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Effect of Growth Regulator and Nitrogen on Height and Branching of *Skimmia reevesiana*[1]

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Abstract

Application of gibberellins A_{4+7} (GA_{4+7}) or 6-benzylamino purine (BA) stimulated a second growth flush on plants of *Skimmia reevesiana* Fort. that had completed normal spring growth. Plants treated with GA_{4+7} were up to 130% taller than untreated plants at the end of the first season, and up to 50% taller after a growth flush the following spring without re-treatment. The number of shoots was increased more than 100% by BA at 4000 ppm, without affecting height. Promalin (BA + GA_{4+7}) at 2000 ppm of each active ingredient increased height 50% the year of treatment, and the number of shoots more than 160%. There was not a significant difference in height after the next spring flush. Increasing the amount of nitrogen (N) supplied to the plants increased the number of shoots the second season and decreased plant height. Application of GA_{4+7} tended to counteract these effects of N.

Index words: 6-benzylamino purine, gibberellins

Introduction

Many kinds of plants respond to treatment with gibberellins by increased growth and shoot elongation. Applegate (1) reported up to 150% increase in height of 11 kinds of woody ornamentals sprayed with Gibrel.

More recently McCarthy (6) reported up to 100% longer shoots on dwarf forms of six species of woody landscape plants sprayed with gibberellic acid (GA_3) in a study to determine whether this treatment could be used to hasten production of dwarf forms in the nursery. Increased shoot length usually was accompanied by a reduction in number of shoots.

Plants of *Skimmia* species normally make one vegetative growth flush each season followed by a flowering flush. This makes them slow growing, requiring two or more seasons for the nurseryman to produce a saleable plant. Whalley and Loach (8) found that application of gibberellic acid (GA_3) to plants of *Skimmia japonica* induced an extra flush of vegetative growth in that species.

Increased branching from increased levels of N fertilization has been reported in various plants, including rhododendrons (*Rhododendron* X) (3, 7), tea (*Camellia sinensis*) (5), *Pyracantha coccinea* (4), and Japanese holly (*Ilex crenata*) (2, 4).

Experiments were started in 1979 to determine effects of gibberellins and BA on growth and branching of a self-fertile clone of *Skimmia reevesiana* Fort. Interaction of the response to these growth regulators with effects of nutritional levels were included in 1981.

Materials and Methods

The plants in these experiments were one year old, having made one flush of growth in the spring following the year in which they were rooted directly in 3.8 L (#1)

[1]Received for publication June 14, 1984; in revised form March 4, 1985. Scientific Paper No. SP6748. Washington State Univ., Coll. of Agric. Res. Center Project No. 0085.

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cans. They were in a growing medium consisting of 70% bark (Douglas fir and hemlock), 15% sphagnum peat, and 15% sand. Throughout each experiment the plants were grown under 50% lath shade.

Growth regulators were applied by spraying to run off with a 0.98 L (1 qt) compressed air sprayer. The 1979 treatments were two concentrations of Promalin applied July 30 (See Table 1 for rates). In 1980, the two ingredients of Promalin (GA_{4+7} and BA) were applied July 25, separately and in combination. Treatments were included in 1980 to determine whether the response to GA_{4+7} was affected by addition of the surfactants X-77 or AG98.

Only GA_{4+7} was used in 1981. Treatments included comparison with surfactants X-77 and AG98 as in 1980. Applications were made June 19. The plants were grown in 1981 at three levels of N, established as follows: 1. No supplemental fertilizer; 2. 240 ml (1 cup) of ammonium sulfate solution (1120 ppm N) applied once a month; 3. 240 ml (1 cup) of ammonium sulfate solution (1120 ppm N) applied twice a month.

A randomized complete block design was used in all experiments. Four replications of four plants per experimental unit were used in 1979, ten single-plant replications were used in 1980, and five single-plant replications in 1981.

Results and Discussion

1979 Experiment. Plants treated with Promalin began to grow within ten days after treatment, and after completing a growth flush, they were 40 to 50% taller and 20 to 25% wider than untreated plants (Table 1). They also had four to five times as many shoots because four to five buds on each shoot had grown in response to the growth regulator application.

Table 1. Effect of BA plus GA_{4+7} on plant size and number of shoots, 1979.[z]

Growth regulator	Rate (ppm)	Plant height (cm)	Plant width (cm)	Number of shoots
None	—	16 a	20 a	11 a
BA + GA_{4+7}	1100 + 1100	23 b	24 b	49 b
BA + GA_{4+7}	2200 + 2200	24 b	25 b	56 b

[z]Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's multiple range test.

1980-1981 Experiment. Plants treated with GA_{4+7} started growth soon after treatment as in 1979, and at the end of the season they were up to 80% taller than untreated plants (Table 2). Application of GA_3 caused only about half as much height increase as GA_{4+7}. Addition of surfactants X-77 or AG98 did not change the effect of GA_{4+7} on plant height (Table 3).

When BA was applied with GA_{4+7}, the increase in height was only about 50%, but there were more than 2-1/2 times as many shoots at the 2000 ppm BA plus 2000 ppm GA_{4+7} rate as on untreated plants. BA applied at 4000 ppm without GA_{4+7} doubled the number of shoots without significantly affecting plant height.

When a growth flush occurred in the spring of 1981 (without additional treatment), new shoot growth on untreated plants was longer than on plants treated the previous season with GA_{4+7} but the treated plants remained 25 to 40% taller than untreated plants (Table 2).

1981-82 Experiment. After a growth flush in response to 500 ppm GA_{4+7}, treated plants were nearly twice as tall as untreated plants. There was an additional 30 to 35% increase in height as the concentration of GA_{4+7} was increased to 2000 ppm (Table 4). The number of shoots per plant was increased 25% by 500 ppm GA_{4+7} and 50 to 60% by 1000 and 2000 ppm.

After a spring growth flush in 1982, the plants treated with GA_{4+7} were still 40 to 50% taller than the untreated plants, but had about 30% fewer shoots (Table 5).

Addition of surfactant X-77 or AG98 did not significantly affect response to GA_{4+7}, and data for surfactants were combined in Tables 4 and 5.

There were no significant effects of N during the year of treatment, and data for N were combined in Table 4. After the spring flush in 1982, the plants with the least N averaged 10% taller than the ones at the high N level (Table 5). In the 1000 ppm GA_{4+7} treatment, the plants with low N were 20% taller than the ones with high N.

The plants with high N had 50% more shoots than the

Table 2. Response of *Skimmia reevesiana* to growth regulators in the year of treatment and the following spring, 1980-81.[z]

		12-24-80		5-31-81	
Treatment	Rate (ppm)	Plant height (cm)	Number of shoots	Plant height (cm)	Number of shoots
None	—	13.3 a	5.8 a	23.1 a	7.4 a
BA	1000	15.8 a	6.8 a	25.3 ab	10.3 abc
BA	2000	13.3 a	8.3 ab	25.1 ab	10.1 ab
BA	4000	14.5 a	12.2 bc	26.3 abc	14.9 bc
GA_{4+7}	1000	23.1 cd	8.9 ab	29.0 bcd	9.7 ab
GA_{4+7}	2000	23.9 d	8.5 ab	30.0 cd	8.4 a
GA_{4+7}	4000	24.1 d	6.6 a	32.3 d	6.6 a
BA + GA_{4+7}	1000 + 1000	19.6 b	9.2 ab	26.9 abc	10.0 ab
BA + GA_{4+7}	2000 + 2000	19.7 b	15.5 c	25.4 ab	15.7 c
BA + GA_{4+7}	4000 + 4000	20.3 bc	11.2 abc	26.0 abc	12.0 abc
GA_3	1000	19.1 b	10.5 abc	28.1 bc	11.3 abc
GA_3	2000	19.0 b	10.2 ab	27.9 bc	10.3 abc
GA_3	4000	19.8 b	8.7 ab	26.3 abc	10.6 abc

[z]Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's multiple range test.

Table 3. Effects of surfactants on response of *Skimmia reevesiana* to GA_{4+7}.[z]

Rate of GA_{4+7} (ppm)	Surfactant[y]	12-24-80 Plant height (cm)	12-24-80 Number of shoots	5-13-81 Plant height (cm)	5-13-81 Number of shoots
0	None	13.0 a	5.7 a	23.8 a	7.5 a
0	X-77	13.3 a	5.8 ab	23.1 a	7.4 a
0	AG98	12.5 a	4.8 a	23.8 a	6.6 a
2000	None	23.9 b	10.8 bc	30.9 b	10.6 ab
2000	X-77	23.9 b	8.5 abc	30.0 b	8.4 ab
2000	AG98	23.4 b	13.1 c	28.8 b	13.3 b

[z]Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's multiple range test.
[y]Surfactant added at 0.2%.

Table 4. Plant height and number of shoots in August after June application of GA_{4+7}, 1981.[z]

Concentration of GA_{4+7}	Plant height (cm)	Number of shoots
0	11.2 a	6.1 a
500	20.9 b	7.7 ab
1000	23.5 bc	10.0 c
2000	24.7 c	9.3 bc
4000	23.8 c	7.0 a

[z]Means within columns followed by the same letter are not significantly different at the 5% level as determined by Duncan's multiple range test.

ones with low N after the spring flush in 1982 (Table 5). For plants in the 0 and 500 ppm GA_{4+7} treatments, the difference between medium and low N was 60 to 80% more shoots, and between high and low N the difference was 80 to 115% more shoots. The trend toward higher number of shoots at the higher N levels was apparent at the 1000 to 4000 ppm GA_{4+7} treatments but the differences were not significant.

Significance to the Nursery Industry

Application of gibberellins resulted in taller plants at the end of the first and second season than without treatment. To decide whether this would be a desirable treatment for a nurseryman to use, it would be necessary to balance the cost of an application against the benefit from increased size. Consideration would have to be given also to the characteristics of the plant resulting from extra elongation of a smaller number of shoots than on plants grown at a high level of N but not treated with gibberellins. Obviously the gibberellin treated plants were less compact. On the other hand, with plants grown at a relatively low level of N, application of 500 or 1000 ppm GA_{4+7} resulted in maximum plant height without reducing number of shoots.

If maximum number of shoots is the primary objective, this can be accomplished by maintaining the proper N level, by application of BA, or probably by a combination of both. When the number of shoots was increased by increasing the level of N, the plants tended to be shorter than with less N. On the other hand, when shoot number was increased with BA treatment, plant height was not reduced. Information on interaction of N levels with BA treatment would be useful.

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Table 5. Plant height and number of shoots after spring growth the year following application of GA_{4+7} and three nitrogen fertilization levels, 1981-82.[z,y]

Concentration of GA_{4+7}	Plant height (cm) Nitrogen level[x] 1	2	3	Mean	Number of shoots Nitrogen level[x] 1	2	3	Mean
0	24.4 ab	22.6 a	20.4 a	22.5 A	12.6 abcd	21.5 e	21.6 e	18.5 B
500	34.6 d	31.0 cd	30.2 cd	31.9 B	7.6 a	11.2 abc	16.4 d	11.7 A
1000	35.0 d	34.8 d	29.2 bc	33.0 B	12.0 abcd	11.6 abcd	15.6 cd	13.1 A
2000	34.6 d	34.4 cd	33.2 cd	34.1 B	10.0 ab	12.0 abcd	13.2 bcd	11.7 A
4000	34.4 cd	32.2 cd	34.8 d	33.8 B	7.6 a	8.6 ab	12.0 abcd	9.4 A
Mean	32.6 B	31.0 AB	29.6 A		10.0 A	13.0 B	15.8 B	

[z]Values for plant height or for numbers of shoots followed by the same lower case letter are not significantly different at the 5% level as determined by Duncan's multiple range test.

[y]Means of columns or lines under plant height or under number of shoots followed by the same capital letter are not significantly different at the 5% level as determined by Duncan's multiple range test.

[x]Nitrogen levels: 1—No supplemental fertilizer during the growing season. 2—Ammonium sulfate solution at 1120 ppm N once a month. 3—Ammonium sulfate solution at 1120 ppm N twice a month.

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Influence of Liming Rate on Phosphorus Leaching from a Peat-Sand Medium[1]

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Abstract

Leaching of phosphorus (P) from a peat-sand medium was measured at 3 liming rates. Leaching of P from superphosphate was reduced only at the highest rate of hydrated lime, 2.65 kg/m^3 (4.5 lb/yd^3), which resulted in pH 6.6. Each rate of lime reduced P leaching from the slightly soluble dicalcium phosphate. Further investigation of sparingly soluble P sources for amending soilless media is suggested.

Index words: soilless media, superphosphate, dicalcium phosphate, plant nutrition

Introduction

A long lasting source of phosphorus (P) is desirable for container nurseries. A common nursery practice is to amend container media with superphosphate or treble superphosphate. These have been assumed to be slowly available forms of P in soilless media because of the known capacity of soil to fix P. Flint in 1962 (2) reported that P was only 0.7 ppm in Spurway extract 3 months after a peat-perlite medium, pH 5.5, had been amended with superphosphate at 3 kg/m^3 (5 lb/yd^3). A similar finding was reported 20 years later (9) with pine bark, pH not given, and additionally that the medium solution P concentration fell 10-fold in the first 3 weeks. By collecting and analyzing the leachate (drainage water) one can measure the amount of P leached from the superphosphate amended media. When this was done, the amounts found were 34% in 9 weeks, pH not reported (4), and as much as 76% in 3 weeks at pH 5.5 (8). The large differences may have been due in part to different volumes of water and frequency of leaching, but could have been caused by differences in pH. Varying soilless media components had relatively little effect on P leaching (8).

Peterson (5) made a significant contribution when he reported the effects of soilless media pH on the availability of several nutrients based on their concentration in the saturated media extract (6). The availability of P was especially affected by pH, being much more available (soluble) at low than at high pH, the opposite to soil. The most striking effect was above pH 6.0, as P was 5 times less available at 6.5 than at 6.0. When P is highly available i.e., highly soluble, it should be readily leached. At high pH, P reacts with calcium to form calcium phosphates of low solubility. If this accounts for the decreased availability of P at high pH, perhaps a calcium phosphate would act as a long lasting source of P.

The purpose of this study was to compare the leaching of P from superphosphate and the less soluble dicalcium phosphate in a soilless medium at wide differences in pH.

Materials and Methods

A container medium of sphagnum peat and concrete grade sand, 1:1 by vol, was amended with hydrated lime at rates of 0, 1.12 kg/m^3 (2 lb/yd^3) or 2.65 kg/m^3 (4.5 lb/yd^3). Media at each rate of lime was further amended with 20% superphosphate at 3 kg/m^3 (5 lb/yd^3) or dicalcium phosphate at 1.35 kg/m^3 (2.3 lb/yd^3). When medium from each treatment was placed in 2.5 L plastic containers (#1 nursery containers), each container had approximately 765 mg P. The containerized medium was saturated with deionized water, covered with plastic film to minimize evaporation and incubated at room temperature. After 4 weeks, 3 containers from each treatment were sampled and the saturated extracts (6) were tested for pH and analyzed for P (7). A duplicate set of containers was leached with 460 ml deionized water (equivalent to 1 acre-in) 7 times at weekly intervals. The leachate (drainage water) from each container

[1]Received for publication January 22, 1985; in revised form March 4, 1985.

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