# Response of Tall Fescue to Plant Growth Regulators and Mowing Frequencies[1]

B. Jack Johnson[2]
*Department of Crop & Soil Sciences, University of Georgia, Georgia Station, Griffin, GA 30223-1797*

## Abstract

Tall fescue (*Festuca arundinace* Schred.) produces rapid growth during a 6- to 8-week period in early spring. A field experiment was initiated on tall fescue to determine the number of mowings that can be eliminated by the use of plant growth regulators (PGRs) during this rapid growth period. Primo (CGA 163935) applied at 0.4 kg/ha (0.36 lb/A) mid-March suppressed vegetative growth for 3 to 5 weeks and eliminated 3 mowings during the first 5 weeks after treatment during 1990 and 1991 and eliminated 2 mowings during 1993. Primo (CGA 163935) applied at this rate did not reduce the quality and density of tall fescue below the acceptable level. Primo (CGA 163935) applied at 0.8 kg/ha (0.72 lb/A) eliminated 1 additional mowing during the 5 weeks after treatment in 2 of 3 years when compared with the 0.4 kg/ha (0.36 lb/A) rate. However, turf quality was consistently lower for 6 to 7 weeks after the tall fescue was treated with the 0.8 kg/ha (0.72 lb/A) rate. Embark (mefluidide) applied at 0.42 kg/ha (0.38 lb/A) performed similarly to Primo (CGA 163935), except the quality and density of the turf were reduced below the acceptable level at various times during the study. There was no advantage in the use of Cutless (flurprimidol) plus Embark (mefluidide) at 1.1 + 0.14 kg/ha (1.0 + 0.12 lb/A) or paclobutrazole (PP 333) plus Embark (mefluidide) at 1.1 + 0.14 kg/ha (1.0 + 0.12 lb/A) on suppressing vegetative growth of tall fescue when compared with Embark (mefluidide) at 0.42 kg/ha (0.38 lb/A) alone. Neither Limit (amidochlor) at 2.8 kg/ha (2.5 lb/A) nor paclobutrazol (PP 333) at 1.1 kg/ha (1.0 lb/A) suppressed vegetative growth as effectively as Primo (CGA 163935) or Embark (mefluidide).

**Index words:** *Festuca arundinacea*, seedhead suppression, turf quality, vegetative suppression, growth regulator.

**Plant growth regulators in this study:** Cutless (flurprimidol), α-(1-methylethyl)-α-[4-trifluoro-methoxy)phenyl]-5-primidinemethanol; Embark (mefluidide), *N*-[2,4-dimethyl-5-[[(trifluoromethyl)sulfonyl]amino]phenyl]-acetamide; Limit (amidochlor), *N*-[(acetylamino)-methyl)]-2-chloro-*N*-2,6-(diethylphenyl)acetamide; paclobutrazol (PP333), (±)-(R*R*)β-[(4-chlorophenyl)-methyl-α-(1,1-dimethylethyl)-1*H*-1,2,4-triazole-1-ethanol; Primo (CGA 163935), 4(cycloproply)-α-hydroxymethy lene)3,5-dioxocycohexanecarboxylic acid ethylester.

## Significance to the Nursery Industry

Mowing makes up a large part of the overall cost of maintaining a high quality tall fescue turf. Plant growth regulators that suppress vegetative growth and seedheads reduce the number of required mowings, thus reducing labor cost. This study demonstrates that PGRs reduce the number of mowings during a 9-week period of maximum growth of Ky-31 tall fescue.

## Introduction

Plant growth regulators have been evaluated for vegetative growth suppression and seedhead suppression on tall fescue (*Festuca arundinacea* Schred.) (9) and other cool-season grasses (1,2,3,4,9) in the northern region of the United States for several years. However, the use of PGRs is not as widespread on tall fescue in the southeastern United States (5,6,7). Plant growth regulators are used to reduce mowing on hazardous slopes, to reduce vegetative growth during rapid growth cycles, and to suppress seedhead formation.

Tall fescue treated with Cutless (flurprimidol) plus Embark (mefluidide) reduced vegetative growth and suppressed seedheads for 5 to 6 weeks in Georgia (5) and 6 to 8 weeks in North Carolina (9). Tall fescue treated with paclobutrazol (PP 333) plus Embark (mefluidide) at 1.1 + 0.14 kg/ha (1.0 + 0.125 lb/A) performed similarly to Cutless (flurprimidol) plus Embark (mefluidide) at 1.1 + 0.14 kg/ha (1.0 + 0.125 lb/A) in Georgia (5). Embark (mefluidide) at 0.43 kg/ha (0.38 lb/A) and Limit (amidochlor) at 2.8 kg/ha (2.5 lb/A) suppressed vegetative growth of tall fescue for 4 weeks (5). In a later study, Embark (mefluidide) applied at 0.28 kg/ha (0.25 lb/A) in each of two applications suppressed tall fescue growth for 6 weeks, but severely injured the turf (6). Limit (amidochlor) applied at 2.8 kg/ha (2.5 lb/A) in each of two applications generally did not improve suppression when compared with a single application (6).

Other PGRs that have been evaluated on tall fescue were paclobutrazol (PP 333) and Primo (CGA 163935) (6). Paclobutrazol (PP 333) at 1.1 kg/ha (1.0 lb/A) suppressed vegetative growth for 7 weeks. However, Primo (CGA 163935) at 0.4 kg/ha (0.32 lb/A) was not as consistent, and suppression of vegetation varied from 3 to 6 weeks.

To improve the length of the suppression period for tall fescue with PGRs alone will probably not be feasible. Multiple PGR applications will either injure the turf too severely for commercial acceptability or multiple treatments will fail to perform any better than a single application (6).

Since PGRs vary in suppressing vegetative growth of tall fescue, mowing must be included to obtain the consistency. When Embark (mefluidide) was applied to Kentucky bluegrass (*Poa pratensis* L.) in Rhode Island (4), the number of mowings was reduced by 4 or 5 during an 8-week period following treatment. In Georgia (5), tall fescue treated with Embark (mefluidide) at 0.43 kg/ha (0.38 lb/A) and mowed 3 and 6 weeks later effectively suppressed vegetative height for 8 weeks. The mowing frequency needed for other PGRs

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on tall fescue growing under stress conditions in the Southeast is not known. Therefore, an experiment was initiated to determine the influence of PGRs and frequency of mowing needed to maintain a high quality tall fescue turf.

## Materials and Methods

A PGR × mowing experiment was conducted on an established 'Ky 31' tall fescue turf at Griffin in the Piedmont region of Georgia. The PGRs were applied as single applications on March 12, 1990 and March 11, 1991 and March 22, 1993. Plant growth regulators and rates of applications were: Embark (mefluidide) at 0.42 kg/ha (0.38 lb/A), Limit (amidochlor) at 2.8 kg/ha (2.5 lb/A), Cutless (flurprimidol) plus Embark (mefluidide) at 1.1 + 0.14 kg/ha (1.0 + 0.12 lb/A), paclobutrazol (PP 333) plus Embark (mefluidide) at 1.1 + 0.14 kg/ha (1.0 + 0.12 lb/A), paclobutrazol (PP 333) at 1.1 kg/ha (1.0 lb/A), and Primo (CGA 163935) at 0.4 and 0.8 kg/ha (0.36 and 0.72 lb/A). Rates were based on active ingredients. Treatments were applied to different plots each year. All PGRs were applied as a broadcast spray in 375 L/ha (40 gal/A) of water. The soil type was a Cecil sandy clay loam (clayey, kaolinitic Thermic Typic Kanhapludult) with 2.1% organic matter, 55% sand, 18% silt, and 27% clay.

Each year, tall fescue was treated uniformly with 50N-22P-42K kg/ha (45N-20P-38K lb/A) in early September and again in mid-February. An additional 50 kg N/ha (45 lb/A) was applied in November.

Tall fescue was irrigated as needed to maintain optimum growing conditions before and after PGR treatments were applied. The turf was mowed with a rotary mower at a height of 7 cm (2.75 in), and clippings were returned prior to PGR treatments. One day before PGR treatments, the tall fescue turf was mowed and clippings were removed. The turf treated with each PGR treatment was mowed when it reached 10.5 cm (4.2 in) during 1990 and 9.3 cm (3.7 in) during 1991 and 1993. Clippings were removed at each mowing.

Ratings of tall fescue on quality and density were estimated visually, while heights were measured from soil surface to tip of leaves. Five heights were measured per each of four replicated plots. Turf quality was rated on a 1-10 scale where 1 = turf brown or dead and 10 = dark green with uniform cover. Ratings were taken beginning at 1 week after treatment (WAT) and continuing to 10 WAT. Data were analyzed as a percentage of the untreated check. Quality ratings < 70% were arbitrarily determined to be commercially unacceptable. Turf density was rated on a 1 to 10 scale where 1 = no grass and 10 = complete uniform grass cover. Density ratings were transformed to percent of the untreated check. Density ratings were taken weekly from 5 through 10 WAT. Density ratings < 90% were commercially unacceptable. Plant heights were measured twice per week (3- or 4-day interval) from 1 through 9 WAT. Vegetative growth was designated as that growth above the cutting height.

The experimental design was a randomized block with 4 replications. Plot size was 1.5 by 3 m (5 by 10 ft). An analysis of variance (ANOVA), using Statistical Analysis Systems (General Linear Model Procedure) (8), was conducted within and across years. Because of significant year-by-PGR treatment interactions, the data are reported weekly for each study. Treatments were separated by LSD at the 0.05 probability level.

## Results and Discussion

*Vegetative suppression.* Tall fescue not treated with PGRs required 8 mowings in 1990, 11 mowings in 1991, and 5 mowings in 1993 for a 9-week period beginning March 12, 1990, March 11, 1991, and March 22, 1993 (Tables 1, 2, 3). The slower growth in 1993 was probably related to temperature. The mean temperature for 1 week before treatment in 1993 was 4C (39F), compared to ≥ 8C (47F) during the same period the other years. During this period in 1993, there was a low of –9 and –8C (16 and 18F) for two consecutive days. However, frequency of mowing was less in PGR-treated plots than in untreated plots.

Embark (mefluidide) plus 1 mowing effectively suppressed vegetative height of tall fescue from 4 to 7 WAT during the 3-year period, when compared with non-treated turf (Tables 1, 2, 3). Because Embark (mefluidide) was effective in suppressing vegetative growth for only 4 to 6 weeks, the frequency of mowings needed to maintain optimum growth level increased significantly. In an earlier study

**Table 1. Effect of plant growth regulators and mowing frequency on vegetative suppression of tall fescue at Griffin, GA 1990.**

| Treatments[z] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Growth regulator | Rate kg/ha | Rate lb ai/A | Vegetative height[y] 1 wk | 2 wk | 3 wk | 4 wk | 5 wk | 6 wk | Mowings 1-6 wk | 7-9 wk |
| | | | in | | | | | | no. | |
| Untreated | — | — | 2.0[m][x] | 1.6[m] | 2.0[m] | 1.8[m] | 1.9[m] | 1.3 | 5 | 3 |
| Embark | 0.42 | 0.38 | 1.4[m] | 1.0 | 1.3 | 1.2 | 1.2 | 1.4[m] | 2 | 3 |
| Limit | 2.8 | 2.5 | 1.6[m] | 1.1 | 2.0[m] | 1.1 | 1.4[m] | 1.4[m] | 4 | 3 |
| Cutless + Embark | 1.1 + 0.14 | 1.0 + 0.12 | 1.5[m] | 0.7 | 1.0 | 1.4 | 1.1 | 0.7 | 1 | 4 |
| Paclobutrazol + Embark | 1.1 + 0.14 | 1.0 + 0.12 | 1.3 | 1.7[m] | 0.7 | 1.0 | 0.6 | 0.6 | 1 | 3 |
| Paclobutrazol | 1.1 | 1.0 | 2.1[m] | 1.7[m] | 1.5[m] | 1.7[m] | 1.6[m] | 1.3 | 5 | 3 |
| Primo | 0.4 | 0.36 | 1.5[m] | 1.0 | 1.6[m] | 0.8 | 1.0 | 1.2 | 2 | 2 |
| | 0.8 | 0.72 | 1.4[m] | 0.7 | 0.9 | 1.3 | 1.4[m] | 0.3 | 2 | 2 |
| LSD @ 0.05 | | | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.5 | — | — |

[z]Plant growth regulators were applied March 12, 1990.

[y]Plant height measurements were made at indicated weeks after PGR treatment and reported as growth above cutting height. Turfgrass was mowed at 2.8-in when the height in each plot reached 50% (4.2-in) of the original growth.

[x]Superscript m represents time of mowing. For example, turfgrass treated with Embark (mefluidide) was mowed at 1 and 6 WAT, while turfgrass treated with Cutless (flurprimidol) plus Embark (mefluidide) was mowed at 1 WAT.

Table 2. Effect of plant growth regulators and mowing frequency on vegetative suppression of tall fescue at Griffin, GA 1991.

| Treatments[z] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Growth regulator | Rate | | Vegetative height[y] | | | | | | | Mowings | |
| | kg/ha | lb ai/A | 1 wk | 2 wk | 3 wk | 3½wk | 4wk | 4½ wk | 5 | 1-5 wk | 6-9 wk |
| | | | in | | | | | | | no. | |
| Untreated | — | — | 1.6mx | 1.4m | 1.5m | 0.6 | 2.0m | 1.1m | 1.5m | 6 | 5 |
| Embark | 0.42 | 0.38 | 1.0m | 0.7 | 0.4 | 0.7 | 0.5 | 1.0m | 1.6m | 3 | 7 |
| Limit | 2.8 | 2.5 | 1.3m | 1.1m | 0.4 | 0.5 | 0.8 | 1.7m | 1.6m | 4 | 7 |
| Cutless + Embark | 1.1 + 0.14 | 1.0 + 0.12 | 1.3m | 1.1m | 0.9 | 1.2m | 0.7 | 1.7m | 1.5m | 5 | 5 |
| Paclobutrazol + Embark | 1.1 + 0.14 | 1.0 + 0.12 | 1.1m | 1.3m | 0.8 | 1.0m | 0.4 | 1.0m | 1.0m | 5 | 4 |
| Paclobutrazol | 1.1 | 1.0 | 1.0m | 1.1m | 0.8 | 1.0m | 0.4 | 1.0m | 0.6 | 4 | 5 |
| Primo | 0.4 | 0.36 | 0.8 | 1.5m | 0.5 | 0.6 | 0.9 | 1.6m | 1.5m | 3 | 6 |
| | 0.8 | 0.72 | 0.4 | 0.9m | .0 | 0.3 | 0.3 | 0.7 | 1.5m | 2 | 4 |
| LSD @ 0.05 | | | 0.5 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | — | — |

[z]Plant growth regulators were applied March 11, 1991.

[y]Plant height measurements were made at indicated weeks after PGR treatment and reported as growth above cutting height. Turfgrass was mowed at 2.8-in when the height in each plot reached 33% (3.7-in) of the original growth.

[x]Superscript m represents time of mowing. For example, turfgrass treated with Embark (mefluidide) was mowed at 1, 4½, and 5 WAT, while turfgrass with Cutless (flurprimidol) plus Embark (mefluidide) was mowed at 1, 2, 3½, 4½, and 5 WAT.

Table 3. Effect of plant growth regulators and mowing frequency on vegetative suppression of tall fescue at Griffin, GA 1993.

| Treatments[z] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Growth regulator | Rate | | Vegetative height[y] | | | | Mowings | |
| | kg/ha | lb ai/A | 3 wk | 5 wk | 6 wk | 7 wk | 1-7 wk | 8-9 wk |
| | | | in | | | | no. | |
| Untreated | — | — | 1.9mx | 1.5m | 0.9m | 0.8 | 3 | 2 |
| Embark | 0.42 | 0.38 | 0.2 | –0.4 | 0.1 | 1.5m | 1 | 3 |
| Limit | 2.8 | 2.5 | 0.2 | 0.4 | 1.4m | 1.6m | 2 | 3 |
| Cutless + Embark | 1.1 + 0.14 | 1.0 + 0.12 | 0.5 | –0.4 | 0.8 | 0.9m | 1 | 3 |
| Paclobutrazol + Embark | 1.1 + 0.14 | 1.0 + 0.12 | 0.5 | –0.6 | 0.7 | 1.5m | 1 | 3 |
| Paclobutrazol | 1.1 | 1.0 | 1.6m | 1.5m | 0.8m | 0.6 | 3 | 2 |
| Primo | 0.4 | 0.36 | 0.7 | –0.1 | 0.7m | 0.9m | 2 | 2 |
| | 0.8 | 0.72 | 0.5 | –0.4 | 0.2 | 0.4m | 1 | 3 |
| LSD @ 0.05 | | | 0.7 | 0.4 | 0.6 | 0.5 | | |

[z]Plant growth regulators were applied March 22, 1993.

[y]Plant height measurements were made at indicated weeks after PGR treatment and reported as growth above cutting height. Turfgrass was mowed at 2.8-in when the height in each plot reached 33% (3.7-in) of the original growth.

[x]Superscript m represents time of mowing. For example, turfgrass treated with either Embark (melfuidide) or Cutless (flurprimidol) plus Embark (mefluidide) was mowed at 7 WAT.

(5), Embark (mefluidide) plus 1 mowing at 3 WAT suppressed vegetative height of tall fescue for 4 weeks. However, in the present study, the timing of the first mowing was not the same each year. The first mowing was needed at 1 WAT in 1990 and 1991, but mowing was not needed until 7 WAT in 1993. The longer suppression period in 1993 from Embark (mefluidide) was related to slower turf growth in all treated and non-treated plots. This is shown by only 3 mowings needed by 6 weeks in non-treated plots during 1993, compared with 5 to 6 mowings needed in non-treated plots during the same period in 1990 and 1991.

Tall fescue treated with Primo (CGA 163935) suppressed vegetative height for 5 to 7 WAT with 1 to 3 timely mowings (Tables 1, 2, 3). During 1990, there was no difference in number of mowings whether Primo (CGA 163935) was applied at 0.4 kg/ha (0.36 lb/A) or 0.8 kg/ha (0.72 lb/A). However, the 0.8 kg/ha (0.72 lb/A) rate required 1 less mowing during the first 5 WAT in 1991 and during the first 7 WAT during 1993. The performance of Primo (CGA 163935) at 0.4 kg/ha (0.36 lb/A) was similar to Embark (mefluidide) applied at 0.42 kg/ha (0.38 lb/A) throughout the 9-week period following treatments, except that turf treated with Primo (CGA 163935) required 1 less mowing than Embark (mefluidide) during 1990 and 1991.

There was no advantage in use of tank-mixed Embark (mefluidide) (0.14 kg/ha; 0.12 lb/A) with Cutless (flurprimidol) (1.1 kg/ha; 1.0 lb/A), or with paclobutrazol (PP 333) (1.1 kg/ha; 1.0 lb/A) in suppressing tall fescue growth, when compared with Embark (mefluidide) (0.42 kg/ha; 0.38 lb/A), or Primo (CGA 163935) (0.4 kg/ha; 0.36 lb/A) applied alone (Tables 1, 2, 3).

Limit (amidochlor) (2.8 kg/ha; 2.5 lb/A) or paclobutrazol (PP 333) (1.1 kg/ha; 1.0 lb/A) applied alone suppressed tall fescue turf very little during 9 WAT each year (Tables 1, 2, 3). In most instances, the number of mowings during this period was similar to that needed in non-treated turf plots. In an earlier study, Limit (amidochlor) (2.8 kg/ha; 2.5 lb/A) suppressed tall fescue (≤ 35%) for 4 WAT, while paclobutrazol (PP 333) (1.1 kg/ha; 1.0 lb/A) suppressed tall fescue turf (≤ 22%) up to 7 WAT (6).

**Table 4. Effect of plant growth regulators and mowing frequency on quality of tall fescue at Griffin, GA.**

| Treatments[z] | | | Turfgrass quality[y] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Growth regulator | Rate | | 1990 | | | 1991 | | | 1993 | | |
| | kg/ha | lb ai/A | 3 wk | 5 wk | 7 wk | 3 wk | 5wk | 6 wk | 3 wk | 5 wk | 7 wk |
| | | | % untreated check | | | | | | | | |
| Untreated | — | — | 100$^{3x}$ | 100$^{5}$ | 100$^{6}$ | 100$^{3}$ | 100$^{6}$ | 100$^{7}$ | 100 | 100$^{1}$ | 100$^{3}$ |
| Embark | 0.42 | 0.38 | 84$^{1}$ | 62$^{1}$ | 85$^{3}$ | 77$^{1}$ | 86$^{3}$ | 81$^{5}$ | 77 | 78 | 69 |
| Limit | 2.8 | 2.5 | 94$^{2}$ | 90$^{3}$ | 96$^{5}$ | 87$^{2}$ | 92$^{4}$ | 91$^{6}$ | 84 | 91 | 92$^{1}$ |
| Cutless + Embark | 1.1 + 0.14 | 1.0 + 0.12 | 85$^{1}$ | 63$^{1}$ | 78$^{2}$ | 90$^{2}$ | 99$^{5}$ | 92$^{6}$ | 79 | 80 | 88 |
| Paclobutrazol + Embark | 1.1 + 0.14 | 1.0 + 0.12 | 84$^{1}$ | 67$^{1}$ | 65$^{2}$ | 87$^{2}$ | 93$^{5}$ | 89$^{5}$ | 81 | 81 | 78 |
| Paclobutrazol | 1.1 | 1.0 | 95$^{3}$ | 97$^{5}$ | 96$^{6}$ | 91$^{2}$ | 97$^{4}$ | 70$^{5}$ | 99 | 96 | 94$^{3}$ |
| Primo | 0.4 | 0.36 | 92$^{2}$ | 86$^{2}$ | 100$^{3}$ | 90$^{1}$ | 101$^{3}$ | 97$^{4}$ | 88 | 92 | 96$^{1}$ |
| | 0.8 | 0.72 | 92$^{1}$ | 76$^{2}$ | 78$^{3}$ | 83$^{1}$ | 81$^{2}$ | 86$^{3}$ | 83 | 89 | 78 |
| LSD @ 0.05 | | | 7 | 12 | 14 | 9 | 7 | 10 | 5 | 4 | 14 |

[z]Plant growth regulators were applied March 12, 1990, March 11, 1991, and March 22, 1993.

[y]Turf quality ratings were made as indicated weeks after PGR treatment and based on percentage of untreated check. Ratings < 70% would not be acceptable.

[x]Superscript number indicates the total number of mowings when quality ratings were made.

**Table 5. Effect of plant growth regulators and mowing frequency on density of tall fescue at Griffin, GA.**

| Treatments[z] | | | Turfgrass density[y] | | | | | |
|---|---|---|---|---|---|---|---|---|
| Growth regulator | Rate | | 1990 | | 1991 | | 1993 | |
| | kg/ha | lb ai/A | 7 wk | 9 wk | 5 wk | 7wk | 7 wk | 9 wk |
| | | | % untreated check | | | | | |
| Untreated | — | — | 100$^{6x}$ | 100$^{8}$ | 100$^{6}$ | 100$^{8}$ | 100$^{3}$ | 100$^{4}$ |
| Embark | 0.42 | 0.38 | 83$^{3}$ | 83$^{5}$ | 86$^{3}$ | 92$^{7}$ | 63 | 83$^{2}$ |
| Limit | 2.8 | 2.5 | 87$^{5}$ | 90$^{7}$ | 91$^{4}$ | 96$^{8}$ | 83$^{1}$ | 96$^{3}$ |
| Cutless + Embark | 1.1 + 0.14 | 1.0 + 0.12 | 82$^{5}$ | 89$^{5}$ | 94$^{5}$ | 99$^{7}$ | 86 | 98$^{2}$ |
| Paclobutrazol + Embark | 1.1 + 0.14 | 1.0 + 0.12 | 89$^{2}$ | 86$^{4}$ | 93$^{5}$ | 100$^{7}$ | 74 | 97$^{2}$ |
| Paclobutrazol | 1.1 | 1.0 | 97$^{6}$ | 98$^{8}$ | 97$^{4}$ | 100$^{6}$ | 99$^{3}$ | 100$^{4}$ |
| Primo | 0.4 | 0.36 | 91$^{3}$ | 101$^{4}$ | 96$^{3}$ | 101$^{6}$ | 94$^{1}$ | 100$^{3}$ |
| | 0.8 | 0.72 | 90$^{3}$ | 87$^{4}$ | 79$^{2}$ | 94$^{4}$ | 68 | 95$^{3}$ |
| LSD @ 0.05 | | | 10 | 12 | 8 | 5 | 13 | 6 |

[z]Plant growth regulators were applied March 12, 1990, March 11, 1991, and March 22, 1993.

[y]Turf density ratings were made as indicated weeks after PGR treatment and based on percentage of untreated check. Ratings < 90% would not be acceptable.

[x]Superscript number indicates the total number of mowings when density ratings were made.

*Turf quality.* Maintenance of acceptable turf quality when using PGRs is important in the overall management program. In the present study, the quality of tall fescue was reduced with all PGRs at times during the study (Table 4). Although turf quality was significantly lower than untreated turf in several instances, Embark (mefluidide), Cutless (flurprimidol) plus Embark (mefluidide), and paclobutrazol (PP 333) plus Embark (mefluidide) were the only PGRs that reduced turf quality below acceptable level (< 70% of untreated check). Primo (CGA 163935) applied at 0.4 kg/ha (0.36 lb/A) maintained a tall fescue quality at ≥ 86% of the untreated check during the 3-year period (Table 4). In all instances, the quality of turf treated with Primo (CGA 163935) at 0.4 kg/ha (0.36 lb/A) was higher than turf treated with Embark (mefluidide).

Turf density. Paclobutrazol (PP 333) applied at 1.1 kg/ha (1.0 lb/A) and Primo (CGA 163935) applied at 0.4 kg/ha (1.0 lb/A) were the only PGRs that did not reduce the density of tall fescue below the acceptable level (< 90% of untreated turf) (Table 5). When Primo (CGA 163935) was increased to 0.8 kg/ha (0.72 lb/A), the density of turf was lower than turf treated with 0.4 kg/ha (0.36 lb/A). The difference in density from Primo (CGA 163935) treatment rates occurred for 7 WAT each year. By 9 WAT, there was no difference in density between Primo (CGA 163935) treatments in 1991 (data not given) and 1993 (Table 5).

The lowest density for tall fescue turf treated with Embark (mefluidide) at 0.42 kg/ha (0.38 lb/A) was 83% in 1990, 86% in 1991, and 63% in 1993 (Table 5). The turf treated with Embark (mefluidide) recovered fully by 9 WAT in 1991 (data not given), but not during 1990 or 1993. Limit (amidochlor) applied at 2.8 kg/ha (2.5 lb/A) did not reduce density of bermudagrass as severely as Embark (mefluidide). In all instances, turf treated with Limit (amidochlor) fully recovered by 7 to 9 WAT.

Embark (mefluidide) applied at 0.42 kg/ha (0.38 lb/A) and Primo (CGA 163935) applied at 0.4 kg/ha (0.36 lb/A) provided the most consistent suppression of vegetative growth of tall fescue and reduced required mowings throughout the 3-year period. Embark (mefluidide) eliminated 2 to 4 mowings and Primo (CGA 163935) eliminated 2 to 3 mowings within 5 WAT. Primo (CGA 163935) at 0.4 kg/ha (0.36 lb/A) was safe to apply to a high quality tall fescue turf, while Embark (mefluidide) at 0.42 kg/ha (0.38 lb/A) reduced turf quality and stand density to an unacceptable level at various times within 9 WAT. Therefore, Primo (CGA 163935) would be a good PGR to use for vegetative growth suppression of tall fescue. It should be emphasized that if tall fescue is not to be mowed in a rough turf, Embark (mefluidide) will suppress seedheads for a longer period of time than Primo (CGA 163935) (5,6).

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# Suitability of Juniper Cultivars for Survival and Growth of the Bagworm[1]


**Monte P. Johnson, Daniel A. Potter and Geoffrey S. Gilmore[2]**

*Department of Entomology, University of Kentucky, Lexington, KY 40546-0091*



## Abstract

Relative suitability of 23 cultivars of juniper (*Juniperus* spp.) for growth and survival of the bagworm, *Thyridopteryx ephemeraeformis* (Haworth) was evaluated in laboratory and field experiments. Weight gain, developmental rate, and survival of bagworms differed significantly among groups of larvae fed foliage from different cultivars. By these criteria, cultivars 'Expansa' and 'Hibernica' were most unsuitable for survival and development of bagworms, whereas 'Broadmoor' and 'Emerald Isle' were consistently among the most suitable cultivars. This study suggests that use of certain juniper cultivars may be useful in managing this perennial insect pest in urban landscapes.

**Index words:** *Thyridopteryx ephemeraeformis, Juniperus*, host plant resistance.


### Significance to the Nursery Industry

Breeding programs for woody landscape plants have historically placed greater emphasis on desirable aesthetic characteristics than resistance to insect pests. Evaluations for cultivar resistance have been made for relatively few plant or pest species. This study suggests that cultivars of juniper differ in their suitability as hosts for the bagworm, a common pest of evergreen landscape plants. Use of relatively less suitable cultivars could help to reduce the need for insecticide use on junipers in nursery and landscape settings.


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[2]Extension Specialist, Professor, and former graduate student, respectively. This research was supported in part by the nursery industry through contributions to the Horticultural Research Institute, a non-profit organization devoted to nursery industry progress through research. J.R. Hartman, Dept. of Plant Pathology, R.E. McNiel and W.M. Fountain, Dept. of Horticulture (University of Kentucky), provided valuable help with this project. We thank Greenleaf Nursery, Park Hill, OK; Hillenmeyer Nurseries, Lexington, KY; Frank Otte Nursery, Anchorage, KY; and Wight Nurseries, Cairo, GA for donating plants. ICI Americas, Rohm and Haas Co., and DowElanco donated herbicides for maintenance of field plots. We extend special thanks to R.T. Bessin, Dept. of Entomology, University of KY, for statistical advice, and P.G. Spicer, J. Doney, D. Slone and L. Terry for technical help. This is paper no. 93-7-72 of the Kentucky Agricultural Experiment Station.


### Introduction

The bagworm, *Thyridopteryx ephemeraeformis* (Haworth) (Lepidoptera: Psychidae), is a common pest of landscape and nursery plants east of the Rocky Mountains. The bagworm feeds upon at least 120 plant species, but is particularly damaging to juniper (*Juniperus* spp.), arborvitae (*Thuja occidentalis* L.) and blue spruce (*Picea pungens* Engelm.). Outbreaks are frequent but can be locally severe, with total defoliation and death of trees (1).

Few studies have investigated possible sources of host plant resistance to bagworms. Sheppard (6), who measured larval development on spruce, pine, maple and oak foliage, concluded that bagworms generally grew faster, weighed more, and had higher survival on the coniferous than on the deciduous hosts. Neal and Santamour (2) found that arborvitae and black locust (*Robinia pseudoacacia* L.) were more favorable for development of bagworms than were eastern white pine *(Pinus strobus* L.), honeylocust (*Gleditsia triacanthos* L.), and sycamore (*Plantanus occidentalis* L.).

There has, however, been almost no research to determine if particular cultivars of woody landscape plants vary in resistance to bagworms. The objective of our study was to compare the development and survival of bagworms on foliage of 23 commonly used juniper cultivars. Identification of cultivars that are relatively less susceptible to bagworms