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Chilling Units Used to Determine Rooting of Stem Cuttings of Junipers[1]

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Abstract

Stem cuttings from 10 juniper cultivars, representing 5 taxa of juniper (*Juniperus chinensis* L. 'Pfitzer Aurea'; *J. horizontalis* Moench 'Bar Harbor', 'Prince of Wales', 'Wiltoni', 'Youngstown'; *J. procumbens* Endl. 'Green Mound'; *J. sabina* L. 'Broadmoor', 'Buffalo', 'Tamariscifolia' and; *J. scopulorium* Sarg. 'Wichita Blue') were inserted into rooting beds twice monthly from October 15, 1986 to February 28, 1987. During this time period, air temperature was monitored continuously 1 m (39 in) above the stock plants and seasonal chilling units (i.e., hours at ≤5°C (41°F)) were determined. Chilling units of the donor stock plants affected the percent rooting of most juniper cultivars. Data suggest that the optimum rooting period of most cultivars of juniper can be determined by their chilling units.

Index words: vegetative propagation, degree hour chilling sum

Species used in this study:

Pfitzer Aurea (*Juniperus chinensis* L.); Bar Harbor, Prince of Wales, Wiltoni, Youngstown (*J. horizontalis* Moench); Green Mound (*J. procumbens* Endl.); Broadmoor, Buffalo, Tamariscifolia (J. sabina L.); Wichita Blue (*J. scopulorium* Sarg.)

Significance to the Nursery Industry

Most junipers produced by the nursery industry are propagated via stem cuttings and each cultivar has a different inherent rooting capability. Thus, knowing when to take cuttings from stock plants can be critical for rooting success. As the environmental conditions change throughout the year, so does the physiological status of stock plants which in turn influences the rooting capacity of cuttings taken from these plants. The chilling unit concept (i.e. the number of hours that air temperature is below some limit known to be effective) may help determine the optimum time to take cuttings from stock plants.

Introduction

Successful propagation of woody plants by stem cuttings is influenced by many cultural, physiological and environmental factors. Time of year has been reported to be im-

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portant for successful rooting for a number of juniper species regardless of treatments administered to the cuttings (3, 6, 8). Most published references associate rooting success with a specific time of year or a calendar date (2, 3, 4, 6, 8, 14). However, calendar dates for maximum rooting can vary from year to year depending on seasonal weather patterns. Thus, calendar dates can be misleading as to the donor plants true physiological status (1).

Rooting success of some woody species has been related to the degree of stock plant dormancy resulting from low temperature exposure (16, 18). Lanphear and Meahl (9) found *Juniperus horizontalis* rooted best from late fall to late winter. Dormancy development in some conifer species is dependent on the number of hours at a specified low temperature (i.e. chilling units) a plant receives (10, 12). Consequently, dormancy status of temperate plants may be predicted by the number of hours that air temperature is below some limit known to be effective at developing dormancy in a species (15).

The objective of this study was to determine the relationship between percent rooting of select cultivars of juniper and chilling units stock plants receive.

Material and Methods

Cultivars utilized represented five species of junipers with varying rootability and commonly produced by the nursery industry (Table 1). All stock plants were 3 to 4 years old growing in one gallon containers in a medium of peat: sand: bark (3:2:5 by vol) and mixed with a slow release 18N-3.0P-9.9K (18-7-12) Osmocote fertilizer. Donor plants remained outside under natural conditions.

For each cultivar, 120 stem cuttings were randomly collected from the donor plants twice monthly beginning October 15, 1986 until Februry 28, 1987. These stem cuttings were separated into 4 groups of 30 and blocked in 4 locations across the propagation benches. The 10 collection dates and 10 different cultivars were arranged in a complete randomized design using a total of 12,000 cuttings.

Rooting studies were conducted in a greenhouse with day and night air temperatures of 10 to 20°C (50 to 68°F), bottom heat at 18°C (65°F), misting as required and natural lighting. Stem cuttings and soil media were prepared and treated consistent with operational protocols from previous years (Table 1). Stem cuttings were approximately 12 cm (4.8 in) with the bottom 4 cm (1.6 in) stripped of branches and the base freshly cut at a 45° angle and dipped in an appropriate rooting solution (Table 1).

The experiment was conducted at a nursery west of Portland, Oregon having a latitude of 45° 30′ N and a longitude of 123° 0′ W. Temperatures at one meter (39 in) above ground were recorded outside continuously from late September 1986, to February 28, 1987 with a sheltered, continuous recording thermograph (Tempscribe model 14-7030, Bacharch Inc.). Chilling unit sum for each planting date was determined by the number of hours the air temperature was at or below 5°C (41°F) previous to that date.

Two months after each planting date, rooting success was assessed for all cultivars and dead stem cuttings were removed to maintain a disease free study. Rooting success was defined as having at least one healthy root greater than 1 cm (0.4 in). Rooting success (i.e. percent rooting) was determined for each replicate block. Data from replicate blocks were analyzed to give a mean and standard error for each cultivar and planting time combination. For each cultivar, rooting percent for each planting date was graphed against corresponding chilling units (Fig. 1a-j).

Results and Discussion

Chilling units received by stock plants affected the rooting of all juniper cultivars (Fig. 1). Cultivar differences occurred in percent rooting and pattern of rooting response.

'Buffalo' cuttings rooted greater than 85% when stuck at a chilling sum of 700 to 1100 degree hours (Fig. 1a). Above and below this optimum degree hour range, rooting decreased.

'Tamariscifolia' cuttings showed the narrowest period for optimum rooting of any species (Fib. 1b). Eighty percent rooting was noted at 1100 degree hours and decreased dramatically above and below this value.

Stem cuttings from 'Prince of Wales' displayed a broad range of degree hours (200 to 1100) for rooting above 75% (Fig. 1c). The optimum was 450 degree hours for 90% rooting. Rooting was low only at a low and high number of degree hours.

'Youngstown' exhibited optimum rooting (i.e. >75%) from 100 to 1100 degree hours (Fig. 1d). This cultivar showed one of the broadest degree hour ranges recorded for successful rooting.

High rooting of 'Bar Harbor' was observed for an extended number of degree hours (i.e. 100 to 1100) (Fig. 1e.).

Table 1. Hormone treatment applied to cuttings and rooting medium used for a particular cultivar.

Cultivar	Hormone conc. (ppm)[z] Indolebutyric Acid (IBA)	Naphthaleneacetic Acid (NAA)	Rooting medium Sand:Perlite: Peat (by vol)
J. chinensis 'Pfitzer Aurea'	1000	500	6:5:1/2
J. horizontalis 'Bar Harbor'	1000	500	6:5:1/2
J. horizontalis 'Prince of Wales'	1000	500	6:5:1/2
J. horizontalis 'Wiltoni'	1333	667	6:5:1/2
J. horizontalis 'Youngstown'	1000	500	6:5:1/2
J. procumbens 'Green Mound'	1333	667	1:2:0
J. sabina 'Broadmoor'	1333	667	6:5:1/2
J. sabina 'Buffalo'	8000(Talc)	—	6:5:1/2
J. sabina 'Tamariscifolia'	1333	667	6:5:1/2
J. scopulorium 'Wichita Blue'	1333	667	1:2:0

[z]Dip 'n Grow (10,000 ppm IBA, 5,000 ppm NAA) was diluted to a particular concentration for each cultivar with the exception of 'Buffalo' which was treated with 8000 ppm IBA in talc (Hormodin 3).

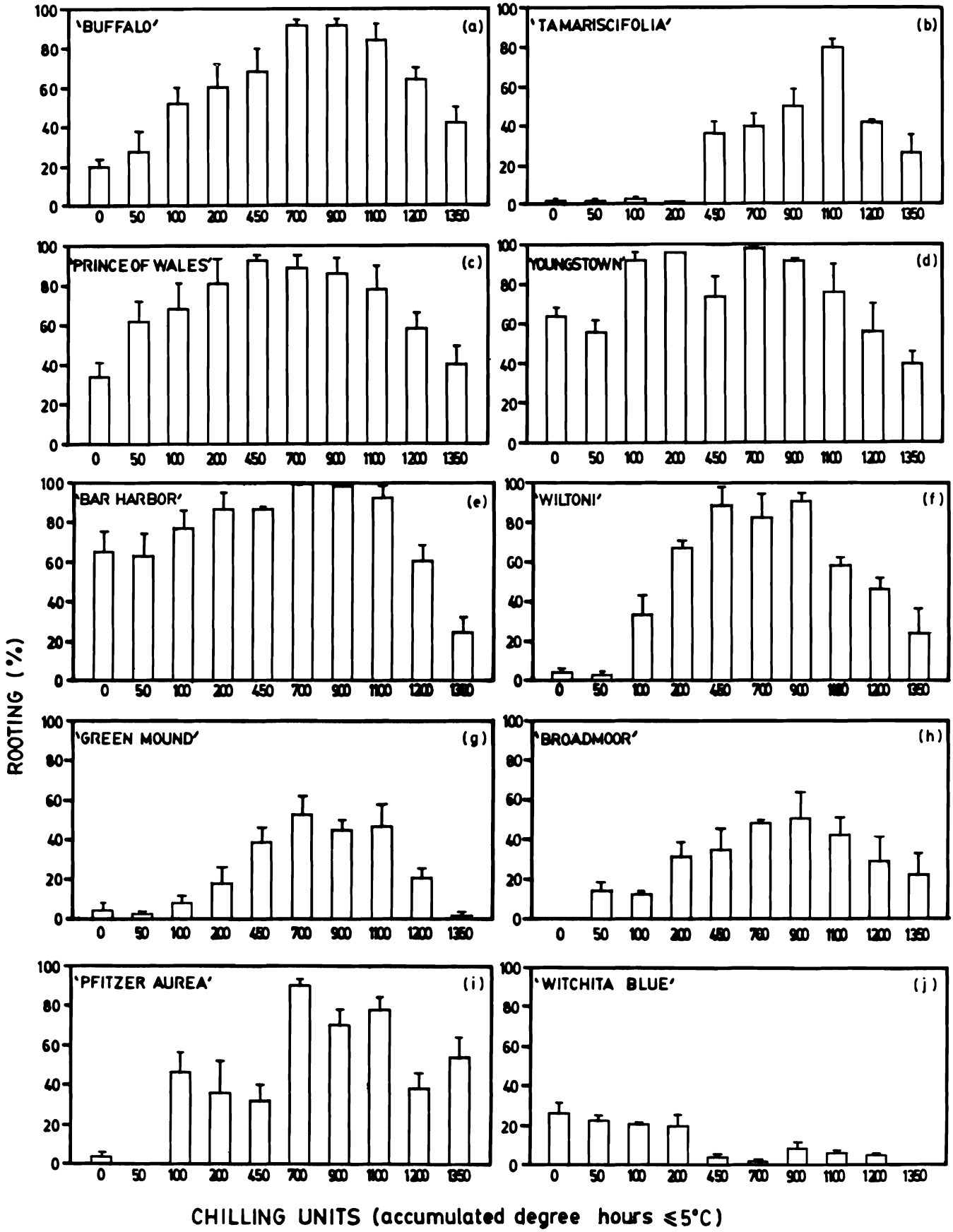

Fig. 1. Percent rooting (mean + 1 SE) versus accumlated chilling units (ie. degree hours ≤ 5°C) for 10 juniper cultivars: (1) 'Buffalo', (b) 'Tamariscifolia', (c) 'Prince of Wales', (d) 'Youngstown', (e) 'Bar Harbor', (f) 'Wiltoni', (g) 'Green Mound', (h) 'Broadmoor', (i) 'Pfitzer Aurea', (j) 'Witchita Blue'.

This cultivar had one of the widest degree hour rooting ranges of all cultivars examined. Beyond 1200 hours rooting decreased precipitously.

'Wiltoni' rooted greater than 80% between 450 to 900 degree hours (Fig. 1f). Rooting decreased dramatically above 900 and below 450 degree hours.

'Green Mound' exhibited low rootability at all levels of degree hours (i.e. <55%) (Fig. 1g). Best rooting occurred between 450 to 1100 degree hours and decreased very rapidly above 1100 and below 450 degree hours.

Best rooting of 'Broadmoor' (i.e. 55%) occurred at 900 degree hours with reductions on both sides of this value (Fig. 1h).

'Pfitzer Aurea' rooted between 70 and 90% with 700 to 1100 degree hours (Fig. 1i). Rooting declined rapidly below and above these values.

'Wichita Blue' produced the lowest rooting of any cultivar tested (Fig. 1j). The best rooting (i.e. 30%) occurred with the least number of degree hours. This cultivar may have rooted better earlier in the fall before the experiment was initiated.

Results suggest certain physiological changes occur in donor plants during the fall and winter causing variation in rooting capacity of stem cuttings. Research has noted high and low rooting periods are related to fluctuations in endogenous hormone levels (7, 13). A recent review into the control of dormancy has shown no single promoter or inhibitor consistently correlates with dormancy (11). Wareing and Phillips (17) suggest that an antagonism may exist between changing levels of promoters (i.e. gibberellins) and a constant level of an inhibitor (i.e. abscisic acid) and this may best describe the control of dormancy.

The chilling unit concept appears to be correlated with rootability of juniper cultivars. The advantage of using chilling units as opposed to calendar dates is that it is based on each seasons temperature data. This may provide a way of calculating a cultivars optimum window of rootability when planning propagation schedules. With difficult-to-root species, this may allow for a more accurate determination of the optimum collection time. The chilling unit concept may help in transferring rooting information from one geographic area to another.

Though the chilling unit concept may be successful, there may be some limitations to its use. As noted with the ten cultivars, it will still be necessary to carry out empirical trials on a particular species or cultivar to determine the optimum time for taking cuttings. Temperature limit used to calculate chilling units is species dependent, though a maximum of 5°C (41°F) is useful for northern conifers (15). This technique needs to be modified for cultivars that have different seasonal rooting characteristics (e.g. 'Wichita Blue') where chilling sum beginning at a slightly different temperature limit, for late summer through the fall, may be necessary to determine optimum rooting periods.

Warm temperature interruptions may negate the influence of previous chilling hours on plant dormancy (5). During this study donor stock plants received consistent coastal weather conditions with a temperature range of −7 to 13°C (19–55°F). Further work needs to be conducted to determine how donor stock exposed to warm or extremely cold temperature fluctuation influence the rooting response of stem cuttings.

In conclusion rooting success of cuttings appears to be related to a particular donor plant physiological status rather than a calendar date. Calendar dates are an acceptable guideline with cultivars known to root successfully over a large number of chilling units (e.g. 'Youngstown', 'Bar Harbor', 'Prince of Wales'). However, for cultivars that root over a small number of chilling units (e.g. 'Tamariscifolia', 'Broadmoor', 'Green Mound') the correct time for taking cuttings may need to be based on the chilling unit concept for improved rooting.

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