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The Effects of Additives on Freshness and Flammability of Christmas Trees

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ABSTRACT

A continuous water supply was sufficient to maintain the freshness and flame resistance of cut Christmas trees indoors. None of the water additives tested was more effective than water alone in preventing needle fall or maintaining flame resistance of trees held indoors for up to 3 weeks. Magnesium carbonate increased water consumed by Colorado spruce without significant effect on needle retention, twig moisture or flame resistance.

Adding hot water initially to white and Colorado spruce indoors was slightly less effective in maintaining freshness and flame resistance than recutting of stems before placing them in cold tap water.

Colorado spruce lost fewer needles, retained more moisture and was more flame resistant than white spruce when both were stored dry indoors.

Introduction and Literature Review

Apart from the general appearance of Christmas trees, the two major concerns of users are needle loss and flammability. Both are influenced greatly by the moisture content of trees, and to a lesser extent, by species differences. Freshly cut Christmas trees with high moisture content usually shed few needles and resist flame. They will burn only after being dried by a sustained flame (3,5,12). Cut Christmas trees continue to lose moisture through needle pores called stomata, and unless the moisture supply is replenished, the needles dry, sometimes shed, and lose their flame resistance.

Deion (3) tested the flammability of several Christmas tree species, using lighted matches, a blowtorch, or three lighted sheets of newspaper at the base of the trees. The trees were held indoors for periods of 4 to 11 days. No tree set up for 11 days in water had more than 50 percent of its needles consumed by the lighted newspapers and, with the exception of a Scots pine (_Pinus sylvestris_ L.) that was cut a month before setup, none had more than 1 percent of its needles consumed by a blowtorch. In contrast, many trees not in water shed many needles and some were highly combustible after 4 to 11 days indoors. Deion concluded that freshly cut evergreens kept in water do not support combustion.

In tests on Norway spruce (_Picea abies_ (L.) Karst), Fox (5) correlated moisture content with flammability of trees held for 20 days indoors. He noted that trees with twig moisture content over 100 percent on a dry weight basis (50 percent fresh weight) would not support combustion. Similar results were reported by Van Wagner (12) with Scots pine, balsam fir (*Abies balsamea* (L.) Mill.), and white spruce (*Picea glauca* (Moench) Voss) in tests with matches or a Bunsen flame. Van Wagner reported that even the fresh trees could be ignited, however, when eight sheets of newspaper were lighted beneath them.

Species differences and crown densities also are important factors in the resistance of evergreens to drying, needle loss, or flammability. Norway and white spruce often retain needles poorly, whereas the pines and balsam fir hold their needles well. Fresh cut Norway (red) pine (*Pinus resinosa* Ait.) was referred to as the "asbestos tree" by Deion (3) because of its resistance to open flame. Dense branching of any species allows greater spread of flame through a tree than does sparse branching.

Others have used matches, a blowtorch, a Bunsen flame, lighted newspapers, or a hotplate to test flammability (3,5,12). We found that matches would ignite only the driest of evergreens. We observed that a 2.5-inch Bunsen flame applied to twig samples gave reproducible results.

Christmas trees lose moisture during storage between cutting and indoor use. High temperatures and low relative humidities accelerate moisture loss (4,10,11). Van Wagner (12) noted that 6.5 weeks of unheated storage outdoors was equivalent to about 4 or 5 days of indoor drying; but this would be expected to vary with temperature and relative humidity. Christmas trees placed near heaters or stoves would be expected to dry out quickly and shorten their period of freshness and safety indoors. Storage conditions are more important than the time of cutting (1,6,9,11). Cool temperatures and shading reduce moisture loss during outdoor storage (10).

Provided the moisture loss is not excessive, Christmas trees will rehydrate when their cut bases are placed in a continuous water supply indoors. The lowest moisture content that the foliage of a tree can endure and still recover when the tree is placed in water has been defined as the "critical moisture content" by Van Wagner (12). For most species the critical moisture content is about 40 to 45 percent of fresh weight or 67 to 82 percent of dry weight (1,11,12).

After several days in water the twig moisture content of cut trees frequently exceeds the moisture content at the time of harvest. However, interruption of the water supply indoors may accelerate moisture loss. Recently, we observed that interrupting the water supply of white spruce for 1 day caused more rapid drying and loss of flame resistance compared to others continuously supplied with water (1). Nevertheless, several studies show that Christmas trees with high moisture content that are simply supplied with water when brought indoors will retain their moisture, needles, and flame resistance for 2 to 3 weeks (1,2,3,5,7,8, 11,12).

Attempts to reduce moisture loss or improve water uptake in cut trees have involved the application of antitranspirants in the field or indoors (2,4,5,12). Antitranspirant sprays or dips reduce moisture loss by closing or sealing stomata. Most studies show that these compounds reduce moisture loss from cut trees during outdoor storage. Under some conditions, they may prolong the freshness of trees held in water indoors.

The recutting of butts before placing trees into water is a practice long recommended to assure rapid uptake of water. A fresh cut removes the water conducting tissue plugged by soil, pitch, or air, and exposes fresh surfaces to the water. Koths and Wyman (7) found no significant effect of recutting butts in a test with white spruce, but the butts of their trees were free of soil.

Commercial additives and home remedies are supposed to improve water uptake or needle retention of Christmas trees. These include sugars, aspirin, mineral salts, and mixtures of substances. Several published evaluations of additives do not show conclusive benefits (5,7,12). Indeed, some water additives have reduced water uptake by the trees and have reduced flame resistance (5). Although sugar and oxyquinoline sulfate have prolonged the life of cut flowers, neither proved beneficial as water additves for Christmas trees (7). However, some water additive might improve needle moisture by closing the stomata or by preventing plugging of the water conducting tissue.

In seven experiments we tested the effects on Christmas trees of several water additives and of hot water, and in one we compared two tree species for their moisture retention, needle loss, and flammability when stored dry.

Experimental Methods and Results

The following procedures were used in handling whole trees in most of our tests. Uniform trees were selected in the field and twigs were sampled for moisture content. After cutting, the trees were bounced several times to remove dead needles and accumulated debris, and then were weighed. Unless set up immediately, the trees were tied to simulate commercial baling and then were stored in a shaded pine grove. When the trees were brought indoors they were sampled for moisture content and flammability. In most cases one or more inches was then sawed from the butt end and the trees were quickly weighed and were set into 1-gallon containers of tap water or treatment solution. Plastic lids on the containers minimized surface evaporation. Trees held dry or receiving hot water initially were not recut. All trees were suspended from the ceiling of a large room averaging 63 to 70 F and 35 to 40 percent relative humidity.

Needle loss was determined by one of the following: weighing fallen needles; by visual estimates; or by gently stripping and then weighing needles removed. In some experiments needles were dislodged by dropping the branches or trees from a uniform height. In most cases, needle loss is expressed in ounces per pound of tree or branch (oz/lb).

Water use was determined by periodic weighing of branches and their covered containers or by recording the volume of liquid added to the containers. To compensate for varying tree size, water use by whole trees was calculated in fluid ounces per pound of tree (oz/lb).

Moisture content of trees or branches was determined by weighing four twigs of current growth within 2 hours of harvest and again after drying in an oven at 212 F for 24 hours. The moisture content was expressed as percent fresh weight (F.W.) as follows:

$$\text{Percent F.W.} = \frac{\text{moisture loss}}{\text{fresh weight}} \times 100$$

Flammability of trees was determined by holding each of four twigs of current growth horizontally at the apex of a 2.5-inch Bunsen flame. The time, in seconds, required to consume the needles on one side of the twig or to cause the twig to flare and ignite was recorded. With the long-needled pine we held 2-inch segments of twig with needles over the flame with a forceps and recorded the time required to consume all of the needles or cause the twig to flare and ignite. Twigs with a high moisture content sputtered and charred until the needles were consumed, but did not support combustion when removed from the flame. As twigs became quite dry they flared and continued burning when removed from the flame. As twig moisture contents decreased, ignition times also decreased.

EXPERIMENT A. "Kris Klingl" cards as a water additive to prevent needle loss in white and Norway spruce.

"Kris Klingl" cards (Forest Research Laboratories, Norwalk, CT), impregnated with "Kling", are claimed to aid needle retention of cut evergreens when the treated cards are placed in water. Analysis of a water extract of the cards revealed that they contain about 1.3 percent potassium chloride (KCl).

In January 1966, branches 6 to 8 inches long, and containing foliage from two or three growing seasons, were cut from a standing white spruce and from a Norway spruce 2 weeks after harvest. The branches were held dry or were placed in paper cups containing tap water, KCl solutions or "Kling" solutions in a warm greenhouse for 4 weeks. The KCl solutions contained 5, 13, or 26 parts per million (ppm) of potassium (K). The "Kling" solutions contained the soluble material leached from 0.5, 1 or 2 cards in a liter (1.06 quarts) of water and contained approximately 8, 16, or 32 ppm K. The eight treatments were replicated five times for a total of 40 branches from each species.

Fresh cut branches of white spruce in tap water, KCl or "Kling" solutions lost no foliage for 4 weeks. At 3 weeks the dry controls had lost less than 7 percent, but at 4 weeks losses averaged 66 percent and ranged from 35 to 98 percent of their foliage. On the other hand, needle loss of Norway spruce branches from a tree cut 2 weeks before treatment was much greater. After 2 weeks the dry controls had completely shed their needles. Needle loss from branches in tap water, KCl or "Kling" solutions did not differ significantly after 2 or 3 weeks, but after 4 weeks needle loss from branches in "Kling" solutions averaged nearly twice that of branches in tap water or KCl solutions (Table 1).

Water clearly aided needle retention of cut spruce, but there was no advantage in using dilute KCl solutions or "Kling". "Kling" solutions containing 16 or 32 ppm K increased needle drop.

A similar experiment comparing the effect of solutions containing K, calcium (Ca), mixtures of K and Ca, and "Kling" on needle retention of branches from a Norway spruce tree cut 17 days earlier showed no superiority over water alone.

EXPERIMENT B. "Pree-Zerv" as a water additive to prevent needle loss in white and Norway spruce.

"Pree-Zerv" (Lake Products Co., Inc., St. Louis, MO) is claimed to prevent needle fall and drying. Chemical analysis revealed it to be a mixture of calcium carbonate (limestone) and citric acid. In December 1973, branch tips containing foliage of two growing seasons were removed from freshly cut white and Norway spruces, and again 1 week after cutting. The branches were placed in paper cups covered with

Table 1. Cummulative needle loss (percent of total needles) of Norway spruce branches at 4 weeks (mean of five branches). (Experiment A)

Treatment	Percent loss
Tap water	12.8 ab[1]
KCl (5 ppm K)	8.1 a
KCl (13 ppm K)	13.9 ab
KCl (26 ppm K)	13.1 ab
"Kling" (8 ppm K)	13.5 ab
"Kling" (16 ppm K)	26.7 c
"Kling" (32 ppm K)	22.5 bc

[1]Mean losses followed by the same letter do not differ significantly at P = .05 with the Duncan multiple range test.

Table 2. Water use (oz/lb dry needles) by cut branches of white and Norway spruce during two weeks. (Experiment B)

	Fresh cut tree		Tree cut one week before treatment	
	Tap water	"Pree-Zerv"	Tap water	"Pree-Zerv"
White spruce	129	219[1]	359	655
Norway spruce	103	180	106	186[2]

[1]Significantly different at P = .05
[2]Significantly different at P = .01

plastic film containing tap water, "Pree-Zerv" mixture prepared according to directions, or held dry. Each treatment was replicated five times. Liquid consumed was determined at the end of a 2-week test in a warm greenhouse.

As expected, the branches held dry lost the most needles. Branches from the freshly cut white spruce lost an average of 11 percent of their needles and those removed from the same tree 1 week later lost an average of 20 percent of their needles. Needle loss from branches from the freshly cut Norway spruce averaged about 1 percent. Needle loss from branches cut from the same tree 1 week later averaged 21 percent.

Branches of both white and Norway spruce in tap water or "Pree-Zerv" solution lost 3 percent or less of their needles. However, in each test needle loss in "Pree-Zerv" was greater than in tap water. In addition, a black, scummy water mold developed on the surface of the "Pree-Zerv" solutions, but not on tap water.

Liquid consumed during the 2 weeks, expressed as fluid ounces per pound of dry needles, was greater in "Pree-Zerv" than in tap water (Table 2). However, the greater liquid use did not enhance retention of needles.

Table 3. Moisture content[1], weight loss, and ignition time of white spruce branches held dry, in water, or in "Prolong" solutions for 7 or 14 days indoors. (Experiment C)

Indoor treatment	Moisture content % F.W.		Percentage of original weight		Ignition time sec	
	7 days	14 days	7 days	14 days	7 days	14 days
Dry	30.4	16.6	68.5	29.6	3.9[2]	3.5[2]
Water	51.2	52.3	103.6	102.7	8.3	9.0
"Prolong"	50.2	52.8	107.6	106.5	8.0	8.3

[1]Moisture contents at harvest and after 7 days of outdoor storage averaged 47.8 and 46.6 percent fresh weight, respectively.
[2]Twigs supported combustion.

EXPERIMENTS C, D, and E. "Prolong" as a water additive to prevent needle loss, drying, and flammability in white spruce and white pine.

"Prolong" (Texize Chemicals Co., Greenville, SC) is claimed to extend the life of cut flowers, keep needles on Christmas trees, and cause cut trees to absorb more water. Chemical analysis of "Prolong" revealed that it is primarily a sugar solution containing small amounts of a wetting agent, and ions of potassium, aluminum, sulfate and chloride.

EXPERIMENT C. In March 1974, 30 uniform branches containing four seasons' growth were cut from standing white spruce, sampled for moisture content, and stored outdoors for 7 days under shade. The branches were brought indoors and separated into three groups of ten, sampled for moisture content and weighed. One group was held dry, the second was placed in tap water, and the third was put in "Prolong" solution at the dilution indicated on the label. The bases of the branches were recut before placing them into the containers. The tap water and "Prolong" solution were replenished daily. After 7 and 14 days, needle drop was estimated and branches from each were weighed and sampled for moisture content and flammability.

During the week in outdoor storage the branches lost only about 1 percent moisture (Table 3). As expected, the branches held dry indoors shed many needles and supported combustion within 7 days. The branches in either water or "Prolong" solution shed few needles and increased in moisture content and total weight. None supported combustion after 14 days. Water uptake and weight increases were slightly greater for branches in "Prolong" than in water, but moisture contents and ignition times did not differ significantly.

EXPERIMENT D. In October 1974, 20 white spruce trees, 3 to 5 ft tall, averaging 7.5 lb, were sampled, harvested, and stored outdoors under shade. After 3 days these trees were brought indoors, their butts recut, and set into containers of tap water or "Prolong" solution. Water and "Prolong" solution were added daily as needed. Moisture content and flammability were determined at 10 and 21 days. Room temperature averaged 65 F for the 3-week period.

As did branches (Experiment C) the white spruce trees lost moisture in outdocr storage, but regained moisture when placed in water or "Prolong" solution (Table 4). The trees used about a pint of liquid per day for the first 12 days (Figure 1), and averaged 18 pints during the 21-day test. All but two trees were in excellent

Table 4. Moisture content of white spruce trees before and after setup indoors, liquid consumed, needle loss, and ignition time of twigs over the 21 day period indoors in water or "Prolong" solution. (Experiment D)

Treatment	Moisture content % F. W. At cutting	After 3 days outdoor storage	After 10 days indoors	After 21 days indoors	Liquid consumed 21 days oz/lb	Needle loss after jarring oz/lb x 100 10 days	21 days	Ignition time 21 days sec
Water	54.8	49.6	55.7	53.9	38.5[1]	3.3	21.6	11.5
"Prolong"	55.1	49.1	55.4	53.8	38.7	2.1	18.1	11.2

[1]Equivalent to about 18 pints of water for a 7.5 lb tree over a 21-day period.

Table 5. Moisture content of white pine trees before and after setup indoors, liquid consumed, and ignition time of twigs over a 22-day period in water or "Prolong" solution. (Experiment E)

	Moisture content % F. W.					
Treatment	At cutting	After 3 days outdoor storage	After 11 days indoors	After 22 days indoors	Total liquid consumed 22 days oz/lb	Ignition time 22 days sec
Water	57.9	57.8	58.5	58.1	38.2	17.8
"Prolong"	57.3	57.4	59.0	59.2	32.0	16.7

condition after the 21 days indoors. One tree in tap water and one in "Prolong" were shedding moderately. Moisture contents, ignition times of twigs, needle losses or liquid consumed during the 21-day period did not differ significantly between trees in water or "Prolong".

EXPERIMENT E. This test was conducted in the same manner as Experiment D. In December 1974, four white pine (Pinus strobus L.) trees were placed in tap water and four in "Prolong" solution for 22 days at a room temperature averaging 64 F. The trees were about 5 ft tall and averaged 10.5 lb.

Few needles fell and, again, there were no significant differences in moisture content, liquid consumed, or ignition times between trees held in water or "Prolong" solution (Table 5). Liquid consumption started at about 1.5 pints per day and exceeded 1 pint per day for about 15 days (Figure 1).

EXPERIMENTS F and G. "Saf-Tree" as a water additive and the effects of initial addition of hot water on moisture loss and flammability of white spruce and Colorado spruce.

"Saf-Tree" (Mag Car Inc., Apex, NC) contains sufficient magnesium carbonate to saturate a solution when added to the water of a tree stand. It is claimed to keep trees moister and safer, help prevent needle shedding, and keep them greener for longer periods than water alone. In Experiment F we tested "Saf-Tree" on white spruce trees and in Experiment G we tested an equivalent amount of magnesium carbonate (U.S.P. grade) on Colorado spruce (Picea pungens Englemann) trees. Both experiments also included comparisons of trees on which the butts were not recut before placing them in hot tap water (138-140 F), as well as trees on which the butts were recut before placing them in cold tap water (50 F). Water was added to all treatments as necessary to replenish the liquid consumed.

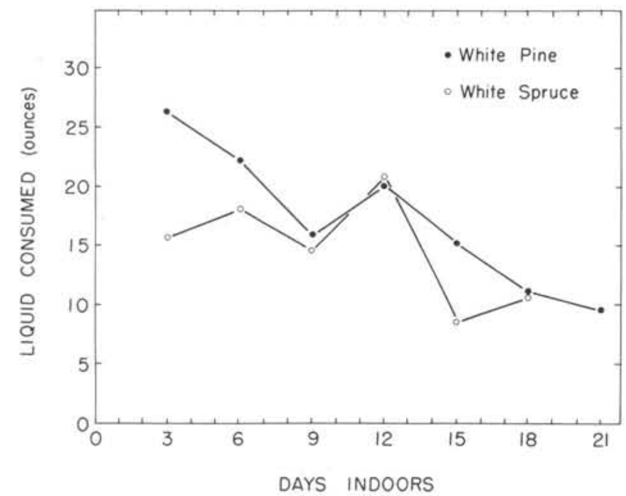
EXPERIMENT F. In December 1974, 12 white spruce trees were cut, stored under shade for 7 days and then brought indoors and set into the treatment solutions for 24 days at an average temperature of 63 F. Four trees, 4 to 5 ft tall, averaging approximately 9 lb, received each treatment. Initial use of hot tap water without recutting butts reduced water uptake and increased needle loss, whereas "Saf-Tree" increased water use, moisture content, and ignition time compared to trees in cold tap water. However, none of the differences was statistically significant at the 5 percent probability level.

Table 6. Moisture content, liquid consumed, needle fall, and ignition time of twigs from white spruce in water or "Saf-Tree" solutions for 24 days. (Experiment F)

Indoor treatment	Moisture content % F. W.: At cutting	After 7 days outdoor storage	After 14 days indoors	After 24 days indoors	Liquid consumed 24 days oz/lb	Needle[1] loss 24 days oz/lb x 100	Ignition[2] time 24 days sec
Water	52.0	51.0	50.8	50.7	19.5	7.5	12.5
Hot Water initially[3]	52.7	50.8	51.1	49.8	12.2	10.8	11.0
"Saf-Tree"	53.2	51.8	54.1	55.3	41.9	7.5	14.4

[1]After dropping trees four times from 6 inches.
[2]Fresh cut twigs of white spruce had an average ignition time of 13.3 seconds.
[3]Butts of these trees were not recut before addition of hot water.

Figure 1. Average daily consumption of liquid by white spruce and white pine (Experiments D and E).



EXPERIMENT G. Colorado spruce trees, cut in January 1975 and stored under shade for 7 days, were brought indoors and held dry, or were placed in tap water, a saturated magnesium carbonate solution (4 grams per container), or initially in hot water (140 F). Five trees, 5 to 6 ft tall, weighing an average of 20 lbs at harvest, received each treatment. The room temperature averaged 64 F during 21 days. Magnesium carbonate increased, and hot water without recutting the butts reduced, the liquid consumed during the test (Table 7, Figure 2). On the evening of the third day, two of the five trees in magnesium carbonate exhausted the 3.5 quarts of liquid in

Figure 2. Average daily consumption of liquid by Colorado spruce (Experiment G).

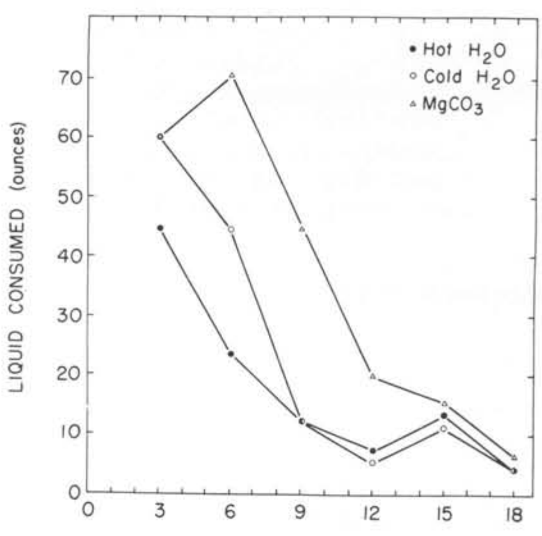


Table 7. Moisture content, liquid consumed, needle fall, and ignition time of twigs from Colorado spruce in water or $MgCO_3$ solution or stored dry for 21 days indoors. (Experiment G)

	Moisture content % F. W.				Needle fall oz/lb x 100		
Indoor treatment	At cutting	After 7 days outdoor storage	After 21 days indoors	Liquid consumed oz/lb	Undisturbed trees	After jarring trees[1]	Ignition time 21 days sec
Water	53.3	52.9	55.3	22.2	0.8	3.7	18.8
Hot Water initially[2]	54.5	54.2	55.6	16.2	1.1	6.7	20.2
$MgCO_3$	53.7	53.3	52.9	33.5	1.1	6.3	19.6
Dry	54.6	54.2	42.1	-	1.9	14.9	12.8
LSD P = .05			2.3	13.1	0.4	4.0	2.8

[1]After dropping trees 4 times from 6 inches.
[2]Butts of these trees were not recut before addition of hot water.

their containers and continued to use 1 to 3 quarts of water per day for 10 days. Nevertheless, after 21 days in liquid, moisture contents of twigs differed little among the trees. Only the trees held dry lost a great deal of moisture and shed many needles. Although the ignition time of twigs from the dry trees was less than the others, none of the twigs supported combustion.

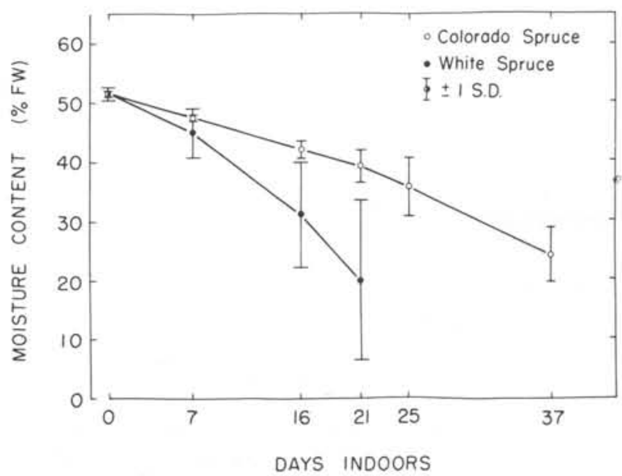
Comparison of dried needles from the trees at harvest and after 21 days showed increases in magnesium concentration of 0 to 20 percent, but the increase was not related to the treatment. Colorado spruce seemed particularly resistant to flame in this experiment, and therefore a further comparison between white and Colorado spruce was made.

EXPERIMENT H. Comparison between white and Colorado spruce held dry indoors.

Three white spruce and three Colorado spruce trees of approximately equal size (5 to 6 ft, averaging 20 lb) were cut and sampled in March 1975, and held dry indoors at a temperature averaging 70 F. Moisture content, needle loss, and ignition time were determined after 7, 16, and 21 days for both species, and after 25 and 37 days for Colorado spruce.

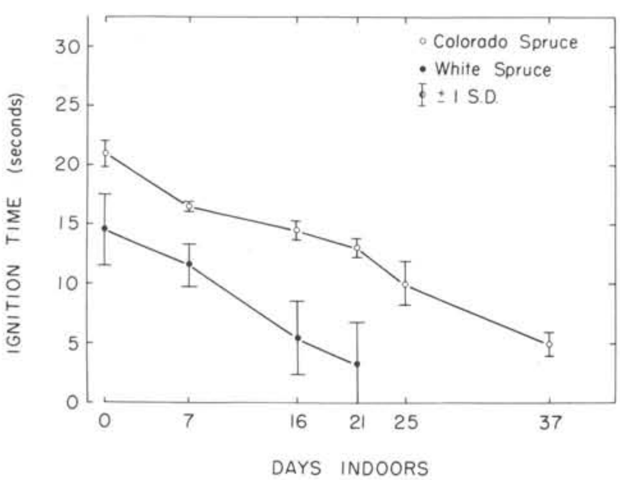
Although the moisture content of the white and Colorado spruce was similar at harvest, white spruce dried more rapidly than Colorado spruce (Figure 3). Colorado spruce also was more

Figure 3. Twig moisture content of white and Colorado spruce (Experiment H).



flame resistant. Fresh twigs of Colorado spruce required an average of 21 seconds to char over a Bunsen flame, whereas twigs of white spruce required only 14.6 seconds (Figure 4). At 21 days needle fall from undisturbed white spruce was 10 times greater than from Colorado spruce. Two of the three white spruce completely defoliated after jarring, whereas only a few needles fell from the Colorado spruce. Twigs from two of the three white spruce supported combustion after 16 days indoors, whereas twigs of Colorado spruce did not support combustion until 25 or 37 days. At 25 days twigs from one of the Colorado spruce, which was beginning to lose needles, supported combustion at approximately 7 seconds. At 37 days when the other two trees were shedding moderately they also supported combustion.

Figure 4. Ignition time of twigs of white and Colorado spruce (Experiment H).



Discussion

The water additives tested showed no clear-cut benefits over tap water alone when properly stored trees were set up indoors. Tap water maintained white spruce, white pine, and Colorado spruce in good condition for 3 weeks, and none of the water additives significantly improved needle retention or increased the time required to consume foliage on twigs held at the apex of a 2.5-inch Bunsen flame.

Two additives containing calcium or magnesium carbonate increased water uptake. Increasing water uptake could be an advantage if the greater water use increased twig moisture, improved needle retention, or improved resistance to flame. In our tests with white and Colorado spruce we did not observe any significant advantage of increased water uptake. Unless high capacity tree stands are used, increased uptake without further benefit could be a distinct disadvantage, because of the difficulty of maintaining a continuous water supply. Previously we observed that interrupting the water supply of white spruce for 1 day caused them to dry excessively even after the water was replaced (1). A continuous water supply, therefore, is essential for white spruce.

The water to provide an uninterrupted supply for a day depends largely on the size of the tree and temperature. Christmas trees 6 to 8 ft tall frequently consume 3 to 4 quarts per day for at least the first few days in a warm room. Stands that immerse the butt in at least 1 gallon, therefore, appear essential. Stands of smaller capacity will require more frequent refilling and increase the chance of running dry.

Others have reported that sugar solutions or solutions containing sugar and minerals have been ineffective as water additives (5,7,12), so it is not surprising that a product such as "Prolong" would provide no advantage in our tests on white spruce and white pine.

The initial addition of hot water to a stand is supposed to melt pitch and free soil from the cut ends of tracheids (water conducting cells). It has frequently been suggested as a substitute for recutting the stem. Although in our tests the differences were not statistically significant for white spruce, the trees receiving hot water initially used less water over 3 weeks and shed more needles. The same trends were evident in Colorado spruce.

How hot is hot? Water near the boiling point could be hazardous and kill plant cells. Perhaps our 140 F water was too hot as some plant tissues can be injured at temperatures exceeding 120 F for extended periods. It seems wise to reject hot water as a means of maintaining tree freshness in the home.

We did not attempt to determine whether recutting the butts of evergreens improves the uptake of cold tap water. Although Koths and Wyman (7) found no advantage to this usually simple procedure in a test on white spruce, they suggested that it be continued to ensure water uptake through the fresh cut.

Although the greater needle retention of Colorado spruce as compared with white spruce has been observed by many growers and sellers of Christmas trees, it was surprising to learn that Colorado spruce also retains more moisture under comparable drying. Colorado spruce also was more flame resistant than white spruce at equivalent twig moisture. Although we did not make direct comparisons, it also apears that white pine, like Colorado spruce, is also very resistant to needle loss and flame. The marked variability among individual white spruce in moisture, needle retention, and flame resistance suggests that microenvironmental or genetic differences within the species could also be important.

Conclusions

Making a fresh cut on the butt of a Christmas tree and holding it continuously in water insures against premature loss of needles and flame resistance. However, an interrupted water supply may be little better than no water at all. In these tests, additives or an initial treatment with hot water provided no conclusive benefits over cool tap water. Colorado spruce held dry indoors resisted drying and flame more and retained its needles longer than white spruce.

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