	70	9	54	78	25	3.9
10	50	NI	90	14	52	82	30	4.0
0	50	SD	10	12	126	203	29	3.0
2	50	SD	80	14	92	116	24	2.3
4	50	SD	80	13	62	88	26	3.8
6	50	SD	70	12	68	105	38	3.6
8	50	SD	60	9	51	75	24	3.1
10	50	SD	80	9	42	67	25	3.2

Significance	LEAVES	VB	FLW	VB to FLW	RATING
weeks (w)	**	***	***	NS	***
photoperiod (p)	NS	NS	NS	NS	NS
(p) x (w)	NS	NS	**	*	NS

z = F-test not possible due to missing data from lack of flowering

n=120

Table 22. Regrowth and flowering response of *Primula* plugs of two sizes after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING

SPECIES: *Primula veris* **Pacific Giants**

WEEKS of 5C	Plug Size	Photo-period	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	.	.	95	9	17	35	62	26	3.8
0	.	.	98	9	17	38	66	28	3.8
2	.	.	100	10	18	41	69	26	3.8
4	.	.	95	8	16	32	56	26	3.8
6	.	.	100	10	18	33	64	29	3.9
8	.	.	93	9	18	39	64	24	4.0
10	.	.	85	9	15	24	50	25	3.8
.	128	.	93	8	18	48	75	26	3.8
.	50	.	97	10	16	22	49	27	3.9
0	128	.	95	8	17	51	80	29	3.7
2	128	.	100	9	19	59	85	23	3.5
4	128	.	95	8	17	45	65	25	3.7
6	128	.	100	9	18	43	73	24	3.9
8	128	.	90	8	19	54	79	25	4.0
10	128	.	80	7	15	37	68	33	3.8
0	50	.	100	11	17	25	53	27	4.0
2	50	.	100	10	16	24	52	28	4.0
4	50	.	95	9	16	20	48	27	3.8
6	50	.	100	10	18	23	56	33	4.0
8	50	.	95	10	17	24	50	24	4.0
10	50	.	90	10	16	11	34	18	3.9
.	.	NI	94	10	17	36	63	25	3.8
.	.	SD	96	9	17	33	61	28	3.9
0	.	NI	95	10	17	41	65	24	3.8
2	.	NI	100	10	19	42	70	22	3.8
4	.	NI	90	9	15	30	48	22	3.9
6	.	NI	100	10	18	37	71	30	3.8
8	.	NI	90	9	18	44	67	21	4.0
10	.	NI	90	9	15	22	56	30	3.8
0	.	SD	100	9	17	35	67	32	3.9
2	.	SD	95	9	17	40	69	29	3.7
4	.	SD	100	8	17	34	64	29	3.7
6	.	SD	100	9	18	29	57	28	4.0
8	.	SD	95	9	18	35	62	27	4.0
10	.	SD	85	8	15	26	44	21	3.9
.	128	NI	93	8	17	51	78	25	3.8
.	50	NI	93	11	17	22	49	25	3.9
.	128	SD	93	8	18	46	73	27	3.8
.	50	SD	98	9	16	21	49	28	4.0
0	128	NI	90	8	16	54	80	25	3.6
2	128	NI	100	9	19	66	91	19	3.5
4	128	NI	90	8	15	46	58	21	3.9
6	128	NI	100	10	17	49	78	23	3.7
8	128	NI	90	8	19	58	75	17	4.0
10	128	NI	90	8	15	37	80	45	3.8
0	50	NI	100	12	18	29	52	23	3.9
2	50	NI	100	11	18	24	49	25	4.0
4	50	NI	90	10	16	15	38	23	3.9
6	50	NI	100	11	19	28	64	36	3.9
8	50	NI	90	10	18	29	59	26	4.0
10	50	NI	90	10	15	6	31	13	3.7
0	128	SD	100	8	18	48	80	32	3.8
2	128	SD	100	9	19	53	79	26	3.5
4	128	SD	100	7	18	43	71	28	3.5
6	128	SD	100	9	20	39	67	26	4.0
8	128	SD	90	8	20	51	83	32	4.0
10	128	SD	70	7	14	38	52	19	3.8
0	50	SD	100	10	17	22	54	32	4.0
2	50	SD	90	10	15	24	56	32	4.0
4	50	SD	100	8	16	25	56	31	3.8
6	50	SD	100	10	17	19	48	29	4.0
8	50	SD	100	10	16	20	43	23	4.0
10	50	SD	90	9	16	15	37	22	4.0

Significance						
weeks (w)	***	**	*	NS	NS	*
size (s)	***	NS	***	***	NS	***
(w) x (s)	NS	NS	NS	NS	NS	*
photoperiod (p)	***	NS	NS	NS	NS	NS
(p) x (w)	NS	NS	NS	NS	NS	NS
(p) x (s)	NS	NS	NS	NS	NS	NS
(p) x (w) x (s)	NS	NS	NS	NS	*	NS

z = F-test not possible due to missing data from lack of flowering

n=239

Table 23. Regrowth and flowering response of *Rudbeckia* plugs of two sizes after 0, 2, 4, 6, 8, and 10 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Regrowth rating was made 6 weeks after planting on a 1 (dead) to 4 (excellent).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), and from VB to FLW are presented.

1992-1993 SPECIES SCREENING

SPECIES: *Rudbeckia fulgida* Goldsturm

WEEKS of 5C	Plug Size	Photo perio	FLOWERING (%)	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
.	.	.	50	6	27	114	156	42	3.6
0	.	.	50	6	26	125	170	45	3.7
2	.	.	50	6	28	125	168	43	3.4
4	.	.	50	6	26	123	166	44	3.5
6	.	.	51	6	29	112	153	41	3.6
8	.	.	50	7	29	109	150	40	3.5
10	.	.	46	6	26	87	126	41	3.9
.	128	.	50	4	28	129	171	42	3.6
.	50	.	49	8	27	99	141	43	3.7
0	128	.	50	5	26	140	186	46	3.6
2	128	.	50	5	27	133	178	45	3.6
4	128	.	50	4	28	142	186	44	3.4
6	128	.	53	4	31	135	175	40	3.7
8	128	.	50	5	28	118	159	39	3.3
10	128	.	47	3	27	103	141	39	3.7
0	50	.	50	7	26	109	154	45	3.8
2	50	.	50	7	29	117	159	42	3.3
4	50	.	50	8	25	104	147	43	3.6
6	50	.	50	8	27	90	131	41	3.5
8	50	.	50	8	30	101	142	41	3.8
10	50	.	45	8	26	73	111	44	4.2
.	.	NI	99	6	27	114	156	42	3.8
.	.	SD	0	6	.	.	.	.	3.4
0	.	NI	100	7	26	125	170	45	3.8
2	.	NI	100	6	28	125	168	43	3.6
4	.	NI	100	6	26	123	166	44	3.7
6	.	NI	100	6	29	112	153	41	3.9
8	.	NI	100	7	29	109	150	40	3.9
10	.	NI	95	7	26	87	126	41	4.1
0	.	SD	0	6	.	.	.	.	3.6
2	.	SD	0	6	.	.	.	.	3.3
4	.	SD	0	6	.	.	.	.	3.3
6	.	SD	0	6	.	.	.	.	3.3
8	.	SD	0	6	.	.	.	.	3.3
10	.	SD	0	5	.	.	.	.	3.8
.	128	NI	100	5	28	129	171	42	3.7
.	50	NI	98	8	27	99	141	43	3.9
.	128	SD	0	4	.	.	.	.	3.4
.	50	SD	0	8	.	.	.	.	3.4
0	128	NI	100	5	26	140	186	46	3.6
2	128	NI	100	5	27	133	178	45	3.6
4	128	NI	100	4	28	142	186	44	3.7
6	128	NI	100	5	31	135	175	40	3.8
8	128	NI	100	5	28	118	159	39	3.9
10	128	NI	100	4	27	103	141	39	3.7
0	50	NI	100	8	26	109	154	45	3.9
2	50	NI	100	7	29	117	159	42	3.6
4	50	NI	100	8	25	104	147	43	3.7
6	50	NI	100	8	27	90	131	41	3.9
8	50	NI	100	9	30	101	142	41	3.9
10	50	NI	90	9	26	73	111	44	4.6
0	128	SD	0	5	.	.	.	.	3.7
2	128	SD	0	5	.	.	.	.	3.5
4	128	SD	0	4	.	.	.	.	3.1
6	128	SD	0	4	.	.	.	.	3.7
8	128	SD	0	5	.	.	.	.	2.9
10	128	SD	0	3	.	.	.	.	3.7
0	50	SD	0	7	.	.	.	.	3.6
2	50	SD	0	7	.	.	.	.	3.0
4	50	SD	0	8	.	.	.	.	3.4
6	50	SD	0	9	.	.	.	.	3.0
8	50	SD	0	8	.	.	.	.	3.6
10	50	SD	0	7	.	.	.	.	3.8

Significance	LEAVES Planting	LEAVES Final	DAYS VB	DAYS FLW	DAYS VB to FLW	RATING
weeks (w)	*	NS	***	***	*	*
size (s)	***	**	***	***	NS	NS
(w) x (s)	***	NS	NS	NS	NS	NS
photoperiod (p)	**	***	z	z	z	***
(p) x (w)	***	NS	z	z	z	NS
(p) x (s)	NS	***	z	z	z	NS
(p) x (w) x (s)	NS	NS	z	z	z	NS

z = F-test not possible due to missing data from lack of flowering

n=238

Table 24. Regrowth and flowering response of *Alcea* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Alcea rosea Chaters Mix

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves Planting	Leaves New	Leaves Final	Days VB	Days FLW	Days VB to FLW	Height (cm)	FLW Count
.	.	.	0	4	.	.	.	.	.	.	.
0	.	.	0	4	.	.	.	.	.	.	.
5	.	.	0	4	.	.	.	.	.	.	.
10	.	.	0	4	.	.	.	.	.	.	.
15	.	.	0	4	.	.	.	.	.	.	.
.	128	.	0	4	.	.	.	.	.	.	.
.	50	.	0	4	.	.	.	.	.	.	.
0	128	.	0	4	.	.	.	.	.	.	.
5	128	.	0	4	.	.	.	.	.	.	.
10	128	.	0	4	.	.	.	.	.	.	.
15	128	.	0	4	.	.	.	.	.	.	.
0	50	.	0	3	.	.	.	.	.	.	.
5	50	.	0	4	.	.	.	.	.	.	.
10	50	.	0	4	.	.	.	.	.	.	.
15	50	.	0	4	.	.	.	.	.	.	.
.	.	NI	0	4	.	.	.	.	.	.	.
.	.	SD	0	4	.	.	.	.	.	.	.
0	.	NI	0	3	.	.	.	.	.	.	.
5	.	NI	0	4	.	.	.	.	.	.	.
10	.	NI	0	4	.	.	.	.	.	.	.
15	.	NI	0	.	.	.	.	.	.	.	.
0	.	SD	0	4	.	.	.	.	.	.	.
5	.	SD	0	4	.	.	.	.	.	.	.
10	.	SD	0	4	.	.	.	.	.	.	.
15	.	SD	0	4	.	.	.	.	.	.	.
.	128	NI	0	4	.	.	.	.	.	.	.
.	50	NI	0	4	.	.	.	.	.	.	.
.	128	SD	0	4	.	.	.	.	.	.	.
.	50	SD	0	4	.	.	.	.	.	.	.
0	128	NI	0	3	.	.	.	.	.	.	.
5	128	NI	0	4	.	.	.	.	.	.	.
10	128	NI	0	5	.	.	.	.	.	.	.
15	128	NI	0	.	.	.	.	.	.	.	.
0	50	NI	0	3	.	.	.	.	.	.	.
5	50	NI	0	4	.	.	.	.	.	.	.
10	50	NI	0	4	.	.	.	.	.	.	.
15	50	NI	0	.	.	.	.	.	.	.	.
0	128	SD	0	5	.	.	.	.	.	.	.
5	128	SD	0	4	.	.	.	.	.	.	.
10	128	SD	0	4	.	.	.	.	.	.	.
15	128	SD	0	4	.	.	.	.	.	.	.
0	50	SD	0	3	.	.	.	.	.	.	.
5	50	SD	0	4	.	.	.	.	.	.	.
10	50	SD	0	3	.	.	.	.	.	.	.
15	50	SD	0	4	.	.	.	.	.	.	.
			Significance								
			weeks (w)	*	z	z	z	z	z	z	z
			size (s)	***	z	z	z	z	z	z	z
			(w) x (s)	NS	z	z	z	z	z	z	z
			photoperiod (p)	NS	z	z	z	z	z	z	z
			(p) x (w)	**	z	z	z	z	z	z	z
			(p) x (s)	NS	z	z	z	z	z	z	z
			(p) x (w) x (s)	***	z	z	z	z	z	z	z

z = F-test not possible due to missing data from lack of flowering

n = 140

Table 25. Regrowth and flowering response of *Armeria maritima* plugs after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Armeria maritima Ornament Mix

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	Bud Count
.	128	.	75	19	168	185	84	96	12	18	2
0	128	.	65	18	144	163	90	100	12	12	2
5	128	.	70	18	207	225	98	107	10	19	2
10	128	.	85	20	181	201	82	95	13	20	2
15	128	.	79	19	134	149	71	83	15	19	1
.	128	NI	79	19	137	155	84	97	13	19	2
.	128	SD	70	18	203	222	85	95	12	16	1
0	128	NI	80	20	119	139	85	98	13	13	2
5	128	NI	90	19	186	205	93	104	10	20	2
10	128	NI	80	19	146	163	87	100	13	21	2
15	128	NI	67	20	69	93	66	83	17	24	2
0	128	SD	50	16	189	206	98	107	10	11	2
5	128	SD	50	17	244	262	101	112	10	16	1
10	128	SD	90	21	213	235	79	91	12	19	2
15	128	SD	90	18	175	192	74	83	13	16	1

Significance	Planting	New	Final	VB	FLW	VB to FLW	Height	Bud Count
weeks (w)	NS	*	*	**	*	**	**	NS
size (s)	z	z	z	z	z	z	z	z
(w) x (s)	z	z	z	z	z	z	z	z
photoperiod (p)	NS	***	**	NS	NS	*	*	NS
(p) x (w)	NS	NS	NS	NS	NS	NS	NS	NS
(p) x (s)	z	z	z	z	z	z	z	z
(p) x (w) x (s)	z	z	z	z	z	z	z	z

z = F-test not possible due to missing data from lack of flowering

n = 79

Table 26. Regrowth and flowering response of *Armeria pseudarmeria* plugs after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994 *Armeria pseudarmeria*											
Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves			Days			Height (cm)	Bud Count
				Planting	New	Final	VB	FLW	VB to FLW		
.	50	.	85	18	79	97	81	101	20	42	3
0	50	.	90	16	88	103	107	126	19	39	3
5	50	.	85	18	75	93	85	104	19	43	3
10	50	.	95	21	84	105	67	89	22	44	3
15	50	.	70	19	63	83	60	80	20	42	3
.	50	NI	83	18	64	82	79	97	19	42	3
.	50	SD	88	19	92	111	83	104	21	41	3
0	50	NI	90	18	85	103	102	121	19	37	3
5	50	NI	90	19	69	88	78	97	19	45	2
10	50	NI	90	19	57	75	70	89	19	46	3
15	50	NI	60	17	37	55	57	75	18	41	3
0	50	SD	90	13	90	104	113	131	18	41	3
5	50	SD	80	18	83	100	92	112	19	40	3
10	50	SD	100	23	109	132	65	89	24	42	3
15	50	SD	80	21	82	104	63	83	21	42	3
			Significance								
			weeks (w)	**	NS	NS	***	***	NS	NS	NS
			size (s)	z	z	z	z	z	z	z	z
			(w) x (s)	z	z	z	z	z	z	z	z
			photoperiod (p)	NS	*	*	NS	NS	NS	NS	NS
			(p) x (w)	**	NS	NS	NS	NS	NS	NS	NS
			(p) x (s)	z	z	z	z	z	z	z	z
			(p) x (w) x (s)	z	z	z	z	z	z	z	z

z = F-test not possible due to missing data from lack of flowering

n = 80

Table 27. Regrowth and flowering response of *Asclepias* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Asclepias tuberosa

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	16	23	41	61	69	89	33	6	3
0	.	.	15	26	47	70	106	142	42	.	4
5	.	.	3	24	43	55	90	96	26	.	2
10	.	.	23	25	26	58	63	76	31	6	3
15	.	.	23	18	51	59	50	66	30	6	2
.	128	.	11	19	57	76	90	122	37	6	4
.	50	.	20	28	32	53	47	71	31	7	2
0	128	.	25	22	50	72	104	141	46	.	5
5	128	.	5	20	43	55	115	96	26	.	2
10	128	.	10	19	61	84	84	105	27	5	4
15	128	.	5	16	95	97	71	83	27	6	1
0	50	.	5	31	31	60	121	143	22	.	1
5	50	.	0	29	.	.	65	.	.	.	.
10	50	.	35	31	16	50	45	68	33	7	2
15	50	.	40	20	45	55	38	64	30	6	2
.	.	NI	32	22	41	61	70	89	33	7	3
.	.	SD	0	25	.	.	49	.	.	6	.
0	.	NI	32	23	47	70	106	142	42	.	4
5	.	NI	5	25	43	55	90	96	26	.	2
10	.	NI	45	27	26	58	64	76	31	6	3
15	.	NI	45	12	51	59	51	66	30	7	2
0	.	SD	0	29	.	.	.	.	.	.	.
5	.	SD	0	23	.	.	.	.	.	.	.
10	.	SD	0	23	.	.	57	.	.	5	.
15	.	SD	0	25	.	.	46	.	.	6	.
.	128	NI	23	19	57	76	90	122	37	6	4
.	50	NI	41	25	32	53	46	71	31	7	2
.	128	SD	0	19	.	.	.	.	.	5	.
.	50	SD	0	30	.	.	49	.	.	6	.
0	128	NI	50	22	50	72	104	141	46	.	5
5	128	NI	10	20	43	55	115	96	26	.	2
10	128	NI	20	21	61	84	84	105	27	4	4
15	128	NI	10	13	95	97	71	83	27	8	1
0	50	NI	11	25	31	60	121	143	22	.	1
5	50	NI	0	31	.	.	65	.	.	.	.
10	50	NI	70	33	16	50	43	68	33	8	2
15	50	NI	80	10	45	55	35	64	30	6	2
0	128	SD	0	22	.	.	.	.	.	.	.
5	128	SD	0	19	.	.	.	.	.	.	.
10	128	SD	0	17	.	.	.	.	.	5	.
15	128	SD	0	20	.	.	.	.	.	5	.
0	50	SD	0	36	.	.	.	.	.	.	.
5	50	SD	0	27	.	.	.	.	.	.	.
10	50	SD	0	28	.	.	57	.	.	6	.
15	50	SD	0	30	.	.	46	.	.	6	.

Significance	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
weeks (w)		***	NS	NS	***	***	NS	NS	NS
size (s)		***	**	*	**	*	NS	NS	NS
(w) x (s)		*	NS	NS	NS	NS	NS	NS	NS
photoperiod (p)		**	Z	Z	NS	Z	Z	Z	Z
(p) x (w)		***	Z	Z	NS	Z	Z	Z	Z
(p) x (s)		*	Z	Z	Z	Z	Z	Z	Z
(p) x (w) x (s)		**	Z	Z	Z	Z	Z	Z	Z

z = F-test not possible due to missing data from lack of flowering

n = 159

Table 28. Regrowth and flowering response of *Coreopsis* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Coreopsis grandiflora Sunray

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	60	11	17	29	65	91	91	33	10
0	.	.	10	11	22	36	118	138	138	37	11
5	.	.	69	11	19	31	76	103	103	36	13
10	.	.	83	11	18	29	61	86	86	31	9
15	.	.	80	13	14	27	54	81	81	32	8
.	128	.	46	10	18	28	69	95	95	31	8
.	50	.	76	12	17	29	63	89	89	34	11
0	128	.	5	11	30	46	111	136	136	44	13
5	128	.	37	10	19	29	90	116	116	33	12
10	128	.	70	10	19	29	67	90	90	29	7
15	128	.	70	11	15	26	58	86	86	32	7
0	50	.	15	12	20	32	120	139	139	36	10
5	50	.	100	12	19	31	71	99	99	37	13
10	50	.	95	11	17	28	56	83	83	32	11
15	50	.	90	15	13	28	50	77	77	32	9
.	.	NI	56	12	16	28	45	67	67	46	18
.	.	SD	65	11	19	30	84	113	113	22	3
0	.	NI	15	12	24	38	113	136	136	43	14
5	.	NI	65	11	17	29	46	68	68	48	22
10	.	NI	80	10	17	27	47	69	69	41	16
15	.	NI	65	14	10	24	25	49	49	48	16
0	.	SD	5	10	16	28	131	146	146	21	4
5	.	SD	74	11	21	32	106	135	135	26	5
10	.	SD	85	11	19	30	74	103	103	21	3
15	.	SD	95	12	17	28	73	104	104	21	3
.	128	NI	38	11	17	28	46	69	69	43	15
.	50	NI	75	13	15	28	44	67	67	46	19
.	128	SD	54	10	19	29	86	113	113	22	3
.	50	SD	75	12	19	31	82	113	113	22	4
0	128	NI	10	12	30	45	111	135	135	44	13
5	128	NI	30	10	17	27	55	78	78	46	20
10	128	NI	60	10	16	26	48	69	69	38	13
15	128	NI	50	12	14	26	26	49	49	49	16
0	50	NI	20	13	22	36	115	136	136	42	16
5	50	NI	100	12	17	30	42	66	66	48	23
10	50	NI	100	10	18	28	46	69	69	42	18
15	50	NI	80	17	8	23	25	49	49	48	16
0	128	SD	0	11	.	.	.	.	.	.	.
5	128	SD	44	10	21	31	117	143	143	22	6
10	128	SD	80	10	21	32	81	106	106	22	3
15	128	SD	90	9	16	25	76	106	106	23	3
0	50	SD	10	10	16	28	131	146	146	21	4
5	50	SD	100	11	21	33	101	132	132	27	4
10	50	SD	90	12	17	28	68	99	99	20	4
15	50	SD	100	14	18	32	71	102	102	19	3
			Significance								
			weeks (w)	***	**	*	***	***	NS	*	NS
			size (s)	***	NS	NS	NS	NS	NS	NS	NS
			(w) x (s)	NS	NS	NS	NS	NS	NS	NS	NS
			photoperiod (p)	**	NS	NS	***	***	NS	***	***
			(p) x (w)	**	NS	NS	**	**	NS	NS	NS
			(p) x (s)	**	NS	NS	NS	NS	NS	NS	NS
			(p) x (w) x (s)	NS	NS	NS	NS	NS	NS	NS	NS

z = F-test not possible due to missing data from lack of flowering
n = 159

Table 29. Regrowth and flowering response of *Delphinium* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994 | **128 Cell--Blue**

Delphinium elatum **Magic Fountains** | **50 Cell--Mix**

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	70	5	15	21	57	76	25	36	3
0	.	.	36	5	22	28	81	98	26	41	4
5	.	.	75	5	16	21	62	75	26	31	3
10	.	.	82	5	16	22	56	80	24	37	2
15	.	.	89	7	11	19	42	67	25	36	2
.	128	.	63	4	18	23	78	99	26	39	3
.	50	.	77	6	13	19	39	61	24	33	2
0	128	.	32	5	17	23	73	86	26	37	3
5	128	.	80	4	19	24	81	91	25	30	3
10	128	.	65	4	22	27	89	114	25	44	3
15	128	.	76	4	14	20	66	94	27	40	3
0	50	.	40	6	24	30	86	106	26	43	4
5	50	.	70	5	13	19	40	65	27	32	2
10	50	.	100	5	13	18	33	56	23	31	2
15	50	.	100	9	9	18	26	50	24	31	2
.	.	NI	70	6	13	18	52	72	25	36	2
.	.	SD	70	5	17	23	61	81	24	36	3
0	.	NI	47	6	16	21	67	76	24	44	2
5	.	NI	75	5	13	18	56	71	27	33	2
10	.	NI	74	5	14	19	53	76	23	35	2
15	.	NI	84	6	11	17	40	66	27	36	1
0	.	SD	25	5	30	36	105	131	29	37	6
5	.	SD	76	4	18	23	67	79	26	30	3
10	.	SD	89	4	18	24	59	83	24	36	3
15	.	SD	94	7	12	20	46	68	23	34	3
.	128	NI	63	5	16	20	71	91	26	38	2
.	50	NI	77	6	11	17	37	60	25	34	2
.	128	SD	63	4	21	26	85	105	25	40	4
.	50	SD	77	6	14	21	42	62	24	31	3
0	128	NI	56	5	11	17	68	69	21	36	3
5	128	NI	80	5	14	19	72	82	27	32	3
10	128	NI	50	5	19	24	82	107	25	39	2
15	128	NI	67	5	14	19	64	93	29	40	2
0	50	NI	40	6	19	24	65	83	26	49	2
5	50	NI	70	6	12	18	38	66	28	33	2
10	50	NI	100	5	11	16	37	59	22	32	2
15	50	NI	100	8	8	16	25	50	25	33	1
0	128	SD	10	4	30	34	97	138	41	36	4
5	128	SD	80	4	22	26	89	95	24	29	3
10	128	SD	80	3	24	29	93	118	25	47	4
15	128	SD	88	4	14	21	71	95	25	41	4
0	50	SD	40	6	30	36	108	129	25	37	6
5	50	SD	70	5	14	20	42	64	26	31	2
10	50	SD	100	6	14	20	29	52	24	31	2
15	50	SD	100	9	10	20	27	49	22	29	2
Significance											
weeks (w)				***	NS	NS	**	**	NS	NS	*
size (s)				***	NS	NS	***	***	*	NS	NS
(w) x (s)				***	NS	NS	NS	*	NS	NS	NS
photoperiod (p)				NS	NS	*	*	*	NS	NS	***
(p) x (w)				NS	NS	NS	NS	*	**	NS	*
(p) x (s)				*	NS	NS	NS	NS	**	NS	NS
(p) x (w) x (s)				NS	NS	NS	NS	NS	**	NS	NS

z = F-test not possible due to missing data from lack of flowering

n = 154

Table 30. Regrowth and flowering response of *Dianthus* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Dianthus deltoides **Brilliant**

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	16	26	18	47	40	52	14	32	2
0	.	.	3	26	.	.	118	.	.	.	.
5	.	.	5	25	25	51	100	112	12	40	2
10	.	.	13	27	19	52	68	82	14	35	2
15	.	.	45	27	18	45	22	36	14	30	2
.	128	.	9	22	21	45	48	63	15	39	2
.	50	.	24	30	18	48	37	47	14	29	3
0	128	.	0	25	.	.	.	.	.	.	.
5	128	.	5	20	32	56	114	129	15	50	1
10	128	.	10	21	22	48	67	83	16	40	3
15	128	.	20	23	18	41	23	38	15	36	1
0	50	.	5	28	.	.	118	.	.	.	.
5	50	.	5	30	18	46	85	94	9	30	2
10	50	.	15	32	17	55	68	82	14	32	2
15	50	.	70	30	18	46	22	36	14	28	3
.	.	NI	20	26	20	47	39	48	14	33	3
.	.	SD	13	26	17	47	43	57	14	30	2
0	.	NI	5	26	.	.	118	.	.	.	.
5	.	NI	5	26	32	56	114	129	15	50	1
10	.	NI	15	28	20	53	54	67	12	29	3
15	.	NI	55	25	19	45	21	36	15	33	3
0	.	SD	0	27	.	.	.	.	.	.	.
5	.	SD	5	24	18	46	85	94	9	30	2
10	.	SD	10	25	18	52	88	105	18	44	2
15	.	SD	35	29	16	46	24	38	14	26	2
.	128	NI	15	23	21	46	52	67	15	40	2
.	50	NI	26	30	19	46	31	35	14	28	3
.	128	SD	3	22	18	42	29	43	14	33	1
.	50	SD	23	30	16	46	44	58	14	30	2
0	128	NI	0	25	.	.	.	.	.	.	.
5	128	NI	10	23	32	56	114	129	15	50	1
10	128	NI	20	23	22	48	67	83	16	40	3
15	128	NI	30	22	17	41	21	36	15	37	1
0	50	NI	11	27	.	.	118	.	.	.	.
5	50	NI	0	30	.	.	.	.	.	.	.
10	50	NI	10	34	16	62	29	35	6	7	3
15	50	NI	80	28	19	46	21	36	15	31	3
0	128	SD	0	24	.	.	.	.	.	.	.
5	128	SD	0	17	.	.	.	.	.	.	.
10	128	SD	0	20	.	.	.	.	.	.	.
15	128	SD	10	25	18	42	29	43	14	33	1
0	50	SD	0	29	.	.	.	.	.	.	.
5	50	SD	10	30	18	46	85	94	9	30	2
10	50	SD	20	30	18	52	88	105	18	44	2
15	50	SD	60	32	16	47	23	37	14	25	2

Significance	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
weeks (w)	NS	NS	NS	***	***	NS	NS	NS
size (s)	***	***	NS	NS	*	NS	***	NS
(w) x (s)	**	***	NS	NS	*	*	***	NS
photoperiod (p)	NS	***	NS	*	**	NS	***	NS
(p) x (w)	**	***	NS	**	**	**	***	NS
(p) x (s)	NS	NS	NS	NS	NS	NS	NS	NS
(p) x (w) x (s)	NS	z	z	z	z	z	z	z

z = F-test not possible due to missing data from lack of flowering
n = 159

Table 31 Regrowth and flowering response of *Gypsophila* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Gypsophila paniculata **Double Snowflake**

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	46	24	59	84	109	125	17	76	8
0	.	.	40	27	49	77	146	163	17	72	6
5	.	.	53	21	70	93	114	133	18	79	6
10	.	.	35	29	55	87	111	125	16	80	7
15	.	.	55	21	58	79	75	93	16	74	10
.	128	.	44	23	50	74	103	120	17	72	7
.	50	.	46	26	67	94	113	130	17	80	8
0	128	.	40	22	44	65	146	164	17	70	8
5	128	.	55	22	64	86	113	132	18	75	5
10	128	.	25	23	55	79	118	134	16	83	6
15	128	.	55	25	42	67	55	77	16	66	9
0	50	.	40	32	55	90	146	162	16	73	5
5	50	.	50	20	76	100	116	133	18	82	7
10	50	.	45	35	56	93	106	120	16	78	8
15	50	.	55	18	75	93	94	111	17	84	11
.	.	NI	59	25	51	78	109	125	16	72	8
.	.	SD	33	24	73	95	107	125	18	84	8
0	.	NI	65	27	47	78	146	162	16	70	7
5	.	NI	55	22	70	95	117	138	19	82	6
10	.	NI	45	30	44	79	118	132	15	75	5
15	.	NI	70	21	43	65	64	79	16	63	11
0	.	SD	15	27	59	83	147	167	19	77	5
5	.	SD	50	21	70	91	111	128	17	75	6
10	.	SD	25	28	73	102	97	115	18	90	10
15	.	SD	40	21	80	101	94	114	18	92	9
.	128	NI	60	23	42	66	104	120	16	67	7
.	50	NI	57	27	59	90	115	131	16	76	8
.	128	SD	28	23	66	89	102	121	18	81	7
.	50	SD	38	26	78	101	111	128	17	86	8
0	128	NI	70	21	43	64	148	165	17	70	8
5	128	NI	60	23	65	89	111	131	19	78	5
10	128	NI	30	22	49	71	139	154	15	86	6
15	128	NI	80	25	26	52	47	62	15	51	9
0	50	NI	60	33	52	90	143	158	15	72	5
5	50	NI	50	20	75	102	125	144	19	86	7
10	50	NI	60	38	42	83	108	119	15	69	5
15	50	NI	60	17	67	84	86	102	16	79	13
0	128	SD	10	22	52	72	136	156	20	72	8
5	128	SD	50	21	62	83	115	133	18	72	5
10	128	SD	20	24	65	91	87	104	17	80	6
15	128	SD	30	24	75	99	78	105	18	95	9
0	50	SD	20	32	62	86	153	172	19	79	4
5	50	SD	50	21	77	98	107	122	16	77	7
10	50	SD	30	32	79	109	103	122	18	98	13
15	50	SD	50	18	85	103	104	121	17	90	9

Significance	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
weeks (w)	***	NS	NS	***	***	NS	NS	NS
size (s)	**	*	**	NS	NS	NS	NS	NS
(w) x (s)	***	NS	NS	NS	NS	NS	NS	NS
photoperiod (p)	NS	**	*	NS	NS	NS	*	NS
(p) x (w)	NS	*	*	*	**	NS	***	NS
(p) x (s)	NS	NS	NS	NS	NS	NS	NS	NS
(p) x (w) x (s)	NS	NS	NS	NS	NS	NS	**	NS

z = F-test not possible due to missing data from lack of flowering

n = 160

Table 32. Regrowth and flowering response of *Heuchera* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Heuchera sanguinea Bressingham Hybrids

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	31	11	24	38	24	41	17	38	1
0	.	.	0	10	.	.	.	.	.	.	.
5	.	.	30	11	37	55	32	48	15	37	1
10	.	.	43	10	24	38	24	40	16	32	1
15	.	.	51	11	16	30	20	38	19	44	2
.	128	.	1	7	14	25	26	40	14	40	1
.	50	.	60	14	24	39	24	41	17	38	2
0	128	.	0	7	.	.	.	.	.	.	.
5	128	.	0	7	.	.	.	.	.	.	.
10	128	.	0	6	.	.	.	.	.	.	.
15	128	.	5	7	14	25	26	40	14	40	1
0	50	.	0	14	.	.	.	.	.	.	.
5	50	.	60	16	37	55	32	48	15	37	1
10	50	.	85	14	24	38	24	40	16	32	1
15	50	.	95	14	16	30	19	38	19	44	2
.	.	NI	32	11	19	35	24	40	16	40	1
.	.	SD	30	10	29	42	25	41	17	38	2
0	.	NI	0	10	.	.	.	.	.	.	.
5	.	NI	30	12	34	52	30	44	15	39	2
10	.	NI	40	11	19	33	26	41	15	35	1
15	.	NI	58	11	11	27	19	37	18	44	2
0	.	SD	0	11	.	.	.	.	.	.	.
5	.	SD	30	11	41	58	35	48	14	34	1
10	.	SD	45	9	29	42	23	39	16	29	2
15	.	SD	45	10	21	34	20	40	20	44	2
.	128	NI	3	7	14	25	26	40	14	40	1
.	50	NI	60	15	19	35	24	40	16	40	2
.	128	SD	0	7	.	.	.	.	.	.	.
.	50	SD	60	14	29	42	25	41	17	38	2
0	128	NI	0	7	.	.	.	.	.	.	.
5	128	NI	0	7	.	.	.	.	.	.	.
10	128	NI	0	6	.	.	.	.	.	.	.
15	128	NI	11	7	14	25	26	40	14	40	1
0	50	NI	0	13	.	.	.	.	.	.	.
5	50	NI	60	17	34	52	30	44	15	39	2
10	50	NI	80	15	19	33	26	41	15	35	1
15	50	NI	100	16	11	27	19	37	18	45	2
0	128	SD	0	7	.	.	.	.	.	.	.
5	128	SD	0	7	.	.	.	.	.	.	.
10	128	SD	0	6	.	.	.	.	.	.	.
15	128	SD	0	7	.	.	.	.	.	.	.
0	50	SD	0	15	.	.	.	.	.	.	.
5	50	SD	60	15	41	58	35	48	14	34	1
10	50	SD	90	13	29	42	23	39	16	29	2
15	50	SD	90	13	21	34	20	40	20	44	2

Significance	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
weeks (w)	NS	***	***	***	**	**	***	NS
size (s)	***	NS	NS	NS	NS	NS	NS	NS
(w) x (s)	NS	*	z	z	z	z	z	NS
photoperiod (p)	NS	**	*	NS	NS	NS	NS	z
(p) x (w)	NS	*	NS	NS	NS	NS	NS	NS
(p) x (s)	NS	z	z	z	z	z	z	z
(p) x (w) x (s)	*	z	z	z	z	z	z	z

z = F-test not possible due to missing data from lack of flowering

n = 158

Table 33. Regrowth and flowering response of *Lavandula* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Lavandula angustifolia Munstead

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	41	35	22	59	30	62	33	31	3
0	.	.	0	36	.	.	.	.	.	.	.
5	.	.	46	37	27	63	40	77	37	38	4
10	.	.	57	37	21	64	28	58	31	29	3
15	.	.	60	30	19	50	24	56	32	28	3
.	128	.	33	23	27	49	38	71	33	33	2
.	50	.	50	47	19	65	25	57	33	30	4
0	128	.	0	23	.	.	.	.	.	.	.
5	128	.	50	23	28	50	47	83	36	40	3
10	128	.	35	23	30	52	36	65	30	28	2
15	128	.	45	24	23	46	29	59	30	30	2
0	50	.	0	49	.	.	.	.	.	.	.
5	50	.	45	51	26	80	32	68	38	35	5
10	50	.	80	51	18	69	24	55	31	29	4
15	50	.	75	37	17	52	21	54	33	28	4
.	.	NI	63	34	22	56	30	62	33	33	3
.	.	SD	20	36	21	66	30	62	34	24	4
0	.	NI	0	37	.	.	.	.	.	.	.
5	.	NI	95	37	27	63	40	77	37	38	4
10	.	NI	70	35	23	62	26	54	30	32	3
15	.	NI	85	27	17	44	23	54	31	30	3
0	.	SD	0	36	.	.	.	.	.	.	.
5	.	SD	0	37	.	.	.	.	.	.	.
10	.	SD	45	39	18	68	31	63	33	25	4
15	.	SD	35	33	25	64	27	61	34	24	4
.	128	NI	55	23	27	49	38	71	32	36	2
.	50	NI	70	45	19	62	24	56	33	32	4
.	128	SD	10	23	25	47	37	71	36	20	2
.	50	SD	30	49	20	71	27	60	33	25	5
0	128	NI	0	24	.	.	.	.	.	.	.
5	128	NI	100	22	28	50	47	83	36	40	3
10	128	NI	50	21	30	52	35	63	29	30	1
15	128	NI	70	24	23	46	28	57	29	33	2
0	50	NI	0	49	.	.	.	.	.	.	.
5	50	NI	90	51	26	80	32	68	38	35	5
10	50	NI	90	48	19	68	21	51	30	33	3
15	50	NI	100	30	13	43	19	51	32	29	3
0	128	SD	0	22	.	.	.	.	.	.	.
5	128	SD	0	23	.	.	.	.	.	.	.
10	128	SD	20	25	28	52	41	75	36	22	3
15	128	SD	20	23	24	45	34	69	36	20	1
0	50	SD	0	50	.	.	.	.	.	.	.
5	50	SD	0	50	.	.	.	.	.	.	.
10	50	SD	70	54	16	71	29	61	32	25	4
15	50	SD	50	43	25	72	24	58	34	26	5
		Significance									
		weeks (w)		***	NS	***	***	***	**	***	NS
		size (s)		***	NS	***	***	*	NS	NS	*
		(w) x (s)		***	NS	**	NS	NS	NS	NS	NS
		photoperiod (p)		**	NS	NS	NS	*	NS	**	NS
		(p) x (w)		**	NS	NS	NS	NS	NS	NS	NS
		(p) x (s)		**	NS	*	NS	NS	NS	NS	NS
		(p) x (w) x (s)		**	NS	NS	NS	NS	NS	NS	NS

z = F-test not possible due to missing data from lack of flowering

n = 160

Table 34. Regrowth and flowering response of *Linum* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Linum perenne **Sapphire**

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves Planting	Leaves New	Leaves Final	Days VB	Days FLW	Days VB to FLW	Height (cm)	FLW Count
.	.	.	42	61	18	84	46	59	11	24	17
0	.	.	18	66	12	89	97	113	13	28	8
5	.	.	13	53	15	78	69	85	10	21	8
10	.	.	63	65	19	85	54	65	10	23	11
15	.	.	77	61	19	83	23	35	12	24	26
.	128	.	35	52	30	86	46	61	11	23	17
.	50	.	49	71	8	83	46	58	12	25	17
0	128	.	10	53	49	103	92	112	11	28	8
5	128	.	5	47	36	91	45	87	14	21	9
10	128	.	55	53	34	90	62	72	10	21	12
15	128	.	74	54	22	78	27	39	12	23	25
0	50	.	25	80	-11	81	99	113	14	28	9
5	50	.	20	58	4	72	75	84	9	22	8
10	50	.	70	77	7	82	48	59	11	25	11
15	50	.	80	69	16	87	21	33	12	26	28
.	.	NI	49	64	19	88	43	58	11	26	18
.	.	SD	35	58	16	78	51	62	11	22	16
0	.	NI	30	72	16	94	100	116	14	29	9
5	.	NI	5	53	25	88	96	108	5	25	7
10	.	NI	65	64	23	90	49	60	11	25	10
15	.	NI	95	69	16	86	18	29	11	24	28
0	.	SD	5	61	-20	58	80	90	10	21	5
5	.	SD	20	53	10	73	63	73	11	20	9
10	.	SD	60	66	15	81	60	70	10	21	12
15	.	SD	58	53	24	78	33	46	13	25	24
.	128	NI	40	54	36	94	40	59	11	23	17
.	50	NI	57	74	5	84	45	57	12	27	19
.	128	SD	31	49	21	74	53	65	11	22	17
.	50	SD	40	67	13	81	48	59	11	22	16
0	128	NI	20	56	49	103	92	112	11	28	8
5	128	NI	0	48	46	101	.	114	.	23	9
10	128	NI	50	50	53	105	57	67	10	23	9
15	128	NI	90	62	21	83	19	31	11	21	26
0	50	NI	40	88	-8	86	104	119	15	30	10
5	50	NI	10	57	4	75	96	101	5	27	5
10	50	NI	80	77	5	80	44	56	12	27	11
15	50	NI	100	77	12	88	17	28	11	26	29
0	128	SD	0	50	.	.	.	.	.	.	.
5	128	SD	10	45	27	80	45	59	14	19	8
10	128	SD	60	56	18	77	66	76	10	19	14
15	128	SD	56	45	23	69	40	53	13	25	22
0	50	SD	10	72	-20	58	80	90	10	21	5
5	50	SD	30	60	4	71	68	78	10	20	9
10	50	SD	60	76	11	85	54	64	9	22	10
15	50	SD	60	61	24	86	27	41	14	24	26

Significance	Planting	New	Final	VB	FLW	VB to FLW	Height (cm)	FLW Count
weeks (w)	***	NS	NS	***	***	NS	NS	***
size (s)	***	**	NS	NS	NS	NS	NS	NS
(w) x (s)	*	NS	NS	NS	NS	NS	NS	NS
photoperiod (p)	**	NS	NS	NS	NS	NS	*	NS
(p) x (w)	**	NS	NS	NS	NS	NS	NS	NS
(p) x (s)	NS	NS	NS	NS	NS	NS	NS	NS
(p) x (w) x (s)	NS	NS	NS	NS	NS	NS	NS	NS

z = F-test not possible due to missing data from lack of flowering

n = 159

Table 35. Regrowth and flowering response of *Lobelia* x *speciosa* cv. Compliment Scarlet plugs after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Lobelia x speciosa Compliment Scarlet

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	Bud Count
.	50	.	29	15	47	65	55	84	28	75	14
0	50	.	0	15	.	.	.	.	.	.	.
5	50	.	0	12	.	.	.	.	.	.	.
10	50	.	26	14	44	60	52	77	25	53	12
15	50	.	90	18	48	67	56	86	29	81	14
.	50	NI	38	16	36	58	42	71	28	69	13
.	50	SD	21	13	68	79	80	109	29	87	14
0	50	NI	0	13	.	.	.	.	.	.	.
5	50	NI	0	14	.	.	.	.	.	.	.
10	50	NI	50	14	44	60	52	77	25	53	12
15	50	NI	100	25	32	57	37	67	30	77	14
0	50	SD	0	17	.	.	.	.	.	.	.
5	50	SD	0	11	.	.	.	.	.	.	.
10	50	SD	0	13	.	.	.	.	.	.	.
15	50	SD	80	12	68	79	80	109	29	87	14
			Significance								
			weeks (w)	***	NS	NS	NS	NS	NS	**	NS
			size (s)	z	z	z	z	z	Z	z	z
			(w) x (s)	z	z	z	z	z	z	z	z
			photoperiod (p)	***	***	*	***	***	NS	NS	NS
			(p) x (w)	***	z	z	z	z	z	z	z
			(p) x (s)	z	z	z	z	z	z	z	z
			(p) x (w) x (s)	z	z	z	z	z	z	z	z

z = F-test not possible due to missing data from lack of flowering

n = 78

Table 36. Regrowth and flowering response of *Lobelia* x *speciosa* cv. Queen Victoria plugs after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Lobelia x speciosa Queen Victoria

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves Planting	Leaves New	Leaves Final	Days VB	Days FLW	Days VB to FLW	Height (cm)	Bud Count
.	128	.	86	8	25	33	68	94	25	63	11
0	128	.	75	9	23	32	72	96	23	56	8
5	128	.	75	7	28	35	64	89	24	51	13
10	128	.	95	8	25	33	71	97	25	58	12
15	128	.	100	8	26	34	66	92	26	80	12
.	128	NI	100	8	25	33	67	91	24	64	9
.	128	SD	73	8	26	34	70	97	26	61	15
0	128	NI	100	9	24	32	73	96	23	62	9
5	128	NI	100	8	27	35	64	89	25	51	9
10	128	NI	100	8	22	30	68	92	24	55	8
15	128	NI	100	8	29	36	64	89	25	86	10
0	128	SD	50	10	23	33	70	93	21	35	6
5	128	SD	50	7	29	35	64	90	23	49	23
10	128	SD	90	8	29	37	75	102	27	60	16
15	128	SD	100	8	23	31	68	96	27	74	15

Significance	Leaves Planting	Leaves New	Leaves Final	Days VB	Days FLW	Days VB to FLW	Height (cm)	Bud Count
weeks (w)	***	NS	NS	NS	NS	NS	***	NS
size (s)	z	z	z	z	z	z	z	z
(w) x (s)	z	z	z	z	z	z	z	z
photoperiod (p	NS	NS	NS	NS	NS	NS	*	*
(p) x (w)	**	*	*	NS	NS	NS	NS	NS
(p) x (s)	z	z	z	z	z	z	z	z
(p) x (w) x (s)	z	z	z	z	z	z	z	z

z = F-test not possible due to missing data from lack of flowering
n = 79

Table 37. Regrowth and flowering response of *Lupinus* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Lupinus hybrida Minarette Mix

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	3	8	24	30	105	119	14	37	1
0	.	.	3	8	16	26	69	83	14	35	1
5	.	.	3	7	25	29	139	153	14	35	1
10	.	.	8	9	26	31	106	119	14	39	1
15	.	.	0	8	.	.	.	.	.	.	.
.	128	.	5	5	26	31	114	128	14	38	1
.	50	.	1	11	16	26	69	83	14	35	1
0	128	.	0	6	.	.	.	.	.	.	.
5	128	.	5	4	25	29	139	153	14	35	1
10	128	.	15	5	26	31	106	119	14	39	1
15	128	.	0	6	.	.	.	.	.	.	.
0	50	.	5	11	16	26	69	83	14	35	1
5	50	.	0	10	.	.	.	.	.	.	.
10	50	.	0	13	.	.	.	.	.	.	.
15	50	.	0	11	.	.	.	.	.	.	.
.	.	NI	6	8	24	30	105	119	14	37	1
.	.	SD	0	8	.	.	.	.	.	.	.
0	.	NI	5	7	16	26	69	83	14	35	1
5	.	NI	5	7	25	29	139	153	14	35	1
10	.	NI	15	9	26	31	106	119	14	39	1
15	.	NI	0	9	.	.	.	.	.	.	.
0	.	SD	0	9	.	.	.	.	.	.	.
5	.	SD	0	7	.	.	.	.	.	.	.
10	.	SD	0	9	.	.	.	.	.	.	.
15	.	SD	0	8	.	.	.	.	.	.	.
.	128	NI	10	6	26	31	114	128	14	38	1
.	50	NI	3	11	16	26	69	83	14	35	1
.	128	SD	0	5	.	.	.	.	.	.	.
.	50	SD	0	12	.	.	.	.	.	.	.
0	128	NI	0	6	.	.	.	.	.	.	.
5	128	NI	10	4	25	29	139	153	14	35	1
10	128	NI	30	5	26	31	106	119	14	39	1
15	128	NI	0	7	.	.	.	.	.	.	.
0	50	NI	10	9	16	26	69	83	14	35	1
5	50	NI	0	9	.	.	.	.	.	.	.
10	50	NI	0	13	.	.	.	.	.	.	.
15	50	NI	0	11	.	.	.	.	.	.	.
0	128	SD	0	6	.	.	.	.	.	.	.
5	128	SD	0	5	.	.	.	.	.	.	.
10	128	SD	0	5	.	.	.	.	.	.	.
15	128	SD	0	5	.	.	.	.	.	.	.
0	50	SD	0	13	.	.	.	.	.	.	.
5	50	SD	0	10	.	.	.	.	.	.	.
10	50	SD	0	13	.	.	.	.	.	.	.
15	50	SD	0	11	.	.	.	.	.	.	.
			Significance								
			weeks (w)	***	NS	NS	NS	NS	NS	NS	***
			size (s)	***	z	z	z	z	z	z	z
			(w) x (s)	**	z	z	z	z	z	z	z
			photoperiod (p)	NS	z	z	z	z	z	z	z
			(p) x (w)	**	z	z	z	z	z	z	z
			(p) x (s)	**	z	z	z	z	z	z	z
			(p) x (w) x (s)	*	z	z	z	z	z	z	z

z = F-test not possible due to missing data from lack of flowering

n = 157

Table 38. Regrowth and flowering response of *Papaver* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Papaver orientale **Brilliant**

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	0	10	.	.	.	.	.	.	.
0	.	.	0	8	.	.	.	.	.	.	.
5	.	.	0	10	.	.	.	.	.	.	.
10	.	.	0	12	.	.	.	.	.	.	.
15	.	.	0	10	.	.	.	.	.	.	.
.	128	.	0	8	.	.	.	.	.	.	.
.	50	.	0	12	.	.	.	.	.	.	.
0	128	.	0	6	.	.	.	.	.	.	.
5	128	.	0	6	.	.	.	.	.	.	.
10	128	.	0	11	.	.	.	.	.	.	.
15	128	.	0	9	.	.	.	.	.	.	.
0	50	.	0	10	.	.	.	.	.	.	.
5	50	.	0	13	.	.	.	.	.	.	.
10	50	.	0	13	.	.	.	.	.	.	.
15	50	.	0	10	.	.	.	.	.	.	.
.	.	NI	0	9	.	.	.	.	.	.	.
.	.	SD	0	11	.	.	.	.	.	.	.
0	.	NI	0	8	.	.	.	.	.	.	.
5	.	NI	0	10	.	.	.	.	.	.	.
10	.	NI	0	11	.	.	.	.	.	.	.
15	.	NI	0	8	.	.	.	.	.	.	.
0	.	SD	0	8	.	.	.	.	.	.	.
5	.	SD	0	9	.	.	.	.	.	.	.
10	.	SD	0	13	.	.	.	.	.	.	.
15	.	SD	0	12	.	.	.	.	.	.	.
.	128	NI	0	8	.	.	.	.	.	.	.
.	50	NI	0	11	.	.	.	.	.	.	.
.	128	SD	0	9	.	.	.	.	.	.	.
.	50	SD	0	12	.	.	.	.	.	.	.
0	128	NI	0	5	.	.	.	.	.	.	.
5	128	NI	0	7	.	.	.	.	.	.	.
10	128	NI	0	10	.	.	.	.	.	.	.
15	128	NI	0	9	.	.	.	.	.	.	.
0	50	NI	0	10	.	.	.	.	.	.	.
5	50	NI	0	14	.	.	.	.	.	.	.
10	50	NI	0	13	.	.	.	.	.	.	.
15	50	NI	0	7	.	.	.	.	.	.	.
0	128	SD	0	6	.	.	.	.	.	.	.
5	128	SD	0	6	.	.	.	.	.	.	.
10	128	SD	0	13	.	.	.	.	.	.	.
15	128	SD	0	11	.	.	.	.	.	.	.
0	50	SD	0	10	.	.	.	.	.	.	.
5	50	SD	0	12	.	.	.	.	.	.	.
10	50	SD	0	14	.	.	.	.	.	.	.
15	50	SD	0	13	.	.	.	.	.	.	.

Significance	Flowering (%)	Planting	New	Final	VB	FLW	VB to FLW	Height (cm)	FLW Count
weeks (w)	***	z	z	z	z		z	z	z
size (s)	***	z	z	z	z		z	z	z
(w) x (s)	**	z	z	z	z		z	z	z
photoperiod (p)	*	z	z	z	z		z	z	z
(p) x (w)	**	z	z	z	z		z	z	z
(p) x (s)	NS	z	z	z	z		z	z	z
(p) x (w) x (s)	NS	z	z	z	z		z	z	z

z = F-test not possible due to missing data from lack of flowering

n = 158

Table 39. Regrowth and flowering response of *Salvia* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Salvia superba **Blue Queen**

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	100	14	17	31	44	62	18	37	8
0	.	.	100	14	27	41	92	110	18	41	7
5	.	.	100	15	16	31	36	53	18	37	8
10	.	.	100	14	15	29	27	43	16	32	9
15	.	.	100	12	11	23	22	40	18	36	8
.	128	.	100	10	18	27	47	64	17	36	8
.	50	.	100	17	17	34	41	59	18	37	9
0	128	.	100	11	26	37	90	107	17	41	8
5	128	.	100	10	17	27	40	57	17	36	7
10	128	.	100	9	16	25	32	48	16	31	8
15	128	.	100	10	12	22	25	44	19	36	7
0	50	.	100	16	29	46	94	113	19	42	7
5	50	.	100	19	15	34	30	49	19	38	8
10	50	.	100	19	14	33	22	38	16	33	10
15	50	.	100	14	11	26	19	37	18	36	10
.	.	NI	100	13	16	29	37	52	16	42	8
.	.	SD	100	14	18	32	51	71	20	31	8
0	.	NI	100	13	30	43	85	102	17	51	8
5	.	NI	100	15	15	30	27	43	16	44	8
10	.	NI	100	13	13	26	20	33	13	34	8
15	.	NI	100	11	8	19	16	31	15	41	9
0	.	SD	100	14	24	39	99	118	19	32	7
5	.	SD	100	14	17	31	43	63	20	30	8
10	.	SD	100	15	17	31	34	53	19	31	10
15	.	SD	100	14	15	28	28	50	21	31	7
.	128	NI	100	10	16	26	39	54	15	41	7
.	50	NI	100	16	16	32	35	51	16	43	9
.	128	SD	100	10	19	28	54	74	20	30	8
.	50	SD	100	19	18	36	48	68	20	31	8
0	128	NI	100	10	29	39	88	104	16	50	7
5	128	NI	100	12	15	27	29	44	15	44	7
10	128	NI	100	9	13	22	22	36	13	31	7
15	128	NI	100	10	8	19	17	33	16	41	7
0	50	NI	100	15	31	47	82	100	18	51	8
5	50	NI	100	19	14	33	25	42	17	44	9
10	50	NI	100	18	12	30	17	31	14	36	9
15	50	NI	100	11	8	19	15	30	15	40	11
0	128	SD	100	11	23	34	92	110	18	32	9
5	128	SD	100	9	19	27	51	70	19	28	8
10	128	SD	100	9	18	27	42	61	19	31	10
15	128	SD	100	10	15	25	33	55	22	30	6
0	50	SD	100	18	26	44	107	126	19	32	6
5	50	SD	100	19	16	35	36	56	20	31	8
10	50	SD	100	21	15	35	26	45	19	30	10
15	50	SD	100	18	14	31	24	45	21	32	8
Significance											
weeks (w)				***	***	***	***	***	**	***	NS
size (s)				***	NS	***	**	**	NS	NS	*
(w) x (s)				***	**	**	*	**	NS	NS	NS
photoperiod (p)				***	**	***	***	***	***	***	NS
(p) x (w)				***	***	***	NS	NS	**	***	NS
(p) x (s)				***	NS	NS	NS	NS	NS	NS	*
(p) x (w) x (s)				*	NS	NS	**	**	NS	NS	NS

z = F-test not possible due to missing data from lack of flowering

n = 160

Table 40. Regrowth and flowering response of *Veronica spicata* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Veronica spicata **Blue**

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	Height (cm)	FLW Count
.	.	.	79	10	24	56	45	66	21	56	9
0	.	.	43	10	56	80	110	131	21	80	14
5	.	.	78	10	23	54	46	65	21	54	9
10	.	.	100	10	17	47	32	53	21	47	9
15	.	.	98	9	16	54	29	50	22	54	8
.	128	.	68	8	19	47	43	66	21	47	8
.	50	.	91	12	27	63	46	67	21	63	10
0	128	.	20	8	51	51	134	148	16	51	15
5	128	.	60	7	22	52	54	74	20	52	7
10	128	.	95	8	15	45	32	53	21	45	8
15	128	.	95	9	14	45	29	51	23	45	8
0	50	.	65	12	56	91	102	125	22	91	14
5	50	.	95	13	25	56	39	60	21	56	10
10	50	.	105	12	19	49	33	53	21	49	10
15	50	.	100	10	19	63	28	49	21	63	9
.	.	NI	80	9	23	62	42	64	21	62	8
.	.	SD	79	10	25	49	48	69	21	49	10
0	.	NI	35	9	49	90	94	115	18	90	10
5	.	NI	85	10	26	64	51	71	20	64	9
10	.	NI	100	9	17	49	31	53	22	49	9
15	.	NI	100	10	13	61	26	47	21	61	7
0	.	SD	50	11	59	72	121	144	23	72	18
5	.	SD	70	11	20	43	37	58	21	43	8
10	.	SD	100	11	17	45	34	53	19	45	9
15	.	SD	95	8	20	47	31	53	22	47	9
.	128	NI	65	8	17	53	39	63	21	53	7
.	50	NI	95	11	27	69	44	64	21	69	9
.	128	SD	70	8	22	41	47	68	21	41	10
.	50	SD	88	13	28	56	48	70	21	56	11
0	128	NI	0	8	34	71	.	139	.	71	5
5	128	NI	70	8	24	65	67	86	20	65	8
10	128	NI	90	8	16	47	32	55	23	47	8
15	128	NI	100	10	10	48	26	47	21	48	6
0	50	NI	70	10	52	93	94	111	18	93	10
5	50	NI	100	11	28	63	40	61	21	63	11
10	50	NI	111	11	19	50	30	50	22	50	9
15	50	NI	100	10	16	74	26	47	22	74	8
0	128	SD	40	9	56	46	134	150	16	46	18
5	128	SD	50	7	18	33	37	57	21	33	7
10	128	SD	100	9	14	42	32	51	19	42	9
15	128	SD	90	8	18	41	32	56	24	41	9
0	50	SD	60	14	61	89	113	140	28	89	19
5	50	SD	90	14	21	48	37	58	21	48	9
10	50	SD	100	13	19	48	36	55	20	48	10
15	50	SD	100	9	22	51	31	51	20	51	10
		Significance									
		weeks (w)		NS	***	***	***	***	NS	***	NS
		size (s)		***	**	***	**	**	NS	***	NS
		(w) x (s)		**	NS	NS	*	NS	NS	**	NS
		photoperiod (p)		NS	NS	NS	NS	NS	NS	***	**
		(p) x (w)		**	**	**	**	**	*	*	*
		(p) x (s)		*	NS	NS	NS	NS	NS	NS	NS
		(p) x (w) x (s)		NS	NS	NS	NS	NS	NS	*	NS

z = F-test not possible due to missing data from lack of flowering

n = 159

Table 41. Regrowth and flowering response of *Veronica longifolia* plugs of two sizes after 0, 5, 10, and 15 weeks chilling at 5C and grown under 9-hr photoperiods (SD) or 9-hr photoperiods with a 4-hr night interruption (NI).

Leaves were counted at planting and at flowering (final). Average days to first visible bud (VB), first flower opening (FLW), from VB to FLW, final height, and FLW count are presented.

1993-1994

Veronica longifolia — Sunny Border Blue

Weeks of 5C	Plug Size	Photo-period	Flowering (%)	Leaves: Planting	Leaves: New	Leaves: Final	Days: VB	Days: FLW	Days: VB to FLW	FLW Count
.	.	.	74	12	21	33	39	66	26	6
0	.	.	3	15	62	80	70	94	24	11
5	.	.	100	11	24	35	48	74	26	5
10	.	.	98	12	19	31	34	60	26	7
15	.	.	98	11	19	30	34	62	28	7
.	55	.	76	12	21	32	34	61	26	6
.	50	.	73	12	22	33	44	71	26	6
0	55	.	5	14	62	80	70	94	24	11
5	55	.	100	11	22	33	40	66	26	5
10	55	.	100	12	19	30	30	56	26	6
15	55	.	100	12	19	31	31	58	27	7
0	50	.	0	15	.	.	.	.	.	.
5	50	.	100	12	26	38	56	81	25	5
10	50	.	95	13	19	32	38	64	26	7
15	50	.	95	10	20	29	38	66	28	6
.	.	NI	74	13	20	32	40	65	25	6
.	.	SD	75	12	22	33	39	66	27	6
0	.	NI	5	14	62	80	70	94	24	11
5	.	NI	100	11	23	34	49	74	26	5
10	.	NI	95	12	19	31	35	60	25	6
15	.	NI	95	13	16	28	34	59	25	6
0	.	SD	0	16	.	.	.	.	.	.
5	.	SD	100	11	25	36	48	73	25	5
10	.	SD	100	12	19	31	34	60	27	7
15	.	SD	100	9	22	32	35	65	30	7
.	55	NI	78	12	21	32	36	61	26	7
.	50	NI	70	14	19	32	44	69	25	5
.	55	SD	75	13	21	32	33	60	27	6
.	50	SD	75	11	24	34	45	72	28	7
0	55	NI	10	13	62	80	70	94	24	11
5	55	NI	100	11	21	33	42	68	27	5
10	55	NI	100	11	19	30	32	58	26	8
15	55	NI	100	12	17	28	29	54	25	6
0	50	NI	0	14	.	.	.	.	.	.
5	50	NI	100	11	24	35	55	81	25	4
10	50	NI	90	14	18	33	38	62	24	5
15	50	NI	90	14	15	28	39	64	25	6
0	55	SD	0	16	.	.	.	.	.	.
5	55	SD	100	10	23	33	39	64	26	5
10	55	SD	100	13	18	30	29	54	26	5
15	55	SD	100	13	21	34	32	61	29	9
0	50	SD	0	16	.	.	.	.	.	.
5	50	SD	100	12	28	40	57	82	25	5
10	50	SD	100	12	20	32	39	67	28	9
15	50	SD	100	6	24	30	38	69	31	6

Significance	Planting	New	Final	VB	FLW	VB to FLW	FLW Count
weeks (w)	***	***	***	***	***	*	***
size (s)	NS	NS	NS	***	***	NS	NS
(w) x (s)	NS	NS	**	NS	NS	NS	NS
photoperiod (p)	NS	***	*	NS	NS	**	*
(p) x (w)	*	NS	NS	NS	NS	**	NS
(p) x (s)	*	NS	NS	NS	NS	NS	**
(p) x (w) x (s)	*	NS	NS	NS	NS	NS	***

z = F-test not possible due to missing data from lack of flowering
n = 160