

Annual bluegrass seedhead suppression in two contrasting golf turf areas as affected by Proxy, a Proxy + Primo Maxx tank-mix and Embark Lite applications, 2006: Purdue University
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Objective:

To evaluate the effects of three plant growth regulators (PGRs): Proxy (ethephon), a Proxy+Primo Maxx (trinexapac-ethyl) tank mix and Embark Lite (mefluidide) when applied at various application rates and timings for the suppression of annual bluegrass seedheads in a mixed annual bluegrass/creeping bentgrass research fairway and golf green.

Experimental Procedures:

This field study was conducted at the W. H. Daniel Turfgrass Research and Diagnostic Center at Purdue University, West Lafayette, IN and the Lafayette Municipal Golf Course (putting green #6), Lafayette, IN from November, 2005 through May, 2006. Both study areas consisted of mature, mixed swards of creeping bentgrass (*Agrostis stolonifera* 'Penncross') and annual bluegrass (*Poa annua*). The annual bluegrass populations that were present were deemed to be primarily the true annual biotype, based on their appearance and growth habit. The turf on the research fairway was grown on a Starks-Fincastle silt-loam (fine-silty, mixed, mesic Aeric Ochraqualf) with pH of 7.2 and the turf at the Municipal golf green was grown on a 30 year-old, native soil push-up putting green that had been regular topdressed with sand that had modified the upper soil profile. Both sites were located in full sun and maintained according to typical maintenance practices to produce moderate quality golf course turf. The research fairway was maintained throughout the growing season at 0.5 inches three times per week with clippings returned. The putting green was mowed daily (0.140 inches) during active growth with clipping removed. Both areas were irrigated to promote growth and received approximately 3.0 lbs N/1000 ft² annually.

All treatments were applied with a pressurized CO₂ (35 psi) sprayer equipped with TeeJet XR 8003 tips calibrated to deliver 1.0 gallon of spray volume per 1000 ft². Treatments were initiated on 30 November, 2005 at both sites and subsequent applications applied on 4/5 April and 26 April, 2006 as dictated by the research protocol. All product rates, and application dates are listed or footnoted in each of the data tables. Plots were 5 x 5 ft, separated by a 6 inch border and arranged in a randomized complete block with three replications of each treatment.

Plots were regularly assessed throughout the study using visual methods for appearance/quality, chemical phytotoxicity, color, percentage annual bluegrass, and percentage annual bluegrass with seedheads. Quality, chemical phytotoxicity and color were assessed on a 1-9 scale with 1=brown turf and 9=highest quality turf, no chemical damage or dark green turf. The amount of annual bluegrass and seedheads present were assessed on a linear 0-100 % scale where 0=no annual bluegrass or seedheads evident and 100 % is total plot coverage. The amount of annual bluegrass in each plot was assessed on two dates and the populations reported in the data tables are the means of the two observations. The amount of annual bluegrass ranged from approximately 20-28 % and 18-22 % annual bluegrass in the research fairway and Municipal golf green, respectively.

All data was subjected to analysis of variance using the SAS system (Statistical Analysis Systems Institute Inc., Cary, N.C.) and mean separation performed using Fisher's protected least significant difference test at the (P<0.05) level.

Results:

Seedhead suppression:

Annual bluegrass (Poa) seedhead suppression due to PGR applications was variable throughout the study and strongly affected both by seasonal rating date, and PGR treatment at both test locations (Tables 1-4). For the fairway height bentgrass (Tables 1 and 2), peak seedheads (>75% of the Poa) in the untreated control plots occurred on 18 April. Among the PGR treatments, two treatments, Proxy + Primo Maxx (three applications) and Embark Lite had two dates where the percentage of Poa displaying seedheads was significantly less than the untreated control. These effects were observed on 11, 18 April and 18, 25 April for Proxy + Primo Maxx and Embark Lite treatments respectively. On 16 May all PGR treatments except for the single fall Proxy application had significantly less (< 43%) Poa displaying seedheads than the untreated control.

For the putting green location, peak (> 94% Poa) seedheads in the untreated control was observed on 11 April (Table 3). This was approximately one week prior to the fairway location and is attributed to the closer mowing height and potential for greater soil warming. There were fewer significant differences for PGRs compared to the untreated control in this location (Tables 3 and 4). Again, however, the two treatments that significantly reduced seedheads relative to the untreated plots were Proxy + Primo Maxx (3 applications) and Embark Lite on the 11 and 18 April dates, respectively. The Embark Lite and Proxy fall only treatments were also significantly lower than the untreated plots on 4 April (Table 3). On this date, however, the Embark Lite had yet to be applied and the effect due to Embark Lite is unlikely and is attributed to natural Poa variations in the study area.

Appearance/Turfgrass Quality:

Turfgrass quality was not strongly affected on a consistent basis at either site due to PGR applications (Tables 5 and 6). On the research fairway location two treatments, Proxy + Primo Maxx (three applications) and Embark Lite, had superior overall quality compared to the untreated control (Table 5). The Proxy + Primo Maxx tank-mix (three applications) resulted in superior quality on three of the seven rating dates, whereas Embark Lite was superior on five of seven rating dates. Additionally the Proxy alone applied twice in the spring or three times fall, plus two spring applications was superior on two of the seven rating dates. At the putting green location, no PGR application resulted in significantly better turfgrass quality than the untreated on any rating date (Table 6).

Chemical phytotoxicity and bentgrass color:

For chemical phytotoxicity there was no significant difference for any PGR treatment compared to the untreated turf (Tables 7 and 8) and where differences in numerical values reported (e.g. Table 8, 18 April) the values were still within acceptable limits (value > 7). For bentgrass color, differences were only observed in the fairway study (Table 7). On 18 April, the only treatment that was significantly different than the untreated turf (7.8) was Proxy applied three times which produced a significantly lower color rating (7.3). This slightly lower value, however, is probably not agronomically important since the rating values are still > 7. On the 16 May rating date, two PGR treatments, Proxy (fall only) and Embark Lite, produced significantly higher color ratings (8.0) relative to all other treatments (7.0). Additionally, no scalping was observed at either site during the course of these studies (data not presented).

Acknowledgements

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Table 1. Percentage annual bluegrass (*Poa annua* L.) displaying seedheads in a mixed mature stand of creeping bentgrass ‘Penncross’/annual bluegrass research fairway as affected by various applications of Proxy, Primo Maxx and Embark Lite, Purdue University, 2006.

Treatment [†]	Application Timing	Application Rate	Percentage <i>Poa annua</i> or <i>Poa annua</i> seedheads [‡]							
			Avg. <i>Pod</i> [§]	4 Apr.	11 Apr.	18 Apr.	25 Apr.	9 May	16 May	23 May
		--/1000 ft ² --	----- Visual percentage (%)-----							
Proxy	Fall	5.0 oz	23.0	7.2 ab*	5.8 bc	48.9 ab	71.9 a	34.2 ab	43.6 a	13.0 ab
Proxy	Spring + 3 wk	5.0 oz	28.5	6.7 ab	15.2 a	73.4 a	57.6 a	26.1 ab	17.8 d	7.6 ab
Proxy	Fall + Spring + 3 wk	5.0 oz	23.5	5.7 b	10.3 ab	50.6 ab	66.9 a	19.2 ab	20.2 cd	8.9 ab
Proxy + Primo Maxx	Spring + 3 wk	5.0 + 0.125 oz	23.3	11.1 a	3.6 bc	43.8 ab	79.5 a	48.3 a	33.5 b	9.5 ab
Proxy + Primo Maxx	Fall + Spring + 3 wk	5.0 + 0.125 oz	20.5	5.1 b	0.8 c	31.8 b	63.0 a	38.5 ab	32.6 b	2.4 b
Embark Lite	Spring only	40 oz/Acre	20.8	6.4 ab	2.4 bc	24.0 b	29.2 b	10.2 b	27.8 bc	18.5 a
Untreated	---	---	24.2	8.1 ab	9.8 ab	75.5 a	60.1 a	33.7 ab	47.1 a	10.8 ab

[†] Percentage plot covered with annual bluegrass seedheads was visually assessed on a 0-100% scale where 0 = no seedheads present and 100 = entire plot covered.

[‡] Treatments were initially applied on 30 Nov., 2005 and sequential applications were applied on 4 and 26 April, 2006 as specified by the research protocol.

[§] Percentage annual bluegrass populations are the mean of two visual rating dates.

*Means in the same column followed by the same letter are not significantly different according to Fisher’s protected LSD (P=0.05).

Table 2. Percentage annual bluegrass (*Poa annua* L.) seedhead reduction in a mixed mature stand of creeping bentgrass ‘Penncross’/annual bluegrass research fairway as affected by various applications of Proxy, Primo Maxx and Embark Lite, Purdue University, 2006.

Treatment [‡]	Application Timing	Application Rate	Avg. <i>Poa</i> [§]	Percentage <i>Poa annua</i> or <i>Poa annua</i> seedhead reduction [†]						
				4 Apr.	11 Apr.	18 Apr.	25 Apr.	9 May	16 May	23 May
		--/1000 ft ² --		----- Visual percentage (%)-----						
Proxy	Fall	5.0 oz	23.0	92.8 ab*	94.2 ab	51.1 ab	28.1 b	65.8 ab	56.3 d	86.9 ab
Proxy	Spring + 3 wk	5.0 oz	28.5	93.3 ab	84.8 c	26.6 b	42.3 b	73.9 ab	82.2 a	92.4 ab
Proxy	Fall + Spring + 3 wk	5.0 oz	23.5	94.3 a	89.7 bc	49.4 ab	33.1 b	80.8 ab	79.8 ab	91.1 ab
Proxy + Primo Maxx	Spring + 3 wk	5.0 + 0.125 oz	23.3	88.9 b	96.4 ab	56.2 ab	20.5 b	51.7 b	66.5 c	90.5 ab
Proxy + Primo Maxx	Fall + Spring + 3 wk	5.0 + 0.125 oz	20.5	95.0 a	99.2 a	68.2 a	37.0 b	61.5 ab	67.4 c	97.6 a
Embark Lite	Spring only	40 oz/Acre	20.8	93.6 ab	97.6 ab	76.0 a	70.8 a	89.8 a	72.2 bc	81.5 b
Untreated	---	---	24.2	91.8 ab	90.2 bc	24.5 b	39.9 b	66.3 ab	52.9 d	89.2 ab

[†] Percentage plot covered with annual bluegrass seedheads was visually assessed on a 0-100% scale where 0 = no seedheads present and 100 = entire plot covered.

[‡] Treatments were initially applied on 30 Nov., 2005 and sequential applications were applied on 4 and 26 April, 2006 as specified by the research protocol.

[§] Percentage annual bluegrass populations are the mean of two visual rating dates.

*Means in the same column followed by the same letter are not significantly different according to Fisher’s protected LSD (P=0.05).

Table 3. Percentage annual bluegrass (*Poa annua* L.) displaying seedheads in a mixed mature stand of creeping bentgrass ‘Penncross’/annual bluegrass golf course putting green (Lafayette Municipal Golf Course) as affected by various applications of Proxy, Primo Maxx and Embark Lite, Purdue University, 2006.

Treatment [‡]	Application Timing	Application Rate	Avg. <i>Pod</i> [§]	Percentage <i>Poa annua</i> or <i>Poa annua</i> seedheads [†]						
				4 Apr.	11 Apr.	18 Apr.	25 Apr.	9 May	16 May	23 May
		--/1000 ft ² --		----- Visual percentage (%)-----						
Proxy	Fall	5.0 oz	22.5	56.3 a*	91.9 a	53.6 a	52.2 ab	72.3 a	13.6 ab	2.9 a
Proxy	Spring + 3 wk	5.0 oz	18.3	38.3 ab	91.7 a	45.6 a	26.1 ab	25.0 b	8.9 b	1.2 a
Proxy	Fall + Spring + 3 wk	5.0 oz	20.3	28.6 ab	78.9 ab	41.0 a	69.6 a	57.3 ab	21.3 a	1.5 a
Proxy + Primo Maxx	Spring + 3 wk	5.0 + 0.125 oz	19.5	51.4 ab	90.9 a	50.7 a	37.2 a	59.0 ab	13.0 ab	1.1 a
Proxy + Primo Maxx	Fall + Spring + 3 wk	5.0 + 0.125 oz	22.5	30.7 ab	71.0 b	29.5 ab	18.1 b	34.4 ab	8.8 b	2.4 a
Embark Lite	Spring only	40 oz/Acre	20.2	15.4 b	81.9 ab	11.8 b	48.5 ab	42.7 ab	9.7 b	0.5 a
Untreated	---	---	19.5	60.4 a	99.2 a	44.4 a	32.8 ab	57.8 ab	11.9 b	2.8 a

[†] Percentage plot covered with annual bluegrass seedheads was visually assessed on a 0-100% scale where 0 = no seedheads present and 100 = entire plot covered.

[‡] Treatments were initially applied on 30 Nov., 2005 and sequential applications were applied on 5 and 26 April, 2006 as specified by the research protocol.

[§] Percentage annual bluegrass populations are the mean of two visual rating dates.

*Means in the same column followed by the same letter are not significantly different according to Fisher’s protected LSD (P=0.05).

Table 4. Percentage annual bluegrass (*Poa annua* L.) seedhead reduction in a mixed mature stand of creeping bentgrass ‘Penncross’/annual bluegrass golf course putting green (Lafayette Municipal Golf Course) as affected by various applications of Proxy, Primo Maxx and Embark Lite, Purdue University, 2006.

Treatment [‡]	Application Timing	Application Rate	Avg. <i>Poa</i> [§]	Percentage <i>Poa annua</i> or <i>Poa annua</i> seedhead reduction [†]						
				4 Apr.	11 Apr.	18 Apr.	25 Apr.	9 May	16 May	23 May
		--/1000 ft ² --		----- Visual percentage (%)-----						
Proxy	Fall	5.0 oz	22.5	43.7 b*	8.1 b	46.4 b	47.8 ab	27.7 b	86.4 ab	97.1 a
Proxy	Spring + 3 wk	5.0 oz	18.3	61.7 ab	8.3 b	54.4 b	73.9 ab	75.0 a	91.1 a	98.8 a
Proxy	Fall + Spring + 3 wk	5.0 oz	20.3	71.4 ab	21.1 ab	59.0 b	30.4 b	42.7 ab	78.7 b	98.5 a
Proxy + Primo Maxx	Spring + 3 wk	5.0 + 0.125 oz	19.5	48.6 ab	9.1 b	49.4 b	62.8 ab	41.0 ab	87.1 ab	98.9 a
Proxy + Primo Maxx	Fall + Spring + 3 wk	5.0 + 0.125 oz	22.5	69.3 ab	29.0 a	70.5 ab	81.9 a	65.6 ab	91.2 a	97.6 a
Embark Lite	Spring only	40 oz/Acre	20.2	84.6 a	18.1 ab	88.2 a	51.5 ab	57.3 ab	90.3 a	99.5 a
Untreated	---	---	19.5	39.6 b	7.8 b	55.6 b	67.3 ab	42.3 ab	88.1 a	97.2 a

[†] Percentage plot covered with annual bluegrass seedheads was visually assessed on a 0-100% scale where 0 = no seedheads present and 100 = entire plot covered.

[‡] Treatments were initially applied on 30 Nov., 2005 and sequential applications were applied on 5 and 26 April, 2006 as specified by the research protocol.

[§] Percentage annual bluegrass populations are the mean of two visual rating dates.

*Means in the same column followed by the same letter are not significantly different according to Fisher’s protected LSD (P=0.05).

Table 5. Visual turfgrass quality of a mixed creeping bentgrass ‘Penncross’/annual bluegrass research fairway as affected by various applications of Proxy, Primo Maxx and Embark Lite, Purdue University 2006.

Treatment [‡]	Application Timing	Application Rate	Turfgrass quality [†]							Mean
			4 Apr.	11 Apr.	18 Apr.	25 Apr.	9 May	16 May	23 May	
		--/1000 ft ² --	----- (1-9 scale) -----							
Proxy	Fall	5.0 oz	8.0 a*	6.0 bc	5.8 bc	4.3 bc	5.0 c	5.3 cd	7.3 ab	6.1 b
Proxy	Spring + 3wk	5.0 oz	8.0 a	5.3 c	5.3 c	4.0 c	5.7 b	6.0 ab	7.2 ab	6.0 b
Proxy	Fall + Spring + 3 wk	5.0 oz	8.0 a	5.7 bc	5.8 bc	4.0 c	6.0 a	6.3 a	7.5 ab	6.2 b
Proxy + Primo Maxx	Spring + 3 wk	5.0 + 0.125 oz	8.0 a	6.3 abc	5.7 c	4.0 c	5.0 c	5.8 abc	7.3 ab	6.2 b
Proxy + Primo Maxx	Fall + Spring + 3 wk	5.0 + 0.125 oz	8.0 a	7.3 a	6.5 ab	4.7 b	5.0 c	5.7 bcd	7.8 a	6.7 a
Embark Lite	Spring	40 oz/Acre	8.0 a	6.7 ab	6.7 a	6.0 a	6.2 a	6.3 a	7.0 b	6.8 a
Untreated	---	---	8.0 a	5.3 c	5.5 c	4.0 c	5.0 c	5.2 d	7.3 ab	5.9 b

[†] Turfgrass quality was visually assessed on a 1-9 scale, where 9 = optimum color, density and uniformity.

[‡] Treatments were initially applied on 30 November, 2005, 4 and 26 April, 2006 as specified by the protocol.

* Means in the same column followed by the same letter are not significantly different according to Fisher’s protected LSD (P=0.05).

Table 6. Visual turfgrass quality of a mixed stand of creeping bentgrass ‘Penncross’/annual bluegrass golf course putting green as affected by various applications of Proxy, Primo Maxx and Embark Lite, Purdue University 2006.

Treatment [‡]	Application Timing	Application Rate	Turfgrass quality [†]						
			5 Apr.	18 Apr.	25 Apr.	6 May	17 May	23 May	Mean
		--/1000 ft ² --	----- (1-9 scale) -----						
Proxy	Fall	5.0 oz	7.7 a*	6.0 a	5.0 a	5.5 ab	6.8 a	6.8 a	6.2 a
Proxy	Spring + 3wk	5.0 oz	8.0 a	5.8 a	5.7 a	6.2 a	6.8 a	6.8 a	6.4 a
Proxy	Fall + Spring + 3 wk	5.0 oz	7.7 a	6.0 a	5.5 a	5.5 a	6.5 a	6.5 a	6.1 a
Proxy + Primo Maxx	Spring + 3 wk	5.0 + 0.125 oz	8.0 a	6.2 a	5.5 a	5.7 b	6.7 a	6.8 a	6.4 a
Proxy + Primo Maxx	Fall + Spring + 3 wk	5.0 + 0.125 oz	7.3 a	6.3 a	5.7 a	5.8 ab	6.7 a	6.8 a	6.3 a
Embark Lite	Spring	40 oz/Acre	7.7 a	6.0 a	6.3 a	5.8 ab	6.8 a	6.8 a	6.5 a
Untreated	---	---	7.7 a	5.7 a	5.3 a	5.8 ab	6.5 a	6.8 a	6.3 a

[†] Turfgrass quality was visually assessed on a 1-9 scale, where 9 = optimum color, density and uniformity.

[‡] Treatments were initially applied on 30 November, 2005, 4 and 26 April, 2006 as specified by the protocol.

* Means in the same column followed by the same letter are not significantly different according to Fisher’s protected LSD (P=0.05).

Table 7. Chemical phytotoxicity and creeping bentgrass color as affected by various applications of Proxy, Primo Maxx and Embark_Lite in a mixed creeping bentgrass ‘Penncross’/annual bluegrass research fairway, Purdue University 2006.

Treatment [‡]	Application Timing	Application Rate	Visual ratings [†]					
			Phytotoxicity		Creeping bentgrass color			
			11 Apr.	9 May	4 Apr.	18 Apr.	16 May	23 May
		--/1000 ft ² --	----- (1-9 scale) -----					
Proxy	Fall	5.0 oz	9.0 a*	9.0 a	8.0 a	8.0 a	8.0 a	7.0 a
Proxy	Spring + 3wk	5.0 oz	9.0 a	9.0 a	8.0 a	7.8 ab	7.0 b	7.0 a
Proxy	Fall + Spring + 3 wk	5.0 oz	9.0 a	9.0 a	8.0 a	7.3 c	7.0 b	7.2 a
Proxy + Primo Maxx	Spring + 3 wk	5.0 + 0.125 oz	9.0 a	9.0 a	8.0 a	7.5 bc	7.0 b	7.2 a
Proxy + Primo Maxx	Fall + Spring + 3 wk	5.0 + 0.125 oz	9.0 a	9.0 a	8.0 a	7.7 abc	7.0 b	7.2 a
Embark Lite	Spring	40 oz/Acre	9.0 a	9.0 a	8.0 a	8.0 a	8.0 a	7.0 a
Untreated	---	---	9.0 a	9.0 a	8.0 a	7.8 ab	7.3 b	7.0 a

[†] Turfgrass phytotoxicity and color were visually assessed on a 1-9 scale, where 9 = no phytotoxicity or a dark green color.

[‡] Treatments were initially applied on 30 November, 2005, 4 and 26 April, 2006 as specified by the protocol.

* Means in the same column followed by the same letter are not significantly different according to Fisher’s protected LSD (P=0.05).

Table 8. Chemical phytotoxicity and creeping bentgrass color as affected by various applications of Proxy, Primo Maxx and Embark_Lite in a mixed stand of creeping bentgrass ‘Penncross’/annual bluegrass golf course putting green, Purdue University 2006.

Treatment [‡]	Application Timing	Application Rate	Visual ratings [†]						
			Phytotoxicity		Creeping bentgrass color				
			18 Apr.	25 Apr	4 Apr.	25 Apr.	10 May	17 May	23 May
		--/1000 ft ² --	----- (1-9 scale) -----						
Proxy	Fall	5.0 oz	9.0 a*	8.7 a	7.7 a	5.7 a	5.7 a	6.7 a	7.0 a
Proxy	Spring + 3wk	5.0 oz	9.0 a	8.7 a	7.7 a	6.0 a	6.0 a	6.7 a	7.0 a
Proxy	Fall + Spring + 3 wk	5.0 oz	9.0 a	9.0 a	7.7 a	6.0 a	6.0 a	6.0 a	7.0 a
Proxy + Primo Maxx	Spring + 3 wk	5.0 + 0.125 oz	8.7 a	9.0a	8.0 a	6.0 a	5.7 a	6.3 a	7.0 a
Proxy + Primo Maxx	Fall + Spring + 3 wk	5.0 + 0.125 oz	7.8 a	9.0 a	7.7 a	5.7 a	5.7 a	6.3 a	7.0 a
Embark Lite	Spring	40 oz/Acre	8.0 a	8.3 a	7.7 a	6.0 a	6.0 a	6.7 a	7.0 a
Untreated	---	---	8.7 a	8.7 a	8.0 a	6.3 a	6.3 a	6.0 a	7.0 a

[†] Turfgrass phytotoxicity and color were visually assessed on a 1-9 scale, where 9 = no phytotoxicity and a dark green color.

[‡] Treatments were initially applied on 30 November, 2005, 4 and 26 April, 2006 as specified by the protocol.

* Means in the same column followed by the same letter are not significantly different according to Fisher’s protected LSD (P=0.05).