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Effects of Application of Benzyladenine to Seedlings of *Pinus sylvestris* and *Pinus nigra*[1]

A.A. Boe[2]
Department of Horticulture and Forestry
North Dakota State University
Fargo, ND 58105

Abstract

Greenhouse grown seedlings of *Pinus sylvestris* L. (Scots pine) and *Pinus nigra* Arnold. (Austrian pine) were treated with plant growth regulators in a 1% solution of dimethyl sulfoxide. Benzyladenine (BA) induced branching of seedlings of Scots pine. Both Scots pine and Austrian pine seedlings were reduced in height by BA treatments. The addition of gibberellic acid (GA) to the BA treatments had little effect on branching or seedling height. After a second growth cycle the Scots pine seedlings treated with BA were shorter and had more branches while the Austrian pine seedlings were also shorter without an increase in the number of branches.

Index words: plant growth regulators, growth substances

Significance to the Nursery Industry

Well-shaped nursery grown pine trees will sell better than misshapen ones. Often seedlings pulled from seed beds are 30 cm (12 in) or taller, with few branches. Branching can be induced by pruning in the seed bed. This is seldom done by seedling producers since size is a criterion of quality. An application of a growth regulator to the seedlings could induce branching and make it possible to produce a better quality tree in a shorter period of time. It could also reduce the cost of producing these trees by decreasing labor required for pruning.

Introduction

A dilemma in the production of pines for landscape plantings and Christmas trees is to have the trees produce full whorls of branches at the lower nodes of the stem. The cytokinin BA has been used to induce bud development on various species of pine (1, 2, 3, 4, 5, 6). This study investigated the effects of BA on the induction of branching and growth retardation on young pine seedlings.

Materials and Methods

Seeds of Scots pine and Austrian pine were sown in 5 × 5 × 12.5 cm (2 × 2 × 6 in) open bottom plant bands. A commercial peat:perlite soil mix (50:50 by vol) was used. The seedlings were grown elevated on a wire mesh to accomplish air pruning of the roots. The seedlings were irrigated as needed with water containing 200 ppm N, P, K plus micronutrients from 20N-8.3P-16.6K (20-20-20). Evaporative coolers in the greenhouse maintained the day temperature below 25°C (77°F); night temperature was maintained at approximately 16°C (60°F). Daylength was extended to 16 hours using metal halide lights (150 $uEm^{-2}s^{-1}$ at bench top) suspended 1.8 m (6 ft.) above the benches.

Uniform plants were selected for the treatments. A randomized block design was used with 3 or 4 blocks (see tables) and 4 seedlings per treatment.

Benzyladenine (BA) at 0.2, 0.4 and 0.6 g/l was used. Gibberellic acid (GA) at 0.04 g/l was used with the BA in some treatments.

In the first experiment, Scots pine and Austrian pine were treated with the growth regulators 90 days after sowing. Only Scots pine was used in the second experiment and the growth regulator treatments were applied 30 days after sowing. A second application of growth regulators was made to half of the seedlings of Austrian pine in the first experiment and the Scots pine in the second experiment. This second treatment was made 14 days after the first or in the case of the Austrian pine 104 days after sowing and of the Scots pine 44 days after sowing.

The chemicals were mixed in water containing 1% dimethyl sulfoxide and 0.1% ortho X77 surfactant. Chemical applications were made with a hand sprayer and the foliage was completely wetted.

Observations on height and number of branches were made 60 days after the first treatment while height, caliper at soil line and the number of buds set on the apical whorl of the central leader were observed 120 days after the first treatment. The seedlings were placed in a cold storage room at 7°C (45°F) 120 days after treatment. After 90 days of cold treatment, the seedlings were repotted into .8 1 (1 qt) nursery containers and grown through a second growth cycle. The soil, fertilizer and growing conditions were as stated above. Observations on height, number of developed branches and the number of buds on the apical whorl of the central leader were recorded sixty days later.

Results and Discussion

Results form the first experiment indicate that BA treatments applied 90 days after sowing increased the number of branches developed on both Scots pine and Austrian pine seedlings (Table 1 and 2). The effect of the growth regulator treatments on the height of the seedlings 60 days after sowing is inconclusive from the data presented. The height of the Scots pine 120 days after sowing was decreased by treatment with 0.4 and 0.8 mg/l of BA. With some excep-

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[2]Professor of Horticulture and Forestry.

Table 1. Effect of Benzyladenine treatments on *Pinus sylvestris* seedlings treated 90 days after sowing.

BA Treatment (g/l)	60 days after treatment		120 days after treatment		
	Height (cm)	No. Branches	Height (cm)	Caliper (mm)	No. Buds[z]
0	10.1[y] ab[x]	6.8 b	11.7 a	6.1 a	7.1 a
0.2	10.6 a	19.7 a	11.0 a	6.1 a	5.4 a
0.4	9.3 ab	21.3 a	9.8 b	5.8 a	5.2 a
0.8	8.6 b	22.0 a	8.5 c	5.4 a	5.1 a

[z]Buds in the apical whorl on the central leader.

[y]Mean of 3 blocks with 4 plants per treatment.

[x]Means not followed by the same letter(s) are different based on Duncan's multiple range test, p = 0.05.

Table 2. Effect of Benzyladenine treatments on *Pinus nigra* seedlings treated 90 or 90 and 104 days after sowing.

Treatment	60 days after treatment		120 days after treatment		
	Height (cm)	No. Branches	Height (cm)	Caliper (mm)	No. Buds[z]
Control	6.8[y] abcde[x]	3.7 d	8.2 abc	5.9 a	2.4 abc
BA					
0.2-1X[w]	7.5 abc	16.0 bc	9.0 a	5.1 cde	2.4 abc
0.2-2X	6.6 cde	14.9 bc	7.2 bc	4.9 de	3.2 abc
0.4-1X	6.9 abcde	11.8 c	7.8 abc	5.5 abcd	3.4 abc
0.4-2X	6.9 abcde	20.6 a	6.9 c	4.6 e	3.0 abc
0.8-1X	7.0 abcde	15.8 bc	7.6 abc	5.0 cde	3.3 abc
0.8-2X	6.6 cde	23.7 a	7.0 bc	4.6 e	2.0 bc
0.4 + GA-0.04-1X	7.8 ab	16.2 b	9.0 a	5.2 cde	3.5 ab
0.4 + GA-0.04-2X	7.4 abcd	13.9 bc	8.5 ab	5.3 bcd	2.9 abc
0.8 + GA-0.04-1X	7.8 a	14.0 bc	8.8 a	5.4 abcd	3.8 a
0.8 + GA-0.04-2X	6.6 cde	22.1 a	7.2 bc	4.9 de	2.8 abc

[z]Buds in the apical whorl on the central leader.

[y]Mean of 4 blocks with 4 plants per treatment.

[x]Means not followed by the same letter(s) are different based on Duncan's multiple range test, p = 0.05.

[w]Number indicates concentration in g/l. 1X = treated once; 2X = treated twice.

tions the caliper of the Austrian pine was decreased by the growth regulator treatments. The number of buds that developed in the apical whorl of the central leader varied considerably from plant to plant and was probably not related to BA treatment.

The application of a second BA treatment increased the number of branches on Austrian pine in three of five treatments. However, the addition of GA to the BA treatments of Austrian pine did not give explainable results.

In the second experiment, Scots pine seedlings were given growth regulator treatments 30 days after sowing. Sixty days after treatment the treated seedlings were discernably shorter and had developed more branches than the control seedlings (Table 3, Fig. 1). Data taken 120 days after treatment in-

Table 3. Effect of Benzyladenine treatments on *Pinus sylvestris* seedlings treated 30 or 30 and 44 days after sowing.

BA Treatment (g/l)	60 days after treatment		120 days after treatment		
	Height (cm)	No. Branches	Height (cm)	Caliper (mm)	No. Buds[z]
0	7.6[y] a[x]	4.5 b	9.3 ab	4.4 a	3.6 ab
0.2-1X	5.2 bc	10.2 a	8.6 abc	4.4 ab	3.0 ab
0.2-2X	5.2 bc	10.4 a	10.5 a	4.1 ab	1.8 ab
0.4-1X	6.0 b	9.8 a	7.8 abcd	4.6 a	4.1 a
0.4-2X	4.5 c	10.8 a	6.3 cd	4.0 ab	1.2 b
0.8-1X	4.8 c	10.9 a	7.2 bcd	4.1 ab	2.3 ab
0.8-2X	4.5 c	11.8 a	5.4 d	3.7 b	2.2 ab

[z]Buds in the apical whorl on the central leader.

[y]Mean of 3 blocks with 4 plants per treatment.

[x]Means not followed by the same letter(s) are differrent based on Duncan's multiple range test, p = 0.05.

[w]1X = treated once: 2X = treated twice.

Fig. 1. Scots pine seedlings treated with BA 30 or 30 and 44 days after sowing. The first number is the concentration (1 = 0.2 mg/l, 2 = 0.4 mg/l, 3 = 0.8 mg/l) of BA and the second is number of times treated (1 = treated 30 days after sowing, 2 = treated 30 and 44 days after sowing).

dicated that height suppression still occurred in seedlings treated twice with 0.4 and 0.8 mg/l of BA. The caliper of the seedlings and the number of buds formed in the apical whorl of the central leader were probably not affected by the treatment.

When the Austrian pine seedlings were grown through a second growth cycle, a significant reduction in height of the treated seedlings was recorded. At the higher concentrations of BA and when two applications of BA were made, growth reduction approached 50%. Combination treatments of BA and GA appeared to reduce this growth suppression as compared to BA treatment only (Table 4).

The Scots pine seedlings treated 30 days after sowing were grown through a second growth cycle, and the suppression of growth was still apparent (Table 4). The height of the treated seedlings was decreased by 12 to 63%. The number of branches was increased in all treatments except when the seedlings were treated twice with 0.4 mg/l of BA (Data not shown). The reason for this anomoly is unknown. The BA treatments did not affect the number of buds on the apical whorl of the central leader.

From the data presented it appears that BA could be used to increase the number of branches in the lower whorls of Scots pine seedlings. BA was not effective for increasing the number of branches on Austrian pine. BA could possibly

Table 4. Effect of Benzyladeneine treatment on height of *Pinus nigra* treated 90 days after sowing and *Pinus sylvestris* treated 30 days after sowing after the second growth cycle.

Treatment	Height	
	P. nigra (cm)	P. sylvestris (cm)
Control	29.3[y] a[x]	37.1[z] a
BA		
0.2-1X[w]	23.7 bc	30.6 b
0.2-2X	22.0 bcd	32.7 b
0.4-1X	24.8 bc	31.3 b
0.4-2X	14.1 de	23.4 c
0.8-1X	22.3 bc	25.8 c
0.8-2X	16.9 cde	14.8 d
0.4 + GA-0.04-1X	26.6 ab	—
0.4 + GA-0.04-2X	23.6 bc	—
0.8 + GA-0.04-1X	25.5 abc	—
0.8 + GA-0.04-2X	17.9 bcd	—

[z]Mean of 3 blocks with 4 plants per treatment.

[y]Mean of 4 blocks with 4 plants per treatment.

[x]Means not followed by the same letter(s) are different. Duncan's multiple range test, p = 0.05.

[w]Number indicates concentration in g/l. 1X = treated once; 2X = treated twice.

be developed as a growth retardant for these pine. This could be useful in the production of seedlings in the nursery or greenhouse where excessive growth is a problem.

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