Turfgrass and Environmental Research Online

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Researchers supported by the Chicago District Golf Association tested plant growth regulators and wetting agents for their ability to suppress annual bluegrass seedhead formation on golf courses in the Chicago area. Of the PGRs tested, mefluidide (Embark T&O) provided the strongest and most consistent seedhead suppression over all sites and years. However, significant phytotoxicity on creeping bentgrass in mixed swards was observed, particularly when hard frosts occurred following treatments.

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PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 215 projects at a cost of $21 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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Field Testing Plant Growth Regulators and Wetting Agents for Seedhead Suppression of Annual Bluegrass

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SUMMARY

Superintendents in northern Illinois have been trying to suppress spring flowering of annual bluegrass for many years. Heavy annual bluegrass seeding causes objectionable turf color and reduced aesthetic appeal of turf swards, and reduces putting speed and smoothness of greens in early to mid-spring. Success of season-long annual bluegrass reduction/control programs may be improved by reducing the annual bluegrass "seedbank" in the soil. Three golf course sites were treated with plant growth regulators and wetting agents in April and May of 2000-02, including both green and fairway height turf. Initial treatments were timed to coincide with flowering of the earliest biotypes.

- Of the PGRs tested, mefluidide (Embark T&O) provided the strongest and most consistent seedhead suppression over all sites and years. However, significant phytotoxicity on creeping bentgrass in mixed swards was observed, particularly when hard frosts occurred following treatments.
- Ethephon (Proxy), alone and in tank mixes with trinexepac-ethyl (Primo), provided good to excellent seedhead suppression, but the results were more variable over sites and years. Phytotoxicity from ethephon is less of a concern than with mefluidide, and may be reduced by tankmixing with trinexepac-ethyl.
- Paclobutrazole (Enhancer, Trimmit) and trinexepac-ethyl did not significantly reduce annual bluegrass seeding when applied alone.
- The wetting agent Aqua-Gro L inhibited annual bluegrass seeding to a limited extent in our tests. This formulation of Aqua-Gro is no longer manufactured.

Many of the annual bluegrass (*Poa annua* L.) biotypes inhabiting the golf courses of Illinois have a "winter annual" life cycle. That is, these biotypes germinate from seed in autumn, overwinter in a vegetative state, flower and set seed in the spring, and then decline or completely die-out during the heat of summer.

Where annual bluegrass is a significant component in a turf, profuse seeding may occur in late April through May, which can become objectionable for several reasons. First, profuse seeding can turn an annual bluegrass-contaminated green or fairway almost white in color, prompting questions about the health of the grass. Second, putting greens with significant annual bluegrass populations provide very poor putting surfaces during spring flowering. Seedheads adversely affect ball roll, causing greens to become slower and more "bumpy." Third, heavy seeding of annual bluegrass contributes to the "seedbank" in surface soil and thatch layers, thus promoting the long-term survival and spread of the species.

There is a growing body of evidence that suggests heavy seeding may not be beneficial for the near-term survival of flowering annual bluegrass. Seed production may divert photosynthate away from vegetative tissues (leaves + roots) to the flowers, resulting in reduced root depth and shoot growth after seeding. Annual bluegrass that hasn't set seed (e.g. in treated plots) is usually better able to survive summer stresses than plants that have flowered and set seed (2). It is interesting to note that most of the plants identified as "perennial biotypes" of annual bluegrass produce less seed than "annual biotypes," which may con-

Three golf courses in the Chicago area provided the testing grounds to compare chemical control of annual bluegrass seedhead formation.

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TRADE NAME	COMMON NAME	PGR MODE OF ACTION
'MH' or SlowGro	maleic hydrazide	Type I cell division
Endothal	endothall	Type I cell division
Embark	mefluidide	Type I cell division
Prograss	ethofumesate	Type I (?)
Enhancer, Trimmit	paclobutrazole	Type II GA inhibitor
Cutless	flurprimidol	Type II GA inhibitor
Primo	trinexepac-ethyl	Type II GA inhibitor
Proxy	ethephon	ethylene effects
Aqua-Gro L	NA (wetting agent)	Unknown

Table 1. Chemicals that have been used for annual bluegrass (*Poa annua* L.) seedhead suppression.

tribute to their longer term, perennial habit.

Chemical seedhead suppression can help maintain the color and playability of fairways, as well as the speed and trueness of putting greens. Also, many superintendents feel that by reducing seed set and the annual contributions to the seedbank, other chemical and management programs used to reduce or eliminate annual bluegrass from cool season turfs may become more effective. There is also a great deal of interest in trying to preserve the purity of newly renovated turf by keeping nearby annual bluegrass from contaminating the renovated site (e.g. a resurfaced putting green).

Techniques to Inhibit Annual Bluegrass Flowering

How do you reduce or suppress annual bluegrass seed set in spring? Several herbicides and plant growth regulators are known to inhibit seeding of *Poa* species and other grasses, including older products like maleic hydrazide, mefluidide, and endothall, (see Table 1). However, most products used in annual bluegrass programs have problems with consistency of seedhead suppression, length of time seedheads are suppressed, or phytotoxicity. Also, application timing and stage of plant growth is critical for best seed inhibition, and calendar dates for application may vary widely from year to year. Note that there is a 'base-50' growing-degree-day prediction model for timing of the first spray for seedhead suppression (3), but this model seems to be as unpredictable as the annual bluegrass itself (Table 2).

Historically, the best results for seedhead suppression on annual bluegrass fairways have been found using mefluidide ('Embark') (1, 5). However, timing and phytotoxicity problems have limited its use, especially on greens-height turf. Many superintendents have tried early spring applications of gibberellin inhibitor plant growth regulators (PGRs) such as paclobutrazole

YEAR	Date that GDD50 >= 50	1st Visible Flowering
2002	April 15	Apr 24-28
2001	April 12	Apr 27-29
2000	Apr 7 or Apr 24	May 3-7
1999	April 4	April 15

Table 2. Comparison of base-50 growing degree day (GDD) annual bluegrass model to first visible flowering over the last four years.

Product	# of apps	Rate/1000 ft^2	% Seedhead Suppression		
			May 10	May 24	June 1
Aqua-Gro L	3	8,4,4 fl oz	55	50	25
Cascade	2	4 fl oz	25	0	20
Trimmit	2	0.18 fl oz	0	0	0
Primo	2	0.125 - 0.25 fl oz	0	15	0
Proxy	1-2	5 - 7.5 fl oz	80	85	80
Proxy+Primo	1-2	5 + .125 fl oz	80	85	80
Embark T&O	1	1.3 fl oz	90	95	80

Table 3. General overview of percent annual bluegrass seedhead suppression by PGRs and wetting agents for tests conducted in the Chicago suburbs (2000-01). Data show percent reduction in seedheads compared to untreated plots.

('Trimmit') or flurprimidol ('Cutless') to try to slow the encroachment of annual bluegrass into bentgrass turf. They reported some seedhead suppression following early season treatments, but seedhead suppression usually is not the primary goal of these applications.

A few adventurous superintendents have also used the wetting agent Aqua-Gro L (5) to limit spring flowering of annual bluegrass, and have found that Aqua-Gro is less phytotoxic than Embark, but provides more variable results. (Note that Aqua-Gro L is no longer manufactured.)

Preliminary field tests have suggested that ethephon ('Proxy') has good activity for annual bluegrass seedhead suppression (4). Proxy is a "new" PGR for the turf market, but has been available in agriculture applications for years. Proxy may be safer and have more timing flexibility than Embark, and could be a potential substitute for Aqua-Gro L. Proxy reportedly has the tendency to make treated turf lighter green to yellow-green, but this can be counteracted to some extent with applications of iron. Also, tank-mixes of Proxy plus trinexepac-ethyl (Primo) have shown good results with less turf discoloration.

Products Tested and Application Techniques

Three golf course sites were treated with PGRs and wetting agents in April and May of 2000-02, including both green and fairway height turf. Initial treatments were timed to coincide with flowering of the earliest annual bluegrass biotypes. Individual plots were 40-50 ft^2 feet in size and were replicated two or three times depending on space available. Treatments were sprayed with a CO_2-powered backpack sprayer (35 psi, flat fan nozzles).

Proxy was tested alone and in tank mixes with Primo and Trimmit. Single and multiple applications of Proxy were made at 5-7.5 fl oz per 1000 ft^2 rates. Primo was applied alone and in in tank mixes at 5-10 fl oz per acre. Trimmit was applied at rates ranging from 6-8 fl oz per acre. Aqua-Gro L has been tested for a number of years on putting greens at 8 fl oz per 1000 ft^2, usually with follow-up applications at 4-8 fl oz per 1000 ft^2 one week later.

The wetting agent Cascade was also included in the study to see if a different type of wetting agent chemistry could inhibit seedheads (note that the manufacturer makes no claims of seedhead control). Embark (Turf & Ornamental Growth Regulator formulation) at 1.3 fl oz per 1000 ft^2 was included as a standard, and to test for phytosafety on greens-height turf.

Summary of Results from Early Studies

A general overview of field test data from Chicago area trials in 2000-01 on greens-height turf can be found in Table 3. Note that the percent seedhead inhibition is an average of several tests, and results can vary greatly with weather conditions, application timing, and annual bluegrass

Product	Rate/1000 ft^2	% Seedhead Suppression			
		App. Date	May 10	May 24	June 1
Proxy	5 fl oz	Apr 18	75	56	40
Proxy	5 fl oz	Apr 24	8	44	48
Proxy + Primo	5 + .125 fl oz	Apr 18	83	74	52
Proxy + Primo	5 + .125 fl oz	Apr 24	33	78	68
Proxy + Trimmit	5 + .14 fl oz	Apr 18	42	70	68
Proxy + Trimmit	5 + .14 fl oz	Apr 24	16	74	40

Table 4. Percent of annual bluegrass seedhead suppression on putting green turf by Proxy alone and in tank mixes with anti-gibberellin PGRs (2002 studies). Data show percent reduction in seedheads compared to untreated plots.

biotypes present in treated areas. Embark is consistently the best flower suppressor, but phytotoxicity (primarily on creeping bentgrass) remains a major concern in northern Illinois. Phytotoxicity of Embark treatments was expressed as a dark blue-green to brown color, with some thinning of the stand. Once warmer weather arrived, turf color and density recovered.

Proxy and Proxy + Primo treatments provided seedhead suppression approaching that of Embark in our trials in 2000 and 2001. In some cases, suppression with split applications of Proxy

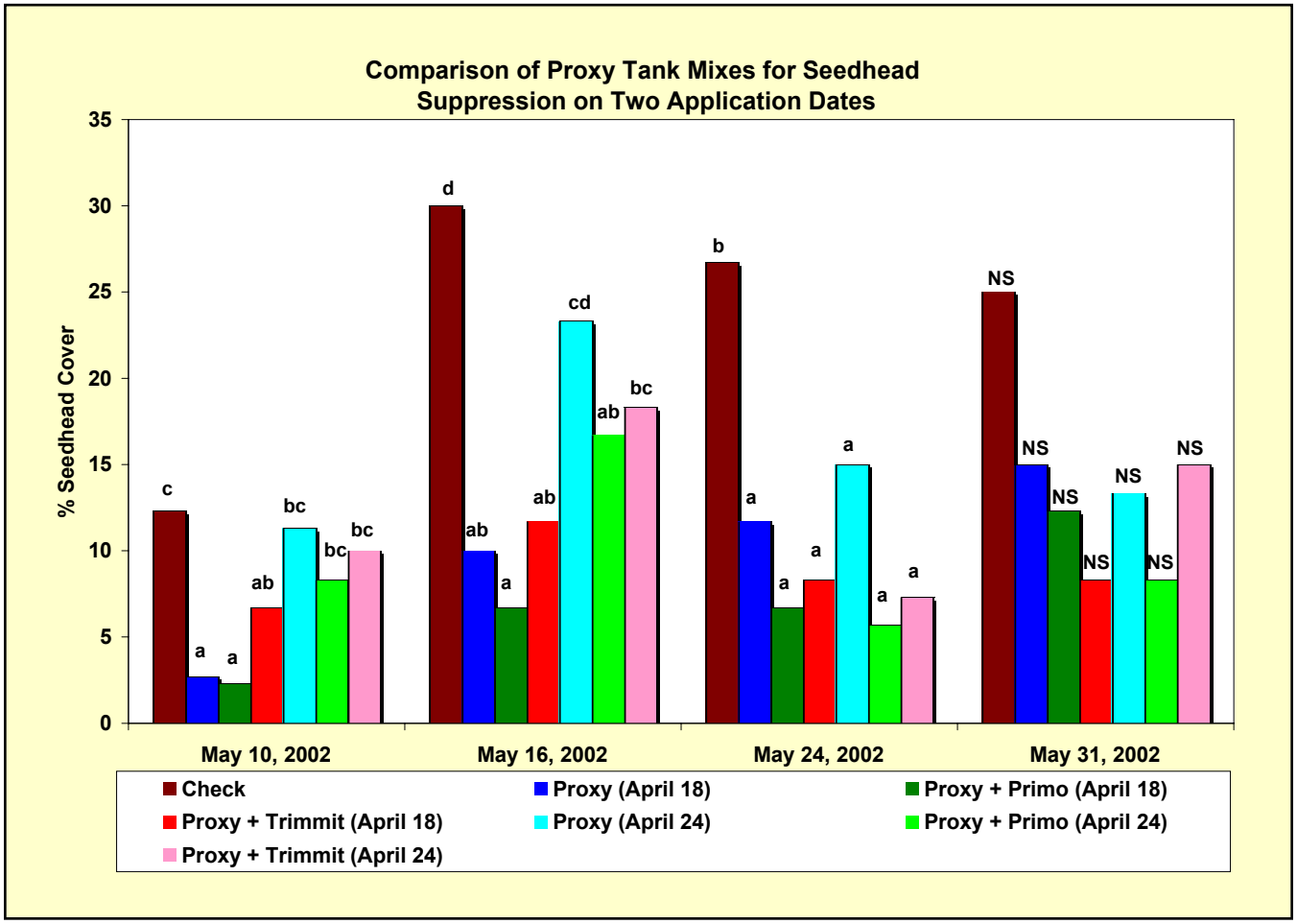


Figure 1. Percent of annual bluegrass seedhead cover on putting green turf by Proxy alone and in tank mixes with anti-gibberellin PGRs (2002 studies). Data show percent reduction in seedheads compared to untreated plots.

Product	Rate/1000 ft^2	% Seedhead Suppression				
		May 10	May 16	May 24	May 31	June 7
Proxy	5 fl oz	52	59	89	48	54
Proxy + Primo	5 + .25 fl oz	59	75	80	20	31
Proxy + Primo	7.5 + .25 fl oz	73	78	89	88	92
Proxy + Trimmit	5 + .28 fl oz	32	38	33	40	0

Table 5. Percent annual bluegrass seedhead suppression on fairway turf - 2002. Application date for all treatments was April 23, 2002. Data show percent reduction in seedheads compared to untreated plots.

lasted longer than single Embark applications. However, higher rates or repeat applications of Proxy caused yellowing and thinning of treated turf, especially at greens- height. Note that repeat Proxy applications were made only 7 to 10 days apart; less discoloration has been observed in other tests if the interval between applications is 28-35 days (4). Tank mixing Proxy with Primo appeared to reduce the discoloration and thinning of turf, although further testing will be required to confirm the effect.

Of the other products/rates tested, only Aqua-Gro L exhibited significant seedhead suppression, and the effect was short-lived and inconsistent from site to site and season to season. The anti-gibberellin growth regulators Primo and Trimmit did not appear to inhibit seedhead formation, and in some situations, these treatments appeared to have more seedheads than check plots. This effect could be due to stunting of the seed stalk to the point where the seedheads remained below the cutting height and were not removed by mowing.

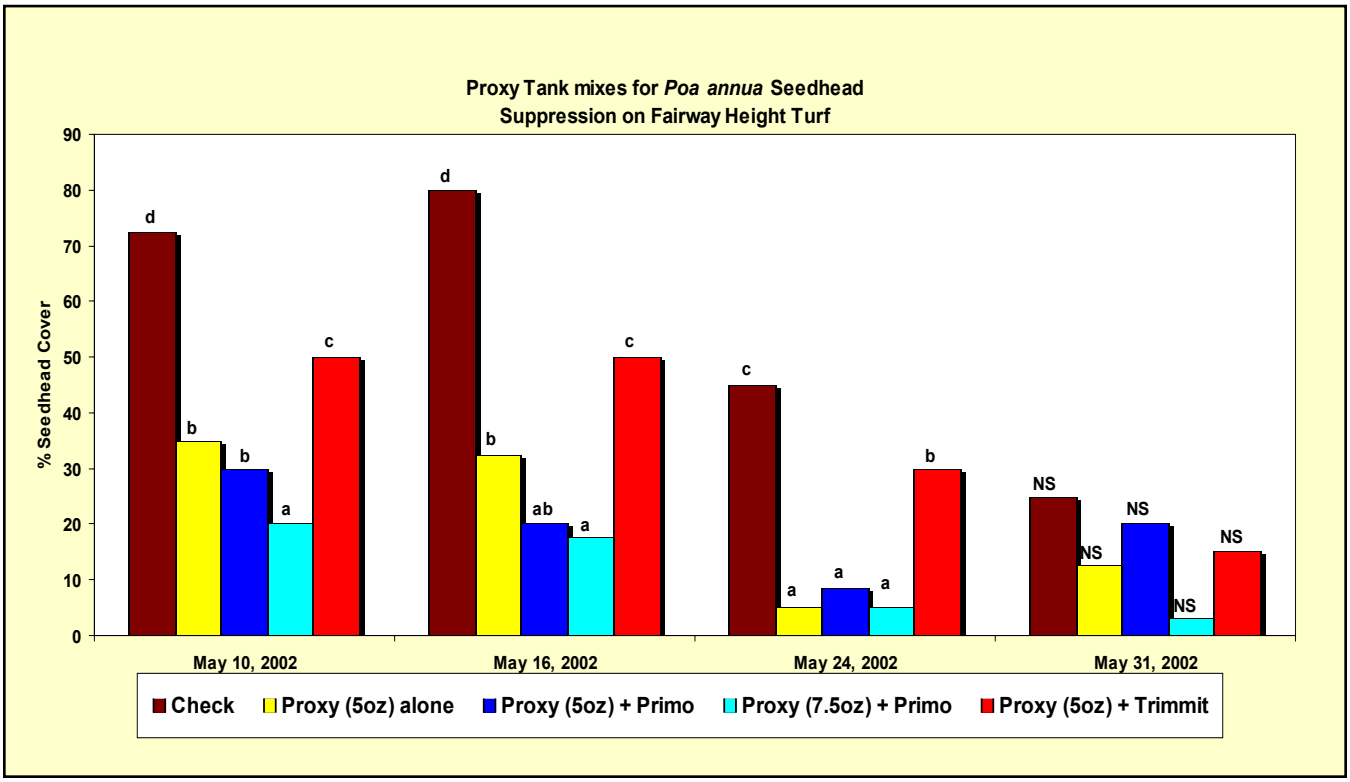
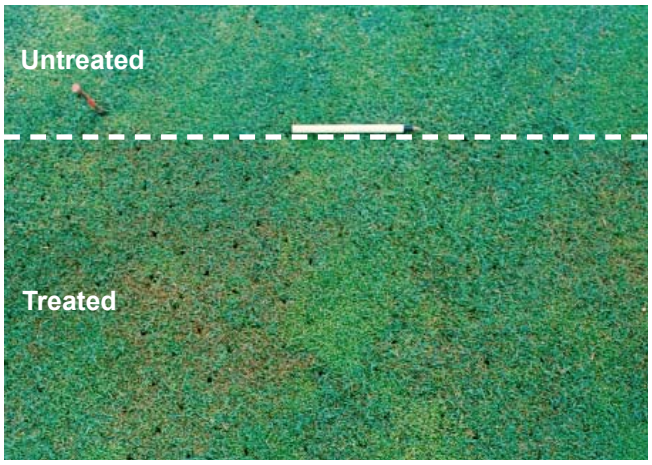


Figure 2. Percent annual bluegrass seedhead cover on fairway turf - 2002. Application date for all treatments was April 23, 2002. Data show percent reduction in seedheads compared to untreated plots.



Embark T&O can cause discoloration and thinning of greens height creeping bentgrass.

Observations from 2002 Studies

For 2002 greens-height trials, we concentrated on Proxy alone or in tank mixes with Primo or Trimmit (Table 4 and Figure 1). We also began a second set of treatments a week later to see if a later application is as effective as a "well-targeted" first application. You can see that the Proxy and Proxy+ tank mixes did not perform as well as in the previous two years. On certain rating dates, the level of seedhead suppression was hovering around 50 percent, with the best levels around 70% suppression. Previous tests were around 90% suppression. Variability in seedhead suppression with PGRs is common (3, 5), and may be due to differing weather and application timing parameters, as well as due to the inherent variability of annual bluegrass biotypes. Proxy treatments applied a week later than the supposed target date still performed well once the time lag was taken into account.

Finally, we took a look at some Proxy tank mixes sprayed on a mixed annual bluegrass / creeping bentgrass fairway (Table 5 and Figure 2). Taking the Proxy rate up to 7.5 fl oz per 1000 ft^2 improved the seedhead suppression, and no noticeable phytotoxicity was observed at this rate when tank mixed with Primo at 10 fl oz per acre. Proxy does not have a separate label rate for fairway treatments or a recommended rate for putting greens on the 2002 pesticide label. It is likely that some broader uses and application rates will appear on future labels.

Conclusions After Three Years of Testing

After three years of testing products for annual bluegrass seedhead suppression, some conclusion can be reached.

- Seedhead production in annual bluegrass is detrimental for various reasons, including poor playability, aesthetics, and reduced plant vigor.
- The most consistent seedhead suppression follows treatments with mefluidide or ethephon, although both chemicals have limitations regarding application timing or possible phytotoxicity.
- Embark can cause discoloration and thinning of bentgrass following cold weather, but remains the best product for seedhead suppression, especially on fairways where some phytotoxicity is tolerable.
- Proxy can be nearly as effective as Embark for seedhead suppression, but results are variable from year to year and from site to site.
- Proxy can cause some objectionable color and growth effects, but tank mixes with Primo or other PGRs may alleviate some of these problems.
- If Proxy (+Primo) applications are made early in spring, a follow-up application 4-5 weeks after the first may be beneficial to maintain the seedhead suppression into June.
- Wetting agents gave inconsistent results, and were approximately 50% as effective as mefluidide or ethephon, at best, .
- Anti-gibberellin PGRs such as paclobutrazole and trinexepac-ethyl did not significantly reduce seedheads in our studies.
- Seedhead suppression can be highly variable from year to year or site to site because of weather fluctuations, application timing, and annual bluegrass variability.

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